LOW-PHOSPHORUS DIETS DURING LATE-FINISHING DECREASE COST OF GAIN WITH MINIMAL EFFECT ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND MEAT QUALITY

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Summary

Partially omitting (up to 66%) the supplemental inorganic phosphorus (P) source from a late-finishing (190 to 250 lb) diet resulted in slightly greater ADG and backfat thickness, which probably resulted from the greater feed (energy) intake. Meat quality was unaffected by treatment. Thus, during late-finishing, a total P concentration of .40% can be used to decrease diet cost without decreasing performance or meat quality of high-lean pigs.

(Key Words: Phosphorus, Performance, Carcass, Meat.)

Introduction

Phosphorus (P) typically is the third most expensive nutrient in swine diets, following energy and protein. Excess dietary P is excreted in urine and feces as an environmental pollutant, and some European countries already have limited expansion of swine production units based on the amount of P that would be excreted. Thus, some nutritionists are considering reduced P in diets to decrease feed costs and excretion in swine waste products.

Today, many researchers believe that diets for late-finishing (over 200 lb) are often overfortified with nutrients (e.g., protein, vitamins, and minerals). This is because diet specifications are derived mostly from experiments with lighter pigs. It is also hypothesized that body stores of many minerals and vitamins may be sufficient to maintain normal growth during the late-finishing period. The experiment reported herein was conducted to determine the effects of removing supplemental P during late-finishing on growth performance, carcass characteristics, and meat quality of high-lean pigs.

Procedures

A total of 128 pigs, with an average initial body wt of 190 lb, was used in the 31-d experiment. Crossbred pigs of PIC origin (line 326 boars × C15 sows) were blocked by weight and sex and allocated to dietary treatments based on ancestry. There were eight pigs per pen and four pens per treatment.

The pigs were housed in 6 ft × 16 ft pens with concrete (50% solid and 50% slatted) flooring, in a modified open-front finishing barn. Each pen was equipped with a two-hole feeder and a nipple waterer to provide ad libitum access to feed and water.

The control diet was corn-soybean meal-based and formulated to .70% lysine, .65% Ca, and .55% P with all other nutrients in excess of NRC recommendations (Table 1). The other diets were achieved by incrementally removing monocalcium phosphate (the source of inorganic phosphorus) from the control such that treatments were: 1) control diet; 2) 33% of the monocalcium phosphate omitted; 3) 66% of the monocalcium phosphate omitted; and 4) all of the monocalcium phosphate omitted. Calcium concentrations were decreased (by omitting limestone) to keep the Ca:P ratio constant at

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1.2:1 in all diets. The diets were fed in meal form.

Pigs and feeders were weighed at the beginning and end of the experiment to allow calculation of ADG, ADFI, and F/G. When pigs in the heaviest pen of a weight block averaged 250 lb, the entire block was slaughtered in a commercial plant. Hot carcass weight, last rib backfat thickness, and longissimus muscle depth were recorded immediately following slaughter. After chilling, the carcasses were fabricated, and the longissimus muscle was scored for color, firmness, and marbling according to NPPC (1991) guidelines. Also, chops from the 10th rib location were cut 1 in thick, placed on an absorbent pad in a styrofoam tray, wrapped with polyvinylchloride film (standard retail film with high oxygen permeability), and displayed for 5 d (36°F with 150 foot candles deluxe warm white fluorescent lighting). A Minolta CR-200 spectrocolorimeter was used to measure meat lightness and intensity of red, yellow, and pink color at d 0, 3, and 5.

Prior to statistical analyses, hot carcass weight, dressing percentage, last rib backfat thickness, and longissimus muscle depth were adjusted by using slaughter weight as a covariable. All data were analyzed for linear, quadratic, and cubic effects of omitting P using the GLM procedure of SAS.

Results and Discussion

Average daily feed intake and F/G were not influenced by treatment ($P > .15$), but ADG increased and days from 190 to 250 lb decreased (quadratic effects, $P < .03$) when 66% of the inorganic P source was omitted (Table 2). Although it is difficult to explain why decreasing P additions would actually increase ADG, the improvements probably were an artifact (chance effect) resulting from the greater feed intake for pigs fed the diet with 66% of the inorganic P source omitted. Thus, omitting up to 66% of the inorganic P source certainly had no negative effect on growth performance. Totally omitting the inorganic P source, however, resulted in reduced ADG and increased days to market.

Carcass characteristics were not influenced apart from a slight increase (.05 and .06 in) in last rib backfat thickness and a slight decrease in NPPC lean index (.6%) when 33% and 66% of the inorganic P source was omitted. Again, these effects were likely artifacts of the greater feed intake for pigs fed the diet with 66% of the inorganic P source omitted. Subjective scores for color, marbling, and firmness of the longissimus muscle were not affected by treatment ($P > .12$).

Omitting the inorganic P source did not have a consistent effect on objective measurements (Hunter values) of color stability (Table 3). The muscle was lighter in color for all treatments before display, but with the inorganic P source omitted, the meat became less red and yellow and total lightness and pink color intensity decreased ($P < .07$). These trends were still present at d 3 and d 5, but omitting P did not cause greater rates of changes in any color determinations. Furthermore, all measurements were considered normal and in acceptable ranges. Thus, omitting the inorganic P source had minimal influence on pork muscle color and (or) color stability during display.

In conclusion, omitting up to 66% of the inorganic P source (i.e., down to .40% total P) from diets in late-finishing can improve profitability of swine operations feeding high-lean pigs to heavy slaughter weights.

Table 1. Diet Composition, %[a]

Ingredients	Control	Inorganic P omitted 33%	66%	100%
Corn	83.82	84.30	84.77	85.24
Soybean meal (46.5% CP)	12.37	12.33	12.29	12.25
Soybean oil	1.00	1.00	1.00	1.00
Monocalcium phosphate (21% P)	1.12	.75	.37	-
Limestone	.94	.87	.82	.76
Salt	.30	.30	.30	.30
Vitamin premix	.15	.15	.15	.15
Trace mineral premix	.10	.10	.10	.10
Lysine-HCl	.15	.15	.15	.15
Antibiotic	.05	.05	.05	.05
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Lysine, %	.70	.70	.70	.70
Ca, %	.65	.56	.47	.37
Total P, %	.55	.47	.40	.32
Available P, %	.29	.22	.14	.06

[a]All diets were formulated to a Ca:P ratio of 1.2 with other nutrients in excess of NRC (1988) recommendations.
[b]Provided 40 g/ton Tylosin.

Table 2. Effects of Omitting the Inorganic Phosphorus Source during Late-Finishing on Growth Performance, Carcass Characteristics, and Meat Quality[a,b]

Item	Total phosphorus % .55	.47	.40	.32	CV	Probability, P < Lin	Quad	Cub
ADG, lb	1.84	1.89	1.92	1.73	5.0	-[g]	.03	-
ADFI, lb	6.72	6.71	6.81	6.36	4.7	-	-	-
F/G	3.66	3.56	3.55	3.69	4.5	-	-	-
Total P intake, g/d	16.8	14.3	12.4	9.2	NA[h]	NA	NA	NA
Available P intake, g/d	8.8	6.7	4.3	1.7	NA	NA	NA	NA
Days to market (190-260 lb)	32.8	31.8	31.3	34.8	5.2	-	.03	-
Dressing percentage	65.7	65.7	66.0	65.6	1.1	-	-	-
Last rib backfat thickness, in	.63	.68	.69	.64	5.1	-	.02	-
Longissimus muscle depth, in	2.19	2.16	2.26	2.26	6.4	-	-	-
NPPC lean index, %[c]	49.4	48.8	48.8	49.4	.9	-	.02	-
Meat color[d]	2.5	2.4	2.5	2.5	6.7	-	-	-
Meat firmness[e]	2.3	2.4	2.5	2.6	15.1	0.12	-	-
Meat marbling[f]	2.1	2.1	2.0	2.6	9.8	-	-	-

[a]A total of 128 pigs with an average initial body wt of 190 lb (8 pigs/pen and 4 pens/treatment).
[b]Carcass measurements were adjusted for final live weight.
[c]Equation used was: Index=51.537 + (.035 × hot carcass wt) – (12.26 × off-midline backfat thickness) (NPPC, 1991).
[d]Scored on a scale of 1=pale, pinkish gray to 5=dark, purplish red (NPPC, 1991).
[e]Scored on a scale of 1=very soft and watery to 5=very firm and dry (NPPC, 1991).
[f]Scored on a scale of 1=practically devoid to 5=moderately abundant (NPPC, 1991).
[g]Dashes indicate P>.15.
[h]Not applicable means no statistical treatment of data.

Table 3. Measurements of Meat Color[a]

Item[b]	Total phosphorus % .55	.47	.40	.32	CV	Probability, P< Lin	Quad	Cub
Day 0								
Lightness	50.8	50.9	51.4	52.4	4.7	-[c]	-	-
Redness	13.3	11.8	12.9	11.7	11.7	-	-	.04
Yellowness	8.5	7.5	8.4	7.9	13.0	-	-	.07
Pink color intensity	15.8	14.0	15.4	14.1	11.5	-	-	.04
Day 3								
Lightness	51.4	51.3	52.8	53.5	4.3	.06	-	-
Redness	10.1	9.7	9.6	8.8	13.1	.07	-	-
Yellowness	8.0	7.7	8.2	7.4	9.7	-	-	.12
Pink color intensity	13.0	12.4	12.6	11.6	9.3	.05	-	-
Day 5								
Lightness	52.6	52.6	54.1	54.0	4.1	.13	-	-
Redness	8.5	8.3	7.6	7.7	15.3	-	-	-
Yellowness	8.3	7.7	8.2	7.6	10.8	-	-	.10
Pink color intensity	12.0	11.4	11.2	10.9	8.8	.06	-	-

[a]A total of 8 loins per treatment.
[b]MINOLTA CR-200 spectrocolorimeter values (lightness is Hunter 'L' value; redness is Hunter 'a' value; yellowness is Hunter 'b' value; pink color intensity is saturation index)
[c]Dashes indicate P>.15.