Effects of pantothenic acid on growth performance and carcass characteristics of growing-finishing pigs fed diets with or without ractopamine hydrochloride[1]

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ABSTRACT: Two experiments evaluated effects of added pantothenic acid on performance of growing-finishing pigs. In Exp. 1, 156 pigs (PIC, initial BW = 25.7 kg) were used in a 3 × 2 × 2 factorial to evaluate the effects of added pantothenic acid (PA; 0, 22.5, or 45 ppm), ractopamine·HCl (RAC; 0 or 10 mg/kg), and sex on growth performance and carcass traits. Pigs were fed increasing PA from 25.7 to 123.6 kg (d 0 to 98) and RAC for the last 28 d before slaughter. Increasing the amount of added PA had no effect ($P > 0.40$) on ADG, ADFI, or G:F from d 0 to 70. A PA × sex interaction ($P < 0.03$) was observed for ADG and G:F from d 71 to 98. Increasing the amount of added PA increased ADG and G:F in gilts, but not in barrows. Increasing the amount of added PA had no effect ($P > 0.38$) on carcass traits. Added RAC increased ($P < 0.01$) ADG and G:F for d 71 to 98 and d 0 to 98 and increased ($P < 0.01$) LM area and percentage lean. In Exp. 2, 1,080 pigs (PIC, initial BW = 40.4 kg, final BW = 123.6 kg) were used to determine the effects of increasing PA on growth performance and carcass characteristics of growing-finishing pigs reared in a commercial finishing facility. Pigs were fed 0, 22.5, 45.0, or 90 mg/kg of added PA. Increasing the amount of added PA had no effect ($P > 0.45$) on ADG, ADFI, or G:F, and no differences were observed ($P > 0.07$) for carcass traits. In summary, adding dietary PA to diets during the growing-finishing phase did not provide any advantages in growth performance or carcass composition of growing-finishing pigs. Furthermore, it appears that the pantothenic acid in corn and soybean meal may be sufficient to meet the requirements of 25- to 120-kg pigs.

Key words: growth, pantothenic acid, pig, ractopamine hydrochloride, vitamin

J. Anim. Sci. 2007. 85:2492–2497
doi:10.2527/jas.2005-550

INTRODUCTION

Pantothenic acid is active in oxidation and acetylation reactions, the citric acid cycle, fatty acid synthesis, and cholesterol synthesis in the form of coenzyme A and the acyl carrier protein. These processes are essential to maximize BW gain and efficiency. Growing-finishing pigs have a pantothenic acid requirement of 6.0 to 10.5 ppm (NRC, 1998), and a common corn-soybean meal diet will supply between 8.0 and 10.0 mg/kg of pantothenic acid to the pig. Pantothenic acid in corn and soybean meal has approximately 100% bioavailability to the pig (Southern and Baker, 1981). There is evidence that increasing pantothenic acid may improve carcass leanness in pigs. Stahly and Lutz (2001) observed that increasing dietary pantothenic acid (0 to 120 mg/kg) reduced subcutaneous fat thickness and increased LM area. Carcass lean content was increased by >1% for pigs fed 45 mg/kg of pantothenic acid. Radcliffe et al. (2003) showed no improvement in LM area and only a numerical decrease in 10th rib fat depth in pigs fed added pantothenic acid.

Feeding ractopamine·HCl has consistently increased ADG and G:F in finishing pigs when dietary lysine is increased to at least 0.85% true ileal digestible lysine (Sutton et al., 2001; Webster et al., 2002; Kelly et al., 2003). In addition to an increased lysine requirement, the increase in ADG and G:F associated with ractopamine·HCl feeding may increase the need for other dietary nutrients, such as vitamins.

Therefore, the objective of our studies was to further evaluate the effects of increasing pantothenic acid intake on pig growth performance and carcass composi-

[1]Contribution No. 06-5-J from the Kansas Agric. Exp. Stn., Manhattan.
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Received September 26, 2005.
Accepted June 4, 2007.

Table 1. Pantothenic acid analysis of the experimental diets (as-fed basis)[1]

	Pantothenic acid, mg/kg			
Item	0.0	22.5	45.0	90.0
Exp. 1				
Phase 1	7.9	17.0	44.5	—
Phase 2	9.5	36.5	43.1	—
Phase 3	6.8	17.5	48.7	—
Phase 4	6.5	36.0	45.0	—
Exp. 2				
Phase 1	10.7	38.5	54.2	82.7
Phase 2	6.2	24.3	42.5	143.4
Phase 3	8.9	16.6	50.6	118.1
Phase 4	9.8	17.2	51.2	74.1

[1]Dietary treatments were fed in 4 phases, d 0 to 28, 29 to 56, 57 to 70, and 71 to 98, respectively; in both experiments, diet samples were analyzed for pantothenic acid (AOAC, 1995; NP Analytical Laboratories, St. Louis, MO).

tion and to determine the interactive effects of ractopamine·HCl and pantothenic acid in growing-finishing pigs.

MATERIALS AND METHODS

The Kansas State University Animal Care and Use Committee approved all experimental protocols used in these experiments.

In both experiments, diet samples were collected and analyzed for pantothenic acid, [Table 1; NP Analytical Laboratories, St. Louis, MO (AOAC, 1995)]. The observed values of pantothenic acid in the corn-soybean meal diets were consistent with formulated values and provided the expected pantothenic acid treatment levels. Before the start of each experiment all pigs were fed diets containing 22.5 mg/kg of added pantothenic acid for approximately 4 wk.

Exp. 1

A total of 156 pigs (PIC 337 × C22, Franklin, KY) with initial BW of 25.7 ± 2.6 kg were used. Pigs were blocked by BW and sex and were randomly allotted to 1 of 6 dietary treatments. There were 42 pens of barrows and 36 pens of gilts, with 2 pigs per pen and 13 pens (7 pens of barrows and 6 pens of gilts) per treatment. Pen was used as the experimental unit. Pigs had ad libitum access to feed and water. Pigs were housed on totally slatted concrete floors in 1.33 × 1.33-m pens. Pigs were fed the experimental corn-soybean meal-based diets in meal form during 4 phases (Table 2). Dietary treatments consisted of a control diet (no added pantothenic acid), or the control diet with 22.5 or 45.0 mg/kg of added pantothenic acid from D-calcium pantothenate (Hoffmann-LaRoche Ltd., Nutley, NJ). Ractopamine·HCl (**RAC**; 0 or 10 ppm; Elanco Animal Health, Indianapolis, IN) was fed the last 28 d before slaughter. Dietary treatments were fed from d 0 to market BW (25.7 to 121.6 kg). All diets contained 0.15% L-lysine·HCl. The vitamin premix contained no pantothenic acid and was formulated to approximately 300% of NRC (1998) estimates for other vitamins. A pantothenic acid premix was prepared with D-calcium pantothenate, cornstarch, and corn to equal 2.92 kg. Corn added to the premix was subtracted from the bulk ingredient addition. The pantothenic acid premix was added to the diet during the microingredient addition.

Table 2. Ingredient and chemical composition of diets (Exp. 1; as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn	67.41	72.74	78.12	74.49
Soybean meal, 46.5% CP	30.03	24.60	19.17	22.80
Monocalcium phosphate, 21% P	0.75	0.85	0.90	0.85
Limestone	1.00	1.00	1.00	1.00
Salt	0.35	0.35	0.35	0.35
Vitamin premix[2]	0.15	0.15	0.15	0.15
Trace mineral premix[3]	0.15	0.15	0.15	0.15
Cornstarch[4]	0.01	0.01	0.01	0.06
L-Lysine·HCl	0.15	0.15	0.15	0.15
	100.00	100.00	100.00	100.00
Calculated analysis				
Total lysine, %	1.20	1.05	0.90	1.00
ME, kcal/kg	3,327	3,327	3,327	3,325
CP, %	19.7	17.6	15.6	16.9
Ca, %	0.64	0.64	0.64	0.64
P, %	0.55	0.55	0.54	0.54
Available P, %	0.23	0.25	0.25	0.24

[1]The dietary treatments were fed in 4 phases, d 0 to 28, 29 to 56, 57 to 70, and 71 to 98, respectively. The analyzed pantothenic acid content is presented in Table 1.

[2]Provided (per kilogram of diet): 11,025 IU of vitamin A, 1,654 IU of vitamin D_3, 44 IU of vitamin E, 4.4 mg of vitamin K (as menadione sodium bisulfate), 55.1 mg of niacin, 9.9 mg of riboflavin, and 0.044 mg of B_{12}.

[3]Provided (per kilogram of the diet): 39.7 mg of Mn (oxide), 165.4 mg of Fe (sulfate), 165 mg of Zn (oxide), 16.5 mg of Cu (sulfate), 0.30 mg of I (as Ca iodate), and 0.30 mg of Se (as Na selenite).

[4]Cornstarch was replaced with D-calcium pantothenate, resulting in 3 dietary treatments (0.0, 22.5, and 45.0 added pantothenic acid). Ractopamine·HCl replaced cornstarch in phase 4 to provide 10 ppm in the diet.

Pigs and feeders were weighed every 14 d to calculate ADG, ADFI, and G:F. Dietary phase changes occurred on weigh days. The intermediate treatment responses were not different from the periods reported; therefore, these data are not shown. At the conclusion of the growth study, all pigs in each pen were tattooed to maintain individual pig identity and transported to a commercial packing facility (R. C. Pork, Downs, KS). Hot carcass weight was measured at the packing facility. Carcasses were chilled for 6 h, and then backfat was measured with a ruler at the first and last rib and last lumbar vertebrae. The LM area and tenth-rib backfat were traced using acetate paper and measured on the left side of all carcasses.

Exp. 2

A total of 1,080 pigs (PIC 337 × 1050) with initial BW 40.4 ± 2.3 kg were used to evaluate the effects of

Table 3. Ingredient and chemical composition of diets (Exp. 2; as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn[2]	61.62	67.22	72.74	81.53
Soybean meal, 46.5%	30.53	25.08	19.63	15.57
Choice white grease	5.00	5.00	5.00	—
Monocalcium phosphate, 21% P	1.05	0.90	0.83	1.10
Limestone	1.00	1.00	1.00	1.00
Salt	0.35	0.35	0.35	0.35
Vitamin premix[3]	0.15	0.15	0.15	0.15
Trace mineral premix[4]	0.15	0.15	0.15	0.15
L-Lysine HCl	0.15	0.15	0.15	0.15
	100.00	100.00	100.00	100.00
Calculated analysis				
Total lysine, %	1.20	1.05	0.90	0.80
ME, kcal/kg	3,545	3,552	3,557	3,322
CP, %	19.4	17.4	15.3	14.2
Ca, %	0.70	0.65	0.62	0.66
P, %	0.60	0.55	0.51	0.57
Available P, %	0.29	0.26	0.23	0.29

[1]The dietary treatments were fed in 4 phases, d 0 to 28, 29 to 56, 57 to 70, and 71 to 98, respectively. Analyzed pantothenic acid content is presented in Table 1.

[2]Corn was replaced with D-calcium pantothenate, resulting in 4 dietary treatments (0, 22.5, 45, and 90 mg/kg added pantothenic acid).

[3]Provided (per kilogram of diet): 6,600 IU of vitamin A; 990 IU of vitamin D_3; 26 IU of vitamin E; 2.65 mg of vitamin K (as menadione sodium bisulfate); 33 mg of niacin; 6 mg of riboflavin; and 0.026 mg of B_{12}.

[4]Provided (per kilogram of the diet): 40 mg of Mn (oxide); 165 mg of Fe (sulfate); 165 mg of Zn (oxide); 17 mg of Cu (sulfate); 0.30 mg of I (as Ca iodate); and 0.30 mg of Se (as Na selenite).

pantothenic acid on growing-finishing pigs reared on a commercial research site. There were 16 pens of gilts and 24 pens of barrows. The 27 pigs per pen were blocked by average initial pen weight and randomly allotted to 1 of 4 dietary treatments with 10 pens per treatment. Pigs had ad libitum access to feed and water. Pigs were housed on totally slatted concrete floors in 3.33 × 6-m pens. Pigs were fed, in meal form, the experimental corn-soybean meal, added fat diets in 4 phases (Table 3). Dietary treatments consisted of a control diet (no added pantothenic acid) or the control diet with 22.5, 45.0, or 90.0 mg/kg of added pantothenic acid from D-calcium pantothenate. Dietary treatments were fed from d 0 to 98 (40.4 to 123.6 kg of BW). The first 3 dietary phases contained 5% choice white grease, and all diets contained 0.15% L-lysine·HCl, trace mineral premix, and a standard vitamin premix manufactured with no pantothenic acid. Pantothenic acid was added at amounts indicated by dietary treatment. Before manufacturing the diets, a pantothenic premix was prepared with D-calcium pantothenate and corn to equal 2.92 kg. Corn added to the premix was subtracted from the bulk ingredient addition. The pantothenic acid premix was added to the diet during the microingredient addition.

Pigs were weighed and feed disappearance was measured every 14 d to calculate ADG, ADFI, and G:F. Dietary phase changes occurred on weigh days. At the conclusion of the growth study, all pigs in each pen were tattooed to maintain pen identity and transported to a commercial packing facility (Swift, Worthington, MN), where the carcass measurements were obtained from the packing facility. Individual pig data was received for HCW, average backfat, LM depth, and fat-free lean index.

Statistical Analyses

Analysis was performed using the MIXED procedure (SAS Inst. Inc., Cary, NC). Pigs were blocked by BW and sex in Exp. 1 and 2. Data from Exp. 1 were analyzed as a 3 × 2 × 2 factorial arrangement, with main effects of pantothenic acid, RAC, and sex in a randomized complete block design. Experiment 2 was analyzed as a 4 × 2 factorial arrangement with main effects of pantothenic acid and sex in a randomized complete block design. All interactions were evaluated. Contrasts for linear and quadratic effects of increasing pantothenic acid were also included in the analysis.

RESULTS

Exp. 1

From d 0 to 70, increasing added pantothenic acid had no effect on ADG, ADFI, or G:F ($P > 0.40$; Table 4). Increasing added pantothenic acid had no effect ($P > 0.26$) on d 0 to 98 ADG, ADFI, G:F, and final BW. When RAC was fed (d 71 to 98) there was no pantothenic acid × RAC × sex or pantothenic acid × RAC interactions observed ($P > 0.16$). Adding RAC increased ($P < 0.01$) ADG and improved ($P < 0.01$) G:F from d 71 to 98 and for the overall feeding period. Pigs fed the RAC had a greater ($P < 0.01$) final BW than pigs fed diets containing no RAC.

A pantothenic acid × sex interaction ($P < 0.03$) was observed for d 71 to 98 ADG and G:F as well as d 0 to 98 G:F (Table 5). Increasing added pantothenic acid increased ($P < 0.05$) ADG and G:F in gilts, but not in barrows. The interaction response observed from d 71 to 98 was similar for overall (d 0 to 98) G:F. As expected, barrows had a greater ADG ($P < 0.01$) and ADFI ($P < 0.01$) than gilts.

There were no pantothenic acid × RAC ($P > 0.13$) or RAC × sex interactions observed for carcass traits (Table 6). Increasing added pantothenic acid had no effect ($P > 0.38$) on carcass traits. Adding RAC increased ($P < 0.01$) LM area and percentage lean and decreased ($P < 0.01$) 10th-rib and last-lumbar fat depth. As expected, gilts had greater ($P < 0.01$) dressing percent and percentage lean than barrows (data not shown). Gilts also had a lower ($P < 0.01$) average backfat and a tendency toward having a smaller ($P = 0.06$) LM area than barrows.

Table 4. Effects of increasing dietary pantothenic acid (PA) on growth performance of finishing pigs fed ractopamine·HCl, (RAC), Exp. 1 (as-fed basis)[1]

	RAC, mg/kg										
	0.0			10.0							
	Added PA, mg/kg							*P*-value			
Item	0.0	22.5	45.0	0.0	22.5	45.0	SEM	PA	RAC	Sex	PA × sex
d 0 to 70											
Initial wt, kg	25.7	25.7	25.7	—	—	—	0.77	0.69	—	0.57	0.18
ADG, kg	0.96	0.96	0.95	—	—	—	0.01	0.43	—	0.01	0.79
ADFI, kg	2.34	2.32	2.29	—	—	—	0.04	0.41	—	0.01	0.45
G:F	0.41	0.41	0.42	—	—	—	0.01	0.79	—	0.68	0.22
d 71 to 98											
D 70 wt, kg	94.5	93.1	92.6	92.3	92.7	91.3	1.38	0.29	0.09	0.01	0.85
ADG, kg	0.93	0.93	0.94	1.11	1.10	1.13	0.04	0.74	0.01	0.25	0.01
ADFI, kg	2.97	2.92	2.84	2.93	2.80	2.96	0.07	0.50	0.82	0.01	0.24
G:F	0.31	0.33	0.35	0.38	0.38	0.37	0.01	0.20	0.01	0.14	0.03
d 0 to 98											
Final wt, kg	120.1	119.2	119.0	123.3	123.7	122.9	1.79	0.84	0.01	0.01	0.14
ADG, kg	0.96	0.95	0.95	0.99	1.00	0.99	0.01	0.93	0.01	0.001	0.21
ADFI, kg	2.55	2.51	2.47	2.47	2.45	2.46	0.05	0.49	0.13	0.01	0.72
G:F	0.38	0.38	0.39	0.40	0.41	0.41	0.01	0.26	0.01	0.66	0.02

[1]A total of 156 pigs (PIC, initial BW = 25.7 ± 2.6 kg) were used in the experiment. The values represent 2 pigs per pen and 13 pens per treatment.

Exp. 2

There were no pantothenic acid × sex interactions observed ($P > 0.10$), and there were no differences in ADG, ADFI, or G:F with increasing added pantothenic acid ($P > 0.45$; Table 7). Barrows had greater ADG ($P < 0.01$) and ADFI ($P < 0.01$) than gilts (data not shown).

Dressing percent, HCW, average backfat, fat-free lean index, and LM depth were measured at a commercial packing facility (Table 7). There were no effects ($P > 0.15$) on carcass traits with increasing added pantothenic acid, but there was a tendency ($P = 0.08$) toward a quadratic effect on dressing percent and HCW. Dressing percent decreased numerically through 22.5 mg/kg of added pantothenic acid, and HCW decreased numerically through 45.0 mg/kg of added pantothenic acid. Gilts had less ($P < 0.01$) backfat and a greater ($P < 0.01$) fat-free lean index than barrows (data not shown). Gilts had a decreased ($P < 0.01$) average backfat compared with barrows. There were no sex differences observed in dressing percent or LM depth.

Table 5. Effects of increasing dietary pantothenic acid (PA) on growth performance of finishing pigs fed ractopamine·HCl (RAC), Exp. 1 (as-fed basis)[1]

	Sex							
	Barrow				Gilt			
	Added PA, mg/kg							
Item	0.0	22.5	45.0	SE	0.0	22.5	45.0	SEM
d 0 to 70								
ADG, kg	1.00	1.01	0.99	0.01	0.92	0.91	0.91	0.02
ADFI, kg	2.40	2.42	2.40	0.05	2.28	2.22	2.18	0.06
G:F	0.42	0.42	0.41	0.01	0.40	0.41	0.42	0.01
d 71 to 98								
ADG,[2] kg	1.09	1.02	1.03	0.03	0.94	1.01	1.04	0.04
ADFI, kg	3.12	2.92	3.04	0.07	2.77	2.80	2.76	0.08
G:F[2]	0.35	0.35	0.34	0.01	0.34	0.36	0.38	0.01
d 0 to 98								
ADG, kg	1.02	1.01	1.00	0.01	0.93	0.94	0.95	0.02
ADFI, kg	2.60	2.57	2.58	0.05	2.42	2.39	2.34	0.06
G:F[2]	0.39	0.40	0.39	0.01	0.38	0.40	0.41	0.01

[1]A total of 156 pigs (PIC, initial BW = 25.7 ± 2.6 kg) were used in the experiment. The values represent 2 pigs per pen and 13 pens per treatment.

[2]Added PA × sex interaction, $P < 0.05$.

DISCUSSION

The NRC (1998) estimates that growing-finishing pigs have a pantothenic acid requirement of 6.0 to 10.5 mg/kg. A corn-soybean meal diet will typically supply between 8.0 and 10.0 mg/kg of pantothenic acid. Furthermore, the pantothenic acid in corn and soybean is estimated to be 100% bioavailable (Southern and Baker, 1981). The pantothenic acid in wheat and sorghum is approximately 60% bioavailable, and therefore, diets containing these ingredients may need supplemental pantothenic acid to meet the requirement estimate (Southern and Baker, 1981). In a survey of commercial feed manufacturers (BASF, 2000), most swine growing-finishing diets contain approximately 20 mg/kg of added pantothenic acid from D-calcium pantothenate, the most common form added to vitamin premixes. The D-calcium pantothenate has an availability of 92% (Baker, 2001). In the United States, it is not uncommon to see a wide margin of safety added to diets in excess of NRC (1998) estimates.

Table 6. Effects of increasing dietary pantothenic acid (PA) on growth performance of finishing pigs fed ractopamine•HCl (RAC), Exp. 1[1,2]

	RAC, mg/kg										
	0.0			10.0							
	Added PA, mg/kg							*P*-value			
Item	0.0	22.5	45.0	0.0	22.5	45.0	SEM	PA	RAC	Sex	PA × sex
Dressing percent	74.86	75.93	76.13	74.11	73.06	74.35	1.50	0.79	0.09	0.01	0.09
HCW, kg	89.18	90.04	90.80	89.72	91.12	89.00	1.32	0.75	0.53	0.66	0.53
Backfat measurement, mm											
Avg. backfat[3]	27.33	27.26	26.78	27.07	27.09	27.03	0.77	0.90	0.92	0.01	0.23
Percentage lean,[3,4] %	56.96	57.49	57.67	60.05	59.33	59.27	0.50	0.98	0.01	0.01	0.26
LM area,[3] cm	52.21	52.63	53.74	58.76	58.01	57.79	1.25	0.93	0.01	0.06	0.68

[1]A total of 156 pigs (PIC, initial BW = 25.7 ± 2.6 kg) were used in the experiment. The values represent 2 pigs per pen and 13 pens per treatment.
[2]There were no PA × RAC × sex, PA × sex, or RAC × PA interactions observed ($P > 0.05$).
[3]Hot carcass weight was used as a covariate.
[4]Percentage lean was calculated using the following equation: [7.231 + (0.437 × HCW) − (18.746 × 10th rib backfat) + (3.877 × LM area)]/Hot carcass wt.

Pantothenic acid is one of the major B vitamins responsible for several metabolic functions, most notably a structural component of coenzyme A. Stahly and Lutz (2001) and Autry et al. (2002) observed that supplementing pig diets with 30 to 45 mg/kg of pantothenic acid reduced backfat thickness and increased fat-free lean and LM area. In addition, feeding RAC has consistently increased ADG and G:F in finishing pigs when dietary lysine is increased to at least 0.85% true ileal digestible lysine (Sutton et al., 2001; Webster et al., 2002; Kelly et al., 2003). We hypothesized that the increased growth and lean tissue deposition in association with feeding ractopamine HCl might further increase the demand for vitamin supplementation. These findings were the justification of our studies to evaluate the effects of increasing pantothenic acid of pigs raised in commercial facilities, as well as to evaluate the interactive effects between pantothenic acid and RAC.

Both Autry et al. (2002) and Stahly and Lutz (2000 and 2001) observed improved carcass leanness with increasing pantothenic acid, but no effect on daily gain or feed efficiency. In agreement with these studies, we observed no improvement in growth performance with increasing pantothenic acid (with the exception of the gilts, but not barrows in Exp. 1). However, contrary to the findings of Autry et al. (2002) and Stahly and Lutz (2000 and 2001), we observed no improvement in carcass leanness. Radcliffe et al. (2003) and Yang et al. (2004) also reported no differences in growth or carcass leanness with increasing added pantothenic acid. The variation in responses observed in these studies might be explained by the differences in the initial BW of the pigs. Autry et al. (2002) and Stahly and Lutz (2000 and 2001) initiated their trials at 8 and 10 kg, respectively, and fed control diets containing 6 to 8 ppm of pantothenic acid from corn and soybean meal. The subse-

Table 7. Effects of increasing dietary pantothenic acid (PA) on growth performance and carcass characteristics of growing-finishing pigs, Exp. 2[1,2]

	Added pantothenic acid, mg/kg					*P*-value			
Item	0.0	22.5	45.0	90.0	SEM	PA	Linear	Quadratic	Sex
d 0 to 98									
Initial wt, kg	40.16	40.30	40.31	39.95	0.78	0.61	0.51	0.25	0.29
ADG, kg	0.85	0.84	0.85	0.87	0.01	0.45	0.24	0.27	0.01
ADFI, kg	2.34	2.33	2.34	2.37	0.02	0.62	0.26	0.48	0.01
G:F	0.37	0.36	0.36	0.37	0.01	0.89	0.92	0.47	0.01
Final wt, kg	123.11	123.12	122.36	123.76	1.05	0.77	0.78	0.46	0.01
Carcass measurement									
Dressing percent	75.46	74.54	75.08	74.97	0.30	0.07	0.34	0.08	0.45
HCW, kg	93.36	92.42	91.47	93.29	0.69	0.19	0.72	0.07	0.01
Average backfat, mm	17.22	17.12	17.65	17.50	0.40	0.71	0.39	0.94	0.01
FFLI[3]	50.42	50.36	50.05	50.29	0.19	0.38	0.32	0.37	0.01
LM depth, cm	5.86	5.81	5.69	5.78	0.15	0.26	0.20	0.26	0.64

[1]A total of 1,080 pigs (PIC, initial BW 40.3 ± 2.3 kg), were used in the experiment. The values represent the mean of 27 pigs per pen and 10 pens per treatment.
[2]There were no PA × sex interactions ($P > 0.10$), observed.
[3]FFLI = fat-free lean index.

quent studies (Radcliffe et al., 2003; Yang et al., 2004), including the results reported herein, all used finishing pigs weighing at least 25 to 40 kg. The pigs used in these studies all would have likely been fed pantothenic acid adequate diets until they were started on test. We hypothesize that the carcass leanness improvements observed by Autry et al. (2002) and Stahly and Lutz (2000 and 2001) are a result of feeding low to deficient pantothenic acid to young pigs (8 to 10 kg), and less likely attributable to the pantothenic acid concentrations in the finishing phase when vitamin requirements typically decrease relative to the nursery phase (NRC, 1998).

Grinstead et al. (1998) showed increased (linear $P < 0.05$) ADG and G:F of nursery pigs (4 kg) fed up to 120 mg/kg of pantothenic acid. This supports the hypothesis that added dietary pantothenic acid is essential in diets for pigs up to approximately 15 kg, but then the requirement estimate decreases thereafter and can probably be met by the pantothenic acid content of a corn-soybean meal diet. Using niacin as a similar model, Real et al. (2002, 2004) observed improvements in ADG and G:F in nursery pigs fed increasing dietary niacin, but relatively little improvement in finishing pigs.

In Exp. 1 there were sex × pantothenic acid interactions observed for ADG and G:F as a result of increased ADG and G:F in gilts but not barrows. However, in Exp. 2 there were no sex interactions observed. We do not have an explanation for the improved performance of gilts in Exp. 1, but the majority of studies have not observed any sex × pantothenic acid interactions.

Dietary RAC has consistently been demonstrated to increase ADG and G:F in finishing pigs when dietary lysine is increased to at least 0.85% true ileal digestible lysine (Sutton et al., 2001; Webster et al., 2002; Kelly et al., 2003). Our results would agree with these previous findings with a 16% improvement in ADG and an 11% improvement in G:F. We hypothesized that the increase in ADG and G:F associated with RAC feeding would exacerbate the need for dietary pantothenic acid for improving carcass leanness. Because we observed no response to added pantothenic acid in 25- to 120-kg pigs, this may indicate that added pantothenic acid is more critical in nursery diets than in finishing diets, including those with added RAC.

Our data suggest that adding dietary pantothenic acid to diets during the growing-finishing phase does not provide any advantages in growth performance or carcass composition of growing-finishing pigs. Furthermore, it appears that the pantothenic acid in corn and soybean meal may be sufficient to meet requirements of 25- to 120-kg pigs.

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