Kansas Agricultural Experiment Station Research Reports

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

Article 827

2000

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J S. Park

Donald H. Kropf

K A. Hachmeister

See next page for additional authors

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Abstract

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Keywords

Swine day, 2000; Kansas Agricultural Experiment Station contribution; no. 01-138-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 858; Swine; Vitamins; Minerals; Pork quality

Authors

J S. Park, Donald H. Kropf, K A. Hachmeister, Robert H. Hines, C L. Jones, D W. Dean, D J. Lee, and Joe D. Hancock

EFFECTS OF VITAMINS AND MINERAL PROTEINATES ON GROWTH PERFORMANCE AND PORK QUALITY IN FINISHING PIGS

J. S. Park, J. D. Hancock, D. H. Kropf, K. A. Hachmeister, R. H. Hines, C. L. Jones, D. W. Dean, and D. J. Lee

Summary

From 185 to 225 lb BW, no differences in ADG, ADFI, or F/G occurred among pigs fed diets without or with vitamin and trace mineral premixes. Then, from 225 to 266 lb BW, a special premix with megadoses of vitamin E, vitamin C, Mg-proteinate, and Fe-proteinate was added to the diets of half the pigs given the previous treatments. Growth performance was not different among pigs fed diets without vitamin or with the KSU and special vitamin and mineral premixes. Also, meat quality (color, marbling, and firmness scores; drip, thawing, and cooking losses; shear force; and Hunter L*a*b*) was not affected by inclusion of the KSU and special vitamin and mineral premixes.

(Key Words: Vitamins, Minerals, Pork Quality.)

Introduction

Pork quality is of increasing concern in the swine industry. Increasing incidence of PSE (pale, soft, and exudative) pork has a major impact an pork quality and the ability of U.S. pork to make inroads into the export market. Many researchers have tried to improve pork quality with nutrient modifications, such as megadosing of vitamins and use of mineral chelates and proteinates, with mixed results. Yet, in previous work done at KSU, deleting vitamin and mineral premixes in late finishing had no negative effects on pork quality. Thus, we designed an experiment to determine the effects of manipulating vitamin and mineral concentrations in diets for late finishing pigs on growth performance and pork quality.

Procedures

A total of 80 crossbred pigs (average initial BW of 185 lb) was fed corn-soybean meal-based diets (Table 1) in meal form. All nutrients met or exceed NRC (1998) requirement except for vitamins and minerals.

The pigs were blocked by weight and allotted to treatments based on ancestry. There were two pigs per pen (5 ft × 5 ft) and 10 pens per treatment in an environmentally controlled building. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water.

Treatments from an average BW of 185 lb to 225 lb were a basal diet (without the KSU vitamin and mineral premixes) and the basal diet with the KSU vitamin and mineral premixes. From 225 lb to 266 lb, treatments were: 1) a negative control diet without the KSU vitamin and mineral premixes; 2) trt 1 with a special premix (500 ppm of vitamin E, 500 ppm of vitamin C, 200 ppm of magnesium proteinate, and 150 ppm of iron proteinate); 3) a diet with the KSU vitamin and mineral premixes; and 4) trt 3 with the special premix.

The pigs were slaughtered when the average BW in the heaviest pen of a weight block reached 270 lb. Dressing percentage (hot carcass weight / final live weight × 100), last rib backfat thickness, and fat-free lean (National Pork Producers Council, 1996) were determined. Also, the front half of each loin was collected for evaluation of pork quality (color, marbling score, and firmness scores; drip, thawing, and cooking losses; shear force; and Hunter L*a*b*). The second half of each loin was vacuum packaged and stored for 45 d at 37°F before evaluation of pork quality. This was done to "stress" pork quality and to simulate the time from slaughter in a U.S. processing plant until consumption by a consumer in Japan.

The data were analyzed as a split-plot design with whole-plot treatments of no vitamin/trace mineral premixes and standard additions of vitamin and mineral premixes from 185 to 225 lb BW. Subplot treatments (no change in vitamin/trace mineral supplementation vs addition of the special premix) were imposed within the whole-plot treatments beginning at 225 lb BW. The orthogonal contrasts used to separate treatment means were: 1) no KSU vit/min premixes vs KSU vit/min premix; 2) no special premix vs with special premix; and 3) no KSU vit/min premix vs KSU vit/min × no special premix vs special premix. Hot carcass weight was used as a covariate in analysis of data for dressing percentage, backfat thickness, and fat free lean. Pen was the experimental unit for all comparisons.

Table 1. Basal Diet[a]

Ingredient	%
Corn	79.86
Soybean meal (46.5% CP)	17.20
Soybean oil	1.00
Lysine HCl	.10
Monocalcium phosphate	.52
Limestone	.85
Salt	.35
KSU vitamin premix[b]	0 or .15
KSU trace mineral premix[b]	0 or .10
Special premix [c]	0 or .11
Antibiotic [d]	.12

[a]All diets were fed in mash form.
[b]Supplied the following per lb of complete diet: 2,999 IU of vitamin A; 449 IU of vitamin D_3; 12.0 IU of vitamin E; 1.2 mg of vitamin K (as menadione sodium bisulfite); 44.9 mg of choline; 13.5 mg of niacin; 7.8 mg of pantothenic acid (as d-calcium pantothenate); 2.2 mg of riboflavin; .009 mg of vitamin B_{12}; 49.8 mg of Zn; 74.8 mg of Fe; 5.0 mg of Cu; 12.0 mg of Mn; .1 mg of I; and .1 mg of Se.
[c]Supplied the following per lb of complete diet: 226 mg of vitamin C; 226 mg of vitamin E; 90 mg of Mg; and 68 mg of Fe.
[d]Supplied 100g/ton tylosin.

Results and Discussion

Calculated concentrations for the vitamins and minerals altered by our dietary treatments are presented in Table 2. As a percentage of NRC recommendations, the diets without added vitamin and mineral premixes were supposedly deficient in vitamin E and K, niacin, riboflavin, vitamin B_{12}, Fe, I, Se, and Zn. With addition of the KSU vitamin and mineral premixes, all of the vitamin and mineral concentrations were increased well above NRC recommendations (from 1.7 × NRC for I to 19 × NRC for Mn). Finally, the special premix resulted in 500, 46, 4.6, and 5.1 × NRC for vitamin C, vitamin E, Fe, and Mg, respectively.

From 185 to 225 lb, removing vitamin and trace mineral premixes from diets did not affect (P>.80) ADG, ADFI, and F/G of the pigs (Table 3). From 225 to 265 lb (Table 4), ADG, ADFI, and F/G again were not different (P>.15) among pigs fed diets without or with vitamin and mineral premixes. Furthermore, adding the special premix did not affect growth performance (P > .36), and no interaction resulted from combining the KSU and special premixes (P>.32).

Dressing percentage, backfat thickness, percentage carcass lean, and muscle pH at 3 h and 24 h were similar among the treatments (P>.29). Marbling and firmness score (P>.11); drip, thawing, and cooking losses (P>.24); shear force (P>.71); and Hunter L*a*b* on d 0, 2, 4, and 6 of display (P>.11) also were not affected by removing vitamin and trace mineral premixes or by adding the special premix. Indeed, the only measurement of pork quality affected by the dietary treatments was color score, for which an interaction (P>.02) occurred. Addition of the special premix decreased the color score for pigs without the KSU premixes to 225 lb and increased the color score for pigs with the KSU premixes to 225 lb. However, the response is difficult to explain and was not supported by changes (P>.11) in objective determination of color via Hunter L*a*b* (Table 5).

After 45 d of storage to stress meat quality, there still were essentially no effects of vitamin and mineral premix addition to the diets (Table 6). The one exception again was an interaction for color score (P>.02). This interaction resulted from a low mean color score when the KSU premixes were fed without the special premix and a high color score when the KSU and special premixes were fed in combination. However, this response would be difficult to explain and was not supported by change in objective measurement of color (P>.06) via Hunter L*a*b* (Table 7).

In conclusion, removing vitamin and mineral premixes had no negative effects on growth performance, carcass characteristics, or meat quality. Also, supplementation with high dosages of vitamin E (500 ppm) and vitamin C (500 ppm), 200 ppm of magnesium proteinate, and 150 ppm of iron proteinate did not improve meat quality. These data demonstrate further the lack of any negative effects in the response criteria measured in this study from deleting the KSU vitamin and mineral premixes in late finishing diets.

Table. 2 Vitamin and Mineral Concentrations in Premixes[a]

		% of NRC			
Item	NRC, unit/kg	None	KSU	Special	KSU & Special
Vit A	1,300 IU	13	523	13	523
Vit C	0	0	0	50,000	50,000
Vit D	150 IU	0	661	0	661
Vit E	11 IU	66	311	4,611	4,856
Vit K	.5 mg	29	560	29	560
Niacin	7 mg	0	534	0	534
Panthothenate	7 mg	115	389	115	389
Riboflavin	2 mg	80	372	80	372
B_{12}	5 µg	0	529	0	529
Cu	3 mg	194	562	194	562
Fe	40 mg	99	412	511	787
I	.14 mg	27	169	27	196
Mg	400 mg	400	400	450	450
Mn	2 mg	573	1,896	573	1,896
Se	.15 mg	70	202	70	202
Zn	50 mg	47	268	47	268

[a]Total basis.

Table 3. Growth Performance of Pigs Fed Diets without and with the KSU Vitamin and Mineral Premixes from 185 to 225 lb[a]

	Vitamin & Mineral Premixes			
Item	None	KSU	SE	P value
ADG, lb	2.08	2.09	.06	.95
ADFI, lb	6.21	6.26	.12	.80
F/G	2.98	3.00	.07	.96

[a]Eighty pigs were used (two pigs/pen and 20 pens/trt).

Table 4. Growth Performance of Pigs Fed Diets without and with KSU and Special Vitamin and Mineral Premixes from 225 to 265 lb[a]

	W/O KSU Premixes to 225 lb		W/ KSU Premixes to 225 lb			P-Value		
Item	W/O Special Premix	W/Special Premix	W/O Special Premix	W/Special Premix	SE	KSU	Special	KSU × Special
ADG, lb	2.38	2.46	2.30	2.21	.11	.15	.97	.45
ADFI, lb	7.23	6.93	7.01	6.98	.18	.59	.36	.50
F/G	3.12	2.89	3.09	3.19	.16	.28	.71	.32
Dressing %	72.5	73.2	72.7	72.8	.7	.88	.56	.63
Backfat thickness, in	.83	.89	.87	.87	.05	.85	.62	.57
Lean %	48.5	50.8	51.1	50.5	1.3	.41	.53	.29
pH at 3h	6.68	6.69	6.68	6.67	.04	.73	.97	.83
pH at 24h	5.90	5.89	5.90	5.92	.05	.52	.74	.50
Color score [b]	3.8	3.4	3.6	4.0	.1	.20	.85	.02
Marbling score [c]	3.0	3.1	3.1	3.7	.2	.11	.16	.28
Firmness score [d]	3.2	3.1	3.2	3.2	.2	.80	.93	.80
Drip loss, %	2.1	1.7	1.7	1.9	.4	.87	.88	.48
Thawing loss, %	1.9	2.1	2.2	1.9	.3	.87	.97	.24
Cooking loss, %	27.5	27.8	29.3	27.3	1.2	.66	.48	.37
Shear force, kg	3.70	3.71	3.79	3.57	.30	.91	.73	.71

[a]A total of 80 pigs was used (two pigs/pen, 10pens/trt).
[b]Scored on a scale of 1 = pale pinkish gray to 6 = dark purplish red (NPPC, 1999) with 3 to 4 as ideal.
[c]Scored on a scale of 1 = partially devoid to 6 = abundant (NPPC 1999) with 3 to 4 as ideal.
[d]Scored on a scale of 1= vary soft and watery to 5 = very firm and dry (1991) with 3 to 4 as ideal.

Table 5. Effects of KSU and Special Premixes on Color Stability of Pork during Display

	W/O KSU Premixes to 225 lb		W/ KSU Premixes to 225 lb			P Value		
Item	W/O Special Premix	W/Special Premix	W/O Special Premix	W/Special Premix	SE	KSU	Special	KSU × Special
Day of display								
0								
L* [a]	52.7	54.6	54.8	55.1	.8	.17	.17	.34
a*	18.7	18.6	18.4	19.1	.3	.81	.40	.17
b*	14.3	14.2	14.5	15.5	.3	.11	.18	.11
2								
L*	55.4	56.6	56.5	56.9	.8	.29	.33	.59
a*	18.1	17.9	17.9	17.9	.3	.74	.70	.70
b*	16.7	16.8	19.9	17.1	.3	.49	.62	.86
4								
L*	55.5	56.4	56.6	56.8	.7	.27	.49	.67
a*	16.7	16.4	16.4	16.5	.3	.48	.71	.45
b*	16.6	16.7	16.9	17.1	.2	.24	.55	.87
6								
L*	56.1	57.0	57.0	57.4	.8	.39	.45	.70
a*	15.4	14.8	14.7	15.0	.4	.33	.78	.35
b*	16.0	16.0	16.0	16.7	.3	.16	.36	.26

[a]Hunter 'L' values (lightness) with an acceptable range of 50 to 55, which is considered equal to color score of 2 to 3.

Table 6. Effects of KSU and Special Premixes on Visual Color and Cooking Characteristics of Pork after 45 Days of Storage

	W/O KSU Premixes to 225 lb		W/ KSU Premixes to 225 lb			P-Value		
Item	W/O Special Premix	W/Special Premix	W/O Special Premix	W/Special Premix	SE	KSU	Special	KSU× Special
Color score [a]	3.7	3.7	3.3	3.9	.1	.76	.04	.02
Marbling score [b]	3.1	3.5	3.3	3.6	.2	.18	.10	.84
Firmness score [c]	3.2	3.2	3.1	3.3	.1	.91	.28	.37
Drip loss, %	.6	.6	.6	.7	.1	.42	.26	.12
Thawing loss, %	2.5	2.6	2.99	2.6	.3	.14	.76	.41
Cooking loss, %	25.1	27.2	27.6	25.5	1.2	.77	.98	.12
Shear force, kg	2.73	2.95	2.88	2.73	.15	.41	.78	.12

[a]Scored on a scale of 1 = pale pinkish gray to 5 = dark purplish red (NPPC, 1991) with 3 to 4 as ideal.
[b]Scored on a scale of 1 = partially devoid to 6 = abundant (NPPC 1999) with 3 to 4 as ideal.
[c]Scored on a scale of 1= vary soft and watery to 5 = very firm and dry (1991) with 3 to 4 as ideal.

Table 7. Effects of KSU and Special Premixes on Color Stability of Pork during Display after 45 Days of Storage

	W/O KSU Premixes to 225 lb		W/ KSU Premixes to 225 lb			P-Value		
Item	W/O Special Premix	W/Special Premix	W/O Special Premix	W/Special Premix	SE	KSU	Special	KSU × Special
Day of display								
0								
L*[a]	57.2	58.1	59.1	58.5	.7	.22	.88	.30
a*	20.6	21.3	20.7	20.3	.3	.49	.54	.06
b*	17.2	17.8	17.65	17.4	.4	.84	.54	.17
2								
L*	56.4	57.6	58.45	57.4	.7	.37	.94	.18
a*	17.6	17.7	16.33	17.8	.4	.08	.10	.21
b*	16.5	17.2	17.00	17.0	.3	.72	.39	.33
4								
L*	55.9	57.1	57.9	56.8	.8	.45	.95	.18
a*	15.2	15.2	14.1	15.9	.5	.59	.08	.08
b*	15.2	16.4	16.0	15.8	.6	.87	.37	.28
6								
L*	55.0	55.6	56.7	55.9	.8	.36	.86	.41
a*	13.5	14.3	13.6	14.5	.4	.79	.12	.85
b*	13.8	14.4	14.6	14.3	.6	.70	.82	.54

[a]Hunter ‘L’ values (lightness) with an acceptable range of 50 to 55, which is considered equal to color score of 2 to 3.