POSTFINISHING MINERALIZATION OF SKELETAL TISSUE IN REPLACEMENT GILTS

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Summary

Thirty-two crossbred gilts averaging 250 lb were selected for the experiment at the conclusion of the finishing phase. Eight of the gilts were slaughtered on d 0 to serve as a pretreatment control group. The remaining 24 gilts were assigned to three dietary treatments to provide daily 100% (14 g/d Ca and 11.3 g/d P), 150% (22.5 g/d Ca and 16.6 g/d P), and 200% (29.9 g/d Ca and 22.0 g/d P) of the Ca/P level consumed per d during the finishing phase. These gilts were slaughtered 35 d later at 291 lb. Gilts receiving 29.9 g/d Ca and 22.0 g/d P yielded ribs that had the highest values for percent ash, bending moment, and modulus of elasticity. Femurs did not differ in any bone characteristics because of treatment; however, the 3rd metacarpal bone showed the highest percent ash and greatest bending moment at the intermediate level of Ca/P.

(Key Words: GF, Performance, Calcium, Phosphorus, Sow.)

Introduction

The current NRC (1988) recommendations for Ca and P for finishing pigs are .50% and .40%, respectively, for growth rate and feed efficiency. However, to maximize bone parameters (wall thickness, modulus of elasticity, and percent ash) the recommendations for Ca and P are .90% and .75%, respectively. Research has shown that compensatory bone mineralization can occur between the growing phase (115 lb) and the conclusion of finishing (205 lb). Therefore, the objective of this study was to determine the effect of different levels of dietary Ca and P on bone mineralization of gilts after the finishing phase.

Procedures

Thirty-two crossbred gilts averaging 250 lb were selected at the conclusion of the finishing phase. Eight gilts were randomly selected for slaughter on d 0 to determine bone characteristics. The remaining 24 gilts were assigned by weight and ancestry to three dietary treatments. During the final 2 wk of the finishing period, the average daily feed intake had been determined to be 5 lb per d of a diet containing .65% Ca and .50% P. At this level of feed intake, the gilts were consuming 14.7 g of Ca and 11.3 g of P daily. Based on the daily feed intake of 5 lb/gilt, the dietary treatments were formulated to provide 100, 150, and 200% g of Ca and P received in the finishing phase. This resulted in daily Ca/P treatment levels of 14.7 g/11.3 g, 22.5 g/16.6 g, and 29.9 g/22.0 g, respectively. Monocalcium phosphate (21% P) was used as the source of P in a milo-soybean meal diet (Table 1). Limestone was used to provide Ca in a calculated 1.3:1 Ca:P ratio.

The 24 gilts were housed in a modified open front building. Eight gilts were maintained in each pen measuring 6 ft × 16 ft. The concrete floors of the pens were partially slatted (50%). The gilts were fed twice a day on the floor to reduce feed wastage and behavior problems. The gilts remained on trial for 35 d.

At the conclusion of the trial, the gilts were weighed and slaughtered. The 3rd metacarpal, 1st rib, and femur from the right side of each carcass were collected for determining bone characteristics.

Table 1. Composition of Diets

		Percent of control diet		
	Initial	100	150	200
Ca, g :	14.7	14.7	22.5	29.9
Ingredient, % P, g :	11.3	11.3	16.6	22.0
Milo	80.30	81.50	79.68	77.87
Soybean meal[a]	17.00	15.68	16.03	16.35
Monocalcium phosphate	.90	.82	1.93	3.08
Limestone	.95	1.15	1.52	1.84
Salt	.50	.50	.50	.50
Vitamin premix	.25	.25	.25	.25
Trace mineral premix	.10	.10	.10	.10

[a]The control diet was formulated with 44% CP soybean meal; treatment diets were formulated with 48.5% CP soybean meal.

Results and Discussion

The calculated and analyzed compositions of the diets are presented in Table 2. After 35 d on trial, the average slaughter weight of the gilts was 291 lb. No difference in average daily gain because of treatment was observed. No differences were observed in carcass data (avg backfat thickness, carcass length, and longissimus muscle area) from treatment.

The mechanical properties and percentage ash of the bones are shown in Table 3. Although the Ca/P levels of the control diet were continued as a treatment, there was a tendency for the bone mechanical properties of this treatment to be lower than those observed in the gilts slaughtered initially. It should be noted that the feed intake was estimated at 5 lb/d while the gilts were still in the finishing phase. However, the gilts were being fed with barrows ad libitum, which could have resulted in an underestimation of actual feed intake of the gilts because of the estimated correction for barrows in the pen. The actual daily feed intake based on analyses of the diets (Table 2) shows the original gilts were receiving 3 g more P/d than those gilts with the continued treatment based on the same feed intake.

Table 2. Analyses of Diets

Item	Initial	Percent of control diet		
		100	150	200
Ca, g :	14.7	14.7	22.5	29.9
P, g :	11.3	11.3	16.6	22.0
Calculated, %				
Crude protein	14.70	14.70	14.70	14.70
Ca	.65	.65	.99	1.32
P	.50	.50	.73	.97
Analyzed, %				
Crude protein	16.48	15.19	15.57	13.95
Ca	.79	.78	1.00	1.33
P	.62	.49	.68	.91
Actual daily intake[a], g				
Ca	17.9	17.7	22.7	30.2
P	14.1	11.1	15.4	20.7
Actual ratio of Ca:P[b]	1.3:1	1.6:1	1.5:1	1.5:1

[a]Based on 5 lb of feed intake per gilt per day. Control diet was fed ad libitum in finishing phase.
[b]Ratio based on diet analyses.

The postfinishing levels of Ca and P in the diet did not influence any mechanical properties or the percentage ash of the femur. Effects of treatment on bone mechanical properties are given in Table 3. Modulus of elasticity, or the rigidity of the bone, was highest at the end of the finishing phase but appeared to decrease during the 35-d postfinishing period. Of the three bones evaluated, the rib was the most responsive. A linear increase ($P<.05$) in modulus of elasticity was observed with increased Ca/P levels. Gilts receiving the highest treatment (29.9 g Ca and 22 g P) had the highest values for bending moment, modulus of elasticity, and percentage ash. Percentage of ash also tended to increase linearly ($P<.16$). Maximum bending moment values were obtained from metacarpals of gilts fed 22.5 Ca and 16.6 g P. The highest level of Ca/P (29.9 g and 22.0 g) resulted in the highest percent of ash. The gilts slaughtered initially yielded metacarpals that had the highest modulus of elasticity compared to those from gilts slaughtered 35 d later. Table 4 shows the data for serum P, Ca, and alkaline phosphatase (AP). The overall final values of P were significantly lower ($P<.01$) than the overall initial values. There was a reduction within treatment between the initial and final P levels for the highest two dietary treatments of Ca and P. Although final levels of calcium were slightly elevated compared to initial values, the differences were not significant. In general, serum P tended to decrease from the initial bleeding to the final period, whereas Ca tended to increase. This inverse relationship of Ca and P has been reported by other researchers working with growing swine, but does not appear to exist for mature animals such as sows. There were no differences in serum AP. Maximum calcification was associated with low AP levels.

Table 3. Bone Mechanical Properties and Mineralization of Gilts Fed Different Levels of Calcium and Phosphorus

		Percent of control diet			
	Initial	100	150	200	
Ca, g :	14.7	14.7	22.5	29.9	
Item P, g :	11.3	11.3	16.6	22.0	CV
Femur[a]					
Bending moment, kg	424	393	426	409	18.9
Modulus of elasticity, kg/cm^2	1,363	1,348	1,180	1,217	44.6
Wall thickness, cm	.42	.40	.42	.39	12.0
Stress, kg/cm^2	32.0	274	278	278	
Ash, %	71.40	71.10	71.10	71.25	1.1
Rib					
Bending moment, kg[d]	125[b]	137[bc]	149[bc]	158[c]	19.6
Modulus of elasticity, kg/cm^2	8,659[bc]	6,605[b]	9,130[bc]	10,606[c]	39.3
Stress, kg/cm^2	695[bc]	567[b]	747[c]	776[c]	
Ash, %[de]	56.47[b]	58.21[bc]	59.20[c]	59.51[c]	3.2
3rd Metacarpal					
Bending moment, kg	235[b]	248[b]	291[c]	258[bc]	15.3
Modulus of elasticity, kg/cm^2	2,615	2,045	2,387	1,926	39.4
Stress, kg/cm^2	714	625	779	716	
Ash, %	60.84	60.77	61.35	61.58	1.9

[a]Control treatment represents the right femur; remaining treatments and CVs represent the pooling of the right and left femur.
[bc]Means with unlike superscripts differ (P<.05).
[d]Linear effect of treatments (P<.05).
[e]Contrast of control vs treatments is significant (P<.01).

Table 4. Serum Blood Values of Gilts Fed Different Levels of Calcium and Phosphorus[a]

		Percent of control diet			
	Initial	100	150	200	
Ca, g :	14.7	14.7	22.5	29.9	
Item P, g :	11.3	11.3	16.6	22.0	CV
P (g/dl)[b]					
Initial	7.03	6.50	7.01[c]	7.07[e]	10.4
Final		5.82	5.97[d]	5.73[f]	16.3
Ca (mg/dl)					
Initial	13.41	12.93[c]	13.82	12.35	13.8
Final		14.46[d]	14.17	13.66	11.1
Alkaline phosphatase (Sigma units)					
Initial	1.35	1.32	1.28	1.42	21.9
Final		1.21	1.25	1.22	19.0

[a]Eight gilts per treatment; controls were slaughtered on d 0.
[b]Final values differ from initial (P<.001).
[cd]Means in columns with unlike superscripts differ (P<.05).
[ef]Means in columns with unlike superscripts differ (P<.01).