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CALCIUM AND PHOSPHORUS RETENTION IN THE CARCASS OF IBERIAN PIGS GROWING FROM 50 TO 100 KG BODY WEIGHT FED HIGH AND LOW DIETARY PROTEIN CONCENTRATIONS

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ABSTRACT

Calcium and phosphorus retention in the carcass of Iberian barrows growing from 50 to 100 kg body weight (BW) were determined. Twenty-eight pigs were randomly assigned to a 2 × 2 factorial arrangement of treatments, with 2 dietary protein concentrations (145 g CP/kg of dry matter (DM) and 70 g/kg DM), 2 feeding levels (0.95 × and 0.80 × *ad libitum*) and 7 pigs per treatment combination. Two diets of similar metabolisable energy (ME) were prepared, which provided excess or marginally deficient amounts of amino acids relative to requirements. Six additional pigs were slaughtered at the start of the trial to estimate initial carcass composition. The comparative slaughter procedure was used. Better performance was obtained for pigs fed the diet containing 70 g CP/kg of BW. Carcass protein and water retention was not affected by dietary protein level, whereas fat deposition increased in pigs fed the diet of 70 g CP/kg of DM ($P < 0.001$). Total ash retention increased in pigs fed the higher protein content diet ($P < 0.05$), although there was no effect of dietary protein concentration in daily retention of Ca and P. Our results indicate that Ca and P retention in the carcass attains average values of 4.7 and 2.3 g/day, respectively, which suggest a minimum net daily requirement of 6.0 g Ca and 2.9 g of P to attain optimum bone mineralization for Iberian pigs growing from 50 to 100 kg BW. A high excess of protein supply did not affect daily carcass retention of Ca and P.

Key words: carcass retention / calcium / phosphorus / dietary protein / Iberian pig

1 INTRODUCTION

The potential of the Iberian pig for growth and lean tissue deposition is low compared to conventional pig genotypes. We have previously shown that in this native pig breed amino acid requirements across all growth stages are below those for leaner pig types (Nieto *et al.,* 2012).

A high correlation has been established between whole-body protein and mineral contents for pigs (Rymarz *et al.,* 1982; Hendriks and Mounhan, 1993). Nevertheless, there is limited information on swine body mineral composition and, in the case of the Iberian pig, it is very scarce. We have reported that for Iberian pigs growing from 15 to 50 kg BW the net Ca and P requirements, based on whole-body direct analyses, are considerably lower than those estimated for leaner pig breeds (Nieto *et al.,* 2008). The effect of dietary protein concentration was also investigated as this parameter has been linked to increased Ca excretion in some human and rat studies (Kerstetter *at al.,* 2005).

The objective of the present study was to determine Ca and P retention in the carcasses of Iberian pigs from 50 to 100 kg BW as an index of Ca and P requirements for pigs at this stage of growth. Additionally, the effect of an excess of protein well over requirements on carcass Ca and P content and retention was also investigated.

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2 MATERIALS AND METHODS

The experimental protocol was reviewed and approved by the Bioethical Committee of the Spanish National Research Council (CSIC).

A total of 34 Iberian barrows (49.9 ± 0.09 kg initial BW) were used. 28 out of them were randomly assigned to the treatments. In a 2 × 2 factorial arrangement, 2 dietary protein concentrations and 2 feeding levels (0.95 × and 0.80 × *ad libitum*) were studied with 7 pigs per treatment. Two diets of similar ME content were prepared from a high protein content mixture, based on barley and soybean meal (formulated according to the ideal protein concept, BSAS, 2003), diluted (app. 1:1) or not with a protein-free component, made of corn, starch, cellulose, vegetable oil and a mineral-vitamin premix. The protein-free mixture matched the nutrient content of the high protein mixture, so relative nutrient proportions in the 2 diets remained constant, except for amino acids. Dietary protein contents were either in excess (145 g/kg of DM; HP diet) or marginally deficient (70 g/kg of DM; LP diet) for Iberian pigs of this BW range (Barea *et al.,* 2007). Each diet was offered at two feeding levels (0.95 × and 0.80 × *ad libitum*) daily, in 2 equal meals. Water was freely available. The experimental diets contained (as analyzed): 145 g crude protein (CP)/kg of DM, 13.9 MJ ME/kg of DM, 7.9 g digestible protein/MJ of ME, 10.7 g Ca/kg of DM and 6.3 g P/kg of DM for the HP diet, and 70 g CP/kg of DM, 14.8 MJ ME/kg of DM, 3.7 g digestible protein/MJ of ME, 10.6 g Ca/kg of DM and 6.5 g P/kg of DM for the LP diet. Pigs were housed in 2 m^2 individual pens in an environmentally controlled room (19.0 ± 1.5 °C) until they reached 100 kg when they were slaughtered. Pigs were weighed weekly before feeding and for each animal the daily feed allowance for the following week was adjusted accordingly. At 100 kg BW pigs were electrically stunned and bled. After emptying the gut, carcass and non-carcass parts were weighed separately and kept at –20 °C until analysis. The carcass without head was split longitudinally. The right half of the carcass was cut into small pieces and grounded, and sub-samples were taken for freeze-drying and subsequent analysis. Aliquot samples were analyzed for DM content, CP (total N × 6.25), gross energy and ash as described by Conde-Aguilera *et al.* (2011). Fat deposition was calculated from total body gross energy assuming energy contents of 23.85 and 39.75 kJ/g for protein and fat, respectively. Ca and P in feeds and pig tissues were analysed by flame atomic absorption spectrophotometry as described in Nieto *et al.* (2008). Six pigs were slaughtered at the start of the trial to estimate initial carcass composition. Increases in protein, energy, fat, ash, Ca and P were calculated as the difference between final measured carcass composition of experimental pigs and estimated initial carcass composition assessed from the initial group.

Treatment effects were assessed by analysis of variance using the GLM procedure of SAS (SAS Inst. Inc. Carry, NC). The effects of dietary protein content, feeding level and their interaction were included in the statistical model. Individual pig was the experimental unit. The level of significance was set at 5%. Interactions were never significant.

3 RESULTS AND DISCUSSION

Average daily feed intakes reached 3,099 g for

Table 1: *Nutrient and mineral retention in the carcass of Iberian pigs growing from 50 to 100 kg BW fed diets differing in protein concentration at two feeding levels*[1]

	Protein (g/day)	Fat (g/day)	Water (g/day)	Ash (g/day)	Ca (g/day)	P (g/day)
Protein content, (g/kg of DM)						
145	37.6	358.9	143.3	15.3	4.78	2.34
70	39.1	425.4	136.4	12.2	4.67	2.26
SEM	1.7	12.5	6.1	1.0	0.35	0.14
P-value	0.541	0.001	0.432	0.045	0.819	0.684
Feeding level (× *ad libitum*)						
0.95	42.2	426.8	149.8	15.4	5.06	2.44
0.80	34.5	357.5	129.8	12.1	4.39	2.15
SEM	1.7	12.5	6.1	1.0	0.35	0.14
P-value	0.004	0.001	0.029	0.036	0.182	0.161

[1] Mean values for 7 pigs per each dietary protein content × feeding level combination

0.95 × *ad libitum* and 2,639 g and 0.80 × *ad libitum* fed pigs. Daily rates of body (737 *vs.* 681 g/day, $P < 0.01$) and carcass (601 *vs.* 548 g/day, $P < 0.001$) growth were greater in pigs fed the LP diet. Gain feed ratio was also greater in the pigs on the LP diet (0.258 *vs.* 0.236 g gain/g feed, $P < 0.001$). All performance variables indicate that protein requirements at this stage of growth are rather low, as reported previously (Barea *et al.* 2007).

Carcass accounted for 0.781 g/g of whole-body weight, on average. The effect of dietary treatments upon nutrient and mineral retention (g/day) in the carcass of pigs is shown on Table 1. Carcass protein and water retention was not affected by dietary protein level, whereas fat deposition increased in pigs fed the diet containing 70 g CP/kg of DM ($P < 0.001$). Total ash retention increased in pigs fed the HP diet ($P < 0.05$), although there was no effect of dietary protein concentration on daily retention of Ca and P. The total amount of Ca and P in the carcass at 100 kg BW was not affected by dietary protein concentration ($P > 0.05$), attaining 580 ± 17.9 g and 308 ± 7.3 g for Ca and P, respectively. In Iberian pigs growing from 15 to 50 kg BW, whole-body daily deposition of Ca and P showed no effect to protein concentrations ranging from 192 to 101 g/kg of DM (Nieto *et al.,* 2008), which is in agreement with the present results. At 100 kg BW, the carcass of pigs on the HP diet showed greater ash concentration (28.6 *vs.* 24.3, g ash/kg of carcass, $P < 0.01$, respectively). Nevertheless, ash was more enriched in Ca (0.306 ± 0.011 *vs.* 0.280 ± 0.011 g Ca/kg of ash, $P = 0.10$) and P (0.166 ± 0.005 *vs.* 0.148 ± 0.005 g P/kg of ash, $P = 0.01$) in the carcass of pigs on the LP diet. This later fact may indicate better bone mineralization in the pigs receiving no excess of dietary protein.

Pigs fed at the higher feeding level deposited daily more protein, fat, water and ash in the carcass (Table 1), in agreement with previous observations (Nieto *et al.,* 2003). Carcass retention of Ca and P, although numerically higher for pigs at the higher level of feeding, showed no significant effect to feed intake. In younger Iberian pigs (15 to 50 kg BW) total daily deposition of Ca and P did respond to feeding levels similar to those used in the present study (Nieto *et al.,* 2008). Carcass retention of Ca and P were significantly related by the following equation:

$$\text{Ca retention}\left(\frac{\text{g}}{\text{day}}\right) = 2.031 \pm 0.0479 \times \text{P retention}\left(\frac{\text{g}}{\text{day}}\right);$$

$P < 0.001$, rsd = 573

Our results indicate that Ca and P retention in the carcass of the Iberian pig growing from 50 to 100 kg BW attain average values of 4.7 and 2.3 g/day, respectively. Assuming similar mineral concentration for carcass and whole-body, Iberian pigs would require at this stage of growth, at least, net amounts of 6.0 g Ca and 2.9 g of P to achieve optimum bone mineralization.

Although it can be concluded that dietary protein concentration provided well above requirements does not affect daily Ca and P retention in carcass, the results obtained so far indicate better bone mineralization for pigs fed low protein content diets. Research on progress would help to clarify this issue.

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