Role of Pantothenic Acid as a Modifier of Body Composition in Pigs

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ASL-R1772

Summary and Implications

Pigs were fed one of four dietary additions of pantothenic acid (PA, 0, 30, 60, and 120 ppm) to determine the effect of PA additions on growth, body composition, and meat quality of pigs fed from 10 to 115 kg of body weight (BW). Fifteen sets (7 barrows, 8 gilts) of four littermate pigs from a high lean strain were used. Pigs were individually penned and reared via SEW scheme. Pigs were self-fed a diet containing 19 ppm PA from weaning to 10 kg BW. Pigs were then fed a 6 ppm PA basal diet and allotted within litter to one of four dietary additions of PA from d-calcium pantothenate.

As dietary PA concentration increased, longissimus muscle area increased quadratically (43.9, 48.0, 45.4, 47.5 cm^2, P = .06) and 10th rib backfat decreased quadratically (2.25, 2.04, 2.07, 1.95 cm, P < .05) resulting in a quadratic increase in fat-free lean (51.4, 53.4, 52.5, 53.6%, P < .04). Daily body weight gain (933, 916, 940, 914 g) and feed:gain (2.34, 2.32, 2.34, 2.33 kg/kg) were not altered by dietary PA. In addition, measures of meat (longissimus) quality, including intramuscular fat content (4.4, 4.2, 4.6, 4.0%), Hunter L (54.5, 54.2, 54.3, 54.3), and Hunter a (8.7, 9.1, 8.9, 8.5) color values and water loss under retail storage (4.7, 4.9, 5.1, 4.7%) at 96 hours post-kill were not (P > .10) altered by dietary PA.

Based on these data, dietary pantothenic acid at concentrations greater than that required to maximize body weight gain elicits reductions in subcutaneous fat thickness while increasing carcass lean content of market weight pigs without altering meat quality.

Introduction

Currently, vitamin requirements are based on the amount of a particular vitamin that results in maximum body growth of the pigs being examined. However, the value of pork products and thus pigs is increasingly being influenced by the composition of the pigs' body, particularly the body content of proteinaceous and fatty tissues. In recent work conducted at our research station, dietary additions of pantothenic acid in amounts above that needed to support maximum body energy accretion exhibited a biological role in regulating body composition (1). Specifically, pantothenic acid was shown to alter the partitioning of dietary energy in the body by redirecting energy from body fat deposition towards protein deposition. This response was especially evident in the moderate lean strain, which consumed more feed and energy per unit of body weight and which accrued a greater proportion of their body energy as fat. Thus, the ability of pantothenic acid to regulate body composition may be greatest in animals during physiological stages of development in which the animals dietary energy intake over their maintenance needs is high and their body fat accretion rates are elevated.

Materials and Methods

The experimental treatments consisted of four dietary additions of pantothenic acid (0, 30, 60, and 120 ppm) added as d-calcium pantothenate (Daiichi Fine Chemicals, Inc.,Vernon Hills, IL) to a basal diet (6 ppm PA). The basal diets contained a mixture of corn, soybean meal, and choice white grease supplemented with crystalline amino acids, minerals, and vitamins (Table 1). Dietary ingredients were derived from one source and were preanalyzed for pantothenic acid content by Ralston Analytical Laboratories (St. Louis, MO) via microbiological technique according to AOAC procedures (2). All essential amino acids were at concentrations relative to lysine equivalent to a minimum of 100% of the ideal amino acid ratio (3). All vitamins except pantothenic acid were supplemented at dietary concentrations equivalent to 600% of the current NRC estimated requirements (4).

Fifteen sets (7 barrows, 8 gilts) of four littermate pigs were evaluated. Pigs were weaned at 18 to 22 days of age, placed in a facility physically isolated from other pigs, and treated with Naxcel for 3 days. Pigs were penned individually on slotted floors in a thermoneutral climate. Postweaning, pigs were fed a diet containing a calculated pantothenic acid concentration of 19 ppm until the pigs reached a body weight of 10 ± 1.5 kg. Pigs were allowed to consume feed and water ad libitum.

At 10 ± 1.5 kg body weight, pigs within each gender were randomly allotted within litter to one of the four experimental dietary regimens. Pig weights, feed consumption, and feed wastage were determined every 7 days. Body composition of each pig was estimated at body weights (± 3.5 kg) of 10, 45, 80, and 115 kilograms via a deuterium oxide dilution technique (5). Deuterium oxide pool space was used as an indirect estimation of body water and thus proteinaceous (i.e., lean) tissue content in pigs at each stage of growth. The first stage of growth represents a stage where any energy redirected from body fat accretion would largely be used to synthesize additional proteinaceous tissue. The third stage of growth represents a stage where the pig exhibits a high biological capacity for fat accretion. During this stage, only a low portion of any energy redirected from body fat accretion would be used to synthesize additional proteinaceous tissue. At body weights of 10, 45, and 80 kg, the pigs' basal diet was adjusted to more closely match the amino acid and mineral intakes of the pigs to their estimated needs at each stage of growth.

Table 1. Basal diet composition, (%).

Ingredient	Pig Weight, kg		
	10 – 45	45 – 80	80 – 115
Corn	51.46	62.66	71.11
Choice white grease	3.0	3.0	3.0
Soybean meal	40.02	30.43	22.73
L-Lysine•HCL	.20	.15	.10
DL-Methionine	.12	.04	---
L-Threonine	.09	.06	.02
Dicalcium	2.40	1.48	1.07
Calcium carbonate	1.21	.83	.63
Salt, iodized	.45	.45	.45
Trace mineral mix	.19[a]	.13[b]	.12[c]
Choline chloride	.23	.17	.17
Vitamin mix	.10[d]	.10[e]	.10[e]
Starch	.40	.40	.40
Antibiotic	.125[f]	.10[g]	.10[h]

[a]Provided per kg of diet: 236 mg Fe; 203 mg Zn; 81 mg Mn; 24 mg Cu; .27 mg I; .30 mg Se.
[b]Provided per kg of diet: 175 mg Fe; 150 mg Zn; 60 mg Mn; 17.5 mg Cu; .20 mg I; .18 mg Se.
[c]Provided per kg of diet: 158 mg Fe; 135 mg Zn; 54 mg Mn; 15.8 mg Cu; .18 mg I; .18 mg Se.
[d]Provided per kg of diet: 10,500 IU Vit. A; 1,200 IU Vit. D_3; 66 IU Vit. E; 3 mg Vit. K; 75 mg niacin; 0 mg pantothenic acid; 18 mg riboflavin; .090 mg Vit. B_{12}; 1.8 mg folacin; .3 mg biotin; 9 mg pyridoxine; 6 mg thiamine.
[e]Provided per kg of diet: 7,800 IU Vit. A; 900 IU Vit. D_3; 66 IU Vit. E; 3 mg Vit. K; 42 mg niacin; 0 mg pantothenic acid; 12 mg riboflavin; .03 mg Vit. B_{12}; 1.8 mg folacin; .3 mg biotin; 6 mg pyridoxine; 6 mg thiamine.
[f]Provided per kg of diet: 110 mg tylosin.
[g]Provided per kg of diet: 44 mg tylosin.
[h]Provided per kg of diet: 22 mg tylosin

Immune status of the pigs was monitored at 10, 45, 80, and 115 kg body weight by monitoring serological titers for six major pathogens, and serum concentrations of the acute phase protein alpha-1-acid acylglycoprotein (AGP). The serological titers for *Actinobacillus pleuronpneumoniae* (APP), *Mycoplasma hyopneumonia* (MP), porcine reproductive and respiratory syndrome (PRRS) virus, pseudorabies (PRV), swine influenza virus (SIV), and transmissible gastroenteritis (TGE) were determined as outlined by Williams et al. (6). The AGP concentrations were analyzed by via a radial immuno-diffusion assay as outlined by Williams et al. (6).

As each pig reached 115 ± 3 kg, the pigs were weighed and transported 3 km to the ISU Meats Laboratory. Pigs were killed within 2 hours of arrival. Each pig was stunned (280 V, 6 s), killed by exsanguination, scalded, dehaired, and eviscerated. The hot carcass and leaf fat weights were recorded. The organs (liver, heart and lung, kidney, reproductive tract, and gastrointestinal tract) were isolated, made free of extraneous tissue, and weighed. At 45 minutes postmortem, muscle pH was determined via an ISFET pH-Thermister probe between the fifth and sixth rib in the longissimus muscle in both the right and left carcass sides. The hot carcass was chilled for 24 h at -2°C. At 24 hours postmortem, standard carcass measurements of cold carcass weight, backfat thickness at midline first rib, last rib, last lumbar vertebrae and at off-midline (6.5 cm) 10th rib, and longissimus muscle area at the 10th rib were determined on the right and left carcass side. Longissimus muscle pH was again determined at 24 hours postmortem, between the fifth and sixth rib on both carcass sides. Carcass fat-free lean content was estimated from hot carcass weight, 10th rib off-midline backfat depth, and longissimus muscle area according to the National Pork Producers Council publication *Pork Composition and Quality Assessment Procedures* (7). The equation used was carcass fat-free lean, lb = 8.588 - 21.896 * 10th rib fat depth, inches + 3.005 * 10th rib loin muscle area, $inches^2$ + 0.465 * warm carcass wt., lb.

The right carcass side was separated into wholesale cuts (ham, loin, shoulder, belly, feet, tail), and individual cut weights were recorded. The right ham from each pig was frozen then thawed and physically separated into muscle, fat, bone, and skin components, and each component weighed to the nearest gram. The dissected muscle in the ham was ground, freeze-dried, and subsequently analyzed for ether extractable lipid and water content according to AOAC procedures (2). The right belly was laid flat and a 2.5-cm-wide cross section from the top to the bottom of the belly was removed. The cross section was ground and analyzed for ether extractable lipid and water content.

Loin chops (2.5 cm thick) from the sixth through the ninth rib from the right carcass side were removed and the subcutaneous fat and bone removed. Loin chops were placed atop an absorbent pad on a styrofoam tray and wrapped in an oxygen permeable over-wrap. Loin chops were stored in a cooler maintained at 2°C and 88% relative humidity. The Hunter color scores (L, a, b) were measured with a model JB-1201 M(A) Hunter LABSCAN machine on day 0 and 3 of retail storage. Percentage water loss from day 0 to 3 post-cut also was determined on each loin chop maintained under retail storage conditions. The intramuscular ether extractable lipid and water content of the longissimus muscle also were analyzed as described for the belly and dissected ham muscle.

Additionally, a 1-inch-thick slice of the longissimus muscle was analyzed for pantothenic acid concentration in eight (4 gilts, 4 barrows) of the 15 replications. The analysis of the pantothenic acid content in the pigs' longissimus muscle was performed by Ralston Analytical Laboratories via microbiological technique according to AOAC procedures (2). Results from a previous experiment have indicated that the assay used for analyzing pantothenic

acid content had a detection limit of 0.412 ppm with an intra- and interassay variation of 8.4 and 9.4%, respectively.

Data were analyzed as a split-plot design by using the GLM procedure of SAS (8). Gender was considered the whole-plot and was tested by an error term of replicate within gender. Dietary pantothenic acid concentrations represented the subplot and the gender by dietary pantothenic acid interaction was tested by the residual error term. Changes in the pigs' growth were analyzed as a repeated measure within the split-plot design. The pig was considered the experimental unit. Linear, quadratic, and cubic contrasts were conducted using coefficients for unequal treatment spacing. Least square means are reported.

Results and Discussion

The basal diets contained 5.8, 6.8, and 5.9 ppm of total pantothenic acid for pigs fed from 10 to 45, 45 to 80, and 80 to 115 kg BW, respectively (Table 2). These values represent 72, 98, and 84% of the estimated requirements (NRC 1998) for pigs in their respective stages of growth. The analyzed dietary pantothenic acid concentrations for each experimental diet within each stage of growth closely matched the calculated pantothenic acid additions of 0, 30, 60, and 120 ppm. Comparing the analyzed to the calculated dietary pantothenic acid concentrations resulted in a range in under- and oversupplementation of 89 to 110% with most diets containing 95% or greater of the calculated additions.

Table 2. Analyzed composition of experimental diets.

Criteria	Stage of growth, kg	Dietary pantothenic acid, ppm 0	30	60	120
Pantothenic acid, ppm					
	10 to 45	5.8	35.9	62.6	124.
	45 to 80	6.8	34.5	59.9	140.
	80 to 115	5.9	31.9	62.3	123.

The pigs used in the study were from a high lean genetic strain and experienced a moderate-to-low level of antigen exposure throughout the study. Initially (10 kg body weight), serum alpha-1-acylglycoprotein (AGP) concentrations were higher than typical high health, SEW reared pigs. Initially, these animals also exhibited serological titers for swine influenza virus (strains H_1N_1 and H_3N_2) and passively acquired titers for transmissible gastroenteritis. At subsequent stages of growth (45, 80 and 115 kg body weights), serum AGP concentrations declined to levels normally found in high health, SEW reared pigs and the pigs exhibited no active or passively acquired titers for *Actinobacillus pleuronpneumoniae, Mycoplasma hyopneumonia*, porcine reproductive and respiratory syndrome virus, pseudorabies virus or transmissible gastroenteritis (Table 3).

Table 3. Characterization of the health status of experimental pigs.

Criteria	Pig weight, kg 10	45	80	115
Serological titers for antigens [a] (number of positive samples for each antigen)				
APP	0/8		0/8	
MP	0/8		0/8	
PRRS	0/8		0/8	
PRV	0/8		0/8	
SIV (H_1N_1)	8/8		4/8	
SIV (H_3N_2)	8/8		8/8	
TGE	7/8		0/8	
Serum alpha-1-acylglycoprotein (AGP), µg/ml				
AGP	1236	479	413	438

[a] *Actinobacillus pleuronpneumoniae* (APP), *Mycoplasma hyopneumonia* (MP), porcine reproductive and respiratory syndrome (PRRS) virus, pseudorabies (PRV), swine influenza virus (SIV), and transmissible gastroenteritis (TGE).

Three pigs were removed from the test. One pig died suddenly, but exhibited anorexia for approximately 2 weeks. Necropsy revealed the cause of death to be gastric ulceration with severe hemorrhage. The second pig was sacrificed due to lack of mobility in the rear legs. The third pig completed the entire test period, but its data were not included because the animal was comparably lighter than any other pig marketed and had exhibited periods of weight loss during the study.

Pantothenic acid additions did not alter daily body weight gain or the efficiency of feed utilization in pigs growing from 10 to 115 kg BW, but daily feed intake tended to decrease as pantothenic acid concentration increased (Table 4).

Table 4. Effect of dietary pantothenic acid concentration on feed intake, growth, and efficiency of feed utilization at various stages of growth in pigs fed from 10 to 115 kg BW.

Criteria	Stage of growth, kg	Dietary pantothenic acid, ppm				SEM	P =				
		0	30	60	120		S	DL	DQ	DC	D*S
No. of pens	10 – 45	15	15	15	15						
	45 – 80	15	14	14	15						
	80 – 115	15	14	13	15						
	10 – 115	15	14	13	15						
Pig weight, kg											
Initial	10 – 45	9.99	9.98	9.66	10.04	.23					
	45 – 80	45.82	45.08	45.99	45.42	.64					
	80 – 115	79.93	80.22	80.12	79.40	.54					
Final	10 – 45	45.82	45.08	45.99	45.42	.64					
	45 – 80	79.93	80.22	80.12	79.40	.54					
	80 – 115	118.1	117.0	118.0	117.6	.79					
Days on test											
	10 – 45	43.0	40.6	42.1	42.5	1.7	.21	.90	.34	.29	.17
	45 – 80	32.2	34.3	32.7	33.4			.82	.56	.27	
	80 – 115	41.5	42.3	40.9	42.4			.75	.57	.24	
	10 – 115	116.6	117.5	115.0	118.4	2.2	.18	.21	.42	.69	.32
Daily feed, g	10 – 45	1374	1337	1382	1321	62	.06	.77	.96	.67	.07
	45 – 80	2433	2334	2392	2332			.65	.59	.35	
	80 – 115	2816	2724	2886	2779			.84	.52	.21	
	10 – 115	2176	2118	2200	2125	42	.02	.08	.41	.56	.16
Daily gain, g	10 – 45	828	822	827	818	27	.23	.93	.98	.86	.13
	45 – 80	1048	1008	1005	1028			.93	.23	.68	
	80 – 115	970	944	995	934			.67	.55	.22	
	10 – 115	933	916	940	914	21	.33	.22	.28	.50	.25
Feed/gain	10 – 45	1.664	1.628	1.667	1.616	.065	.39	.73	.94	.70	.92
	45 – 80	2.332	2.313	2.386	2.269			.68	.67	.49	
	80 – 115	2.935	2.907	2.924	3.043			.29	.09	.96	
	10 – 115	2.341	2.316	2.344	2.332	.043	.26	.73	.72	.90	.97

Daily feed intake, body weight gain, and feed/gain ratios were not altered during any of the three stages of growth studied. However, feed/gain during the third stage of growth (80 to 115 kg BW) tended to be increased by the highest addition (120 ppm) of pantothenic acid (Table 4).

At market weight, dietary PA additions resulted in linear reductions of midline backfat thickness at the last rib and last lumbar vertebra. The magnitude of the reductions tended to be larger in barrows than gilts. Off midline backfat at the 10th rib was decreased quadratically and tenth rib longissimus muscle area was increased quadratically as dietary PA additions increased. Consequently, the percentage of estimated fat-free lean also increased quadratically as dietary PA additions increased (Table 5). Visceral component weights were not altered by dietary PA regimen except for heart and lung weights (Table 5).

Table 5. Effect of dietary pantothenic acid concentration on carcass traits and offal component weights of pigs at 115 kg BW.

	Dietary pantothenic acid, ppm					P =				
Item	0	30	60	120	SEM	S	DL	DQ	DC	D*S
Carcass weight, kg										
Hot	88.7	87.9	88.1	88.6	.63	.06	.38	.82	.79	.83
Cold[a]	85.9	85.9	85.9	85.9	.03	.04	.60	.85	.12	.52
Backfat thickness, cm[a]										
Midline										
First rib	4.27	4.14	3.92	3.93	.20	.07	.52	.97	.60	.71
Last rib	2.08	1.97	1.94	1.94	.07	.21	.01	.96	.71	.08
Last lumbar	2.06	2.15	2.03	1.91	.09	.06	.02	.57	.21	.08
Off-midline (6.5 cm)										
Tenth rib	2.25	2.04	2.07	1.95	.11	.03	.15	.04	.40	.22
Longissimus muscle area, cm^2										
Tenth rib[a]	43.89	48.02	45.45	47.49	1.19	.02	.36	.06	.46	.49
Estimated fat free lean[a,b]										
% of hot carcass	51.5	53.4	52.5	53.6	.7	.02	.17	.03	.84	.37
Offal component, kg[a]										
Leaf fat	1.365	1.233	1.220	1.113	.088	.15	.76	.47	.51	.91
Liver	1.719	1.709	1.699	1.623	.041	.75	.09	.11	.81	.23
Kidney	.359	.357	.352	.341	.011	.91	.01	.24	.85	.14
Heart and lungs	1.955	1.929	1.925	1.865	.066	.62	.53	.32	.07	.27
Gastrointestinal tract[c]	9.506	8.948	9.435	9.598	.255	.19	.53	.43	.86	.41
Reproductive tract	.284	.232	.266	.231	.020	.14	.98	.45	.11	.35
Head	6.725	6.732	6.740	6.760	.115	.74	.48	.62	.54	.22
Jowl trim	.819	1.039	.821	.912	.090	.52	.18	.93	.01	.36

[a]Data adjusted for hot carcass weight.

[b]Estimated based on the National Pork Producers Council publication *Pork Composition and Quality Assessment Procedures*. The equation used was carcass fat-free lean, lb = 8.588 - 21.896 * 10th rib fat depth, inches + 3.005 * 10th rib loin muscle area, $inches^2$ + 0.465 * warm carcass wt., lb.

[c]Gastrointestinal tract contained digesta contents.

Wholesale ham, loin, shoulder, and belly weights were not altered by dietary PA additions (Table 6). The separable tissue contents of the ham (muscle, fat, bone, skin) as well as the chemical composition (lipid, water) of the dissected ham muscle were independent of dietary PA regimen (Table 6).

Deuterium oxide pool, an indicator of body lean tissue content, was not altered by PA feeding at 45, 80, or 115 kg BW. Deuterium oxide pool as a proportion of body weight gain or as a percentage of total body weight were not significantly altered by dietary PA additions during any of the three stages of growth. However, PA additions did elicit numerical improvements in body D_2O pool space during the third stage (80 to 115 kg BW) of growth (Table 7).

Composition (lipid, water) of a 2.5-cm-wide belly cross-section slice and loin muscle slice was not altered by dietary PA concentration (Table 8). PA concentration in the longissimus muscle increased linearly as dietary PA concentration increased (Table 8).

Quality traits of the longissimus muscle including postmortem muscle pH (45 min and 24 h), Hunter L and a scores, and intramuscular fat and water contents at 24 h postmortem were not influenced by dietary PA regimen (Table 9). During a subsequent 72 h retail storage period, water losses were not altered by dietary PA additions.

Similar to a previous trial conducted at our station with 10 to 26 kg pigs, pantothenic acid additions were again effective in reducing body fat accretion while enhancing accretion of proteinaceous tissues. Also similar to the previous experiment, changes in body composition occurred with no detectable change in daily body weight gain or efficiency of feed utilization. It was initially hypothesized that the greatest reductions in body fat would occur during the third stage of growth, which is characterized by a high rate of fat deposition. D_2O pool space, as a percentage of body weight gain, was used as an indirect estimator of changes in body composition during the three stages of growth. During the first two stages of growth pantothenic acid additions resulted in small numerical increases in D_2O pool space as a percentage of body weight gain, whereas in the third stage of growth this criterion was improved to a greater extent (3.3% absolute change).

Pantothenic acid additions also had no negative impact on meat quality as measured by muscle pH or water loss and muscle color scores during retail storage. Of importance also, is that PA additions were effective in reducing subcutaneous fat depots, but intramuscular fat in the belly, ham, and loin were not altered by PA regimen.

Table 6. Effect of dietary pantothenic acid concentration on wholesale cut weight and ham tissue and nutrient content.

	Dietary pantothenic acid, ppm					P =				
Criteria	0	30	60	120	SEM	S	DL	DQ	DC	D*S
Wholesale cut weight, kg[a]										
Ham	10.716	10.932	10.880	11.042	.099	.06	.52	.79	.63	.96
Loin	11.409	11.395	11.306	11.221	.145	.09	.43	.94	.09	.26
Shoulder	10.377	10.386	10.308	10.401	.129	.20	.09	.84	.42	.09
Belly	8.468	8.394	8.436	8.278	.130	.91	.91	.59	.57	.95
Ham separable tissue at 118 kg BW, %[a]										
Muscle	66.27	66.59	65.69	67.37	.62	.04	.17	.51	.95	.18
Fat	19.94	19.41	20.47	18.96	.65	.05	.18	.59	.77	.09
Bone	9.67	9.79	9.74	9.62	.13	.75	.43	.94	.71	.72
Skin	4.12	4.17	4.10	4.05	.10	.30	.17	.37	.25	.42
Chemical composition of separable ham muscle, %[a,b]										
Water	73.47	74.10	73.54	73.56	.20	.18	.34	.45	.74	.90
Lipid	4.11	3.67	4.04	3.92	.19	.10	.76	.73	.63	.81

[a]Data adjusted for hot carcass weight.

[b]Water loss during dissection was added back as muscle weight and the fat content of the dissected muscle tissue was subtracted from the dissected muscle weight and added to the dissected fat weight.

Literature Cited

1. Stahly, T.S. and T.R. Lutz. 2000. Pantothenic acid needs for specific biological processes in pigs. ISU Swine Research Report. ASL-R652.

2. AOAC. 1995. Official Methods of Analysis (16th Ed.). Association of Official Analytical Chemists, Arlington, VA.

3. Chung, T. K. and D. H. Baker. 1992. Ideal amino acid pattern for 10-kilogram pigs. J. Anim. Sci. 70: 3102-3111.

4. NRC. 1998. Nutrient Requirements of Swine(10th Ed.). National Academy Press. Washington, DC.

5. Rudolph, B.C., T.S. Stahly, and G.L. Cromwell. 1988. Estimation of body composition of neonatal pigs via deuterium oxide dilution: validation of technique. J. Anim. Sci. 66: 53-61.

6. Williams, N. H., T.S. Stahly, and D.R. Zimmerman. 1997. Effect of chronic immune system activation on the rate, efficiency, and composition of growth and lysine needs of pigs fed from 6 to 27 kg. J. Anim. Sci. 75: 2463-2471.

7. Pork Composition and Quality Assessment Procedures. 2000. National Pork Producers Council.

8. SAS. 1996. SAS for Windows (Release 6.12 Ed.). SAS Inst. Inc., Cary, NC.SAS. 1994.

Table 7. Effect of dietary pantothenic acid concentration on estimated body composition at four stages of growth.

Criteria	Stage of growth, kg	Dietary pantothenic acid, ppm 0	30	60	120	SEM	P = S	DL	DQ	DC	D*S
Body D_2O pool space, % of body weight											
	10	81.6	82.7	83.4	82.6	.82	.82	.30	.05	.83	.14
	45	73.30	74.71	73.95	74.11	.59	.50	.48	.29	.09	.37
	80	66.72	67.06	66.63	67.84	.48	.07	.12	.56	.51	.84
	115	61.52	62.91	62.33	62.65	.67	.02	.35	.28	.25	.86
Body D_2O pool space, % of body weight gain											
	10 – 45	71.21	72.43	71.42	71.73	.85	.40	.84	.65	.15	.59
	45 – 80	57.89	57.05	56.90	59.20	1.21	.01	.37	.32	.97	.57
	80 – 115	50.61	53.89	53.71	52.95	1.86	.07	.34	.13	.51	.57

Table 8. Chemical composition of belly slice and loin chop, (%).

	Dietary pantothenic acid, ppm					P =				
Criteria	0	30	60	120	SEM	S	DL	DQ	DC	D*S
Belly slice[a]										
Water	45.51	46.37	44.34	46.78	1.03	.04	.36	.23	.69	.12
Lipid	41.39	39.61	41.87	39.03	1.41	.06	.23	.25	.67	.06
Loin chop[a]										
Water	72.86	73.06	72.32	73.27	.34	.01	.63	.77	.58	.83
Lipid	4.38	4.23	4.55	3.97	.33	.01	.99	.47	.56	.94
PA, ppm	3.67	6.33	8.12	9.85	.48	.28	.01	.15	.88	.03

[a]Data adjusted for hot carcass weight.

Table 9. Effect of dietary pantothenic acid concentration on longissimus muscle quality traits.

	Time	Dietary pantothenic acid, ppm					P =				
Criteria	postmortem	0	30	60	120	SEM	S	DL	DQ	DC	D*S
pH[a]											
	45 min	6.11	6.15	6.14	6.10	.04	.49	.48	.11	.83	.32
	24 h	5.84	5.81	5.89	5.78	.05	.81	.40	.62	.65	.57
Color[a]											
Hunter L											
	24 h	52.0	50.9	51.2	50.8	1.26	.06	.52	.18	.55	.43
	96 h	54.5	54.2	54.3	54.3	1.06	.02	.30	.27	.89	.67
Hunter a											
	24 h	6.95	7.64	7.12	7.25	.24	.84	.59	.93	12	.46
	96 h	8.74	9.05	8.92	8.45	.48	.54	.89	.66	.54	.36
Hunter b											
	24 h	12.06	12.20	12.14	11.92	.34	.03	.55	.43	.90	.69
	96 h	12.87	12.92	12.91	12.85	.12	.01	.23	.02	35	.12
Water loss, %[a]											
	24 to 96 h	4.65	4.89	5.11	4.73	.76	.35	.85	.45	.96	.69

[a]Data adjusted for hot carcass weight.