

Relationship between mineral and protein deposition in restricted and realimented pigs

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ABSTRACT

Mineral retention and its relation to protein deposition was measured in 54 crossbreed pigs allocated to a control and two restricted (up to 50 or 80 kg BW) groups. Control pigs were continuously fed a basal diet (B) and restricted pigs, diet B mixed with 20% grass meal. During re-alimentation, previously restricted pigs were fed diet B up to 105 kg. The animals were slaughtered at 25, 50, 80 and 105 kg BW. The previously restricted pigs showed a compensatory response with regard to protein as well as P, Ca and Mg deposition. The reaction in both protein and minerals depended on the duration of previous restriction and was full only in the pigs restricted to 50 kg BW. According to an allometric equation, the mineral content increased faster ($b > 1$) than protein. Compensatory mineral gains in the body were closely related to protein gain and the daily mineral/protein deposition ratio was the same in all treatments.

KEY WORDS: protein, minerals, pigs

INTRODUCTION

A positive correlation between protein and mineral deposition in the pig body has been documented (Rymarz et al., 1982; Mahan and Shields, 1998). It is also known that in temporarily restricted pigs, protein deposition is decreased, but during subsequent realimentation, it is enhanced. However, information on mineral deposition in so-treated pigs is lacking. Thus, the aim of the study was to assess mineral deposition in pigs in relation to protein accretion during restriction and realimentation.

MATERIAL AND METHODS

Fifty-four crossbreed pigs from 25 to 105 kg body weight were kept individually and fed *ad libitum*. Two diets, basal (B) and high-fibre (F) were used.

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Diet B contained 13.1 MJ EM and 8.9 g digestible lysine, 5.29 g total phosphorus, 6.7 g calcium (with Ca:P ratio of 1.3:1), and 119 g zinc. Diet F was a mixture of diet B (80%) and grass meal (20%) and contained less energy, digestible lysine, total and digestible phosphorus, calcium and zinc by 12, 17, 8, 11, 7 and 8%, respectively. Control pigs were continuously fed the basal diet. The F_{50} and F_{80} pigs were restricted by feeding them diet F up to 50 or 80 kg, respectively. During realimentation, all previously restricted pigs were fed diet B up to 105 kg. The animals were slaughtered at 25 (n=6), 50 (n=12; 6 each from groups B and F), 80 (n=18; 6 each from groups B, F, and F_{50}) and 105 kg (n=18; 6 each from groups B F_{50} and F_{80}). The protein content was determined according to standard methods (AOAC, 1990), P spectrophotometrically using molybdovanadate as the colour-forming reagent, Ca and Zn from ash solutions by atomic absorption spectrophotometry. Protein and mineral retention in the body were calculated from the difference between their final and initial contents in a particular growth stage using the comparative slaughter technique.

RESULTS AND DISCUSSION

At 25 kg the body of pigs contained 4.0 kg of protein, 580 g of ash and 115, 196, 6.58 and 0.41 g of P, Ca, Mg and Zn, respectively. The content of these components increased with growth and, in pigs fed on diet B up to 105 kg liveweight, reached levels of 15.2 kg of protein, 2.6 kg ash of ash and 485, 850, 28 and 1.9 g of P, Ca, Mg and Zn, respectively; these values are similar to those reported by Kirchgessner et al. (1994).

During restriction up to 50 kg (group F_{50}), pigs deposited daily 24 g less protein ($P<0.05$) as compared with the B pigs. This was associated with a significant decrease of ash and P deposition (16.8 vs 20.6 and 2.5 vs 3.4 g/day, respectively). Retention of the remaining minerals was also less in restricted pigs: by 0.9 g of Ca, 38 mg of Mg and 2.1 mg Zn (differences nonsignificant).

Pigs restricted from 25 to 80 kg (F_{80}) reduced protein and phosphorus deposition by 9 and 0.4 g, and zinc retention by 2.7 mg, but the deposition of other minerals during this time was similar. However, at 80 kg they were 6 days older than their analogues from the control group. In this growth period, pigs re-alimented from 50 kg (F_{50}) increased daily protein deposition by 19 g ($P<0.01$) and P retention by 0.5 g ($P<0.01$) more than restricted animals. The F_{80} and F_{50} pigs also deposited more Ca.

When the total growth period (25-105 kg) was considered, pigs from the basal group and those realimented from 50 kg deposited similar amounts of protein, ash, P, Ca and Mg. However, in pigs realimented from 80 kg, deposition of body

components was lower than in control animals, which may indicate that compensation in this group was not complete. Therefore, a certain compensatory response could be expected during subsequent growth, which was examined by an allometric model with protein content in the body as the independent variable. In calculations, 3 different paths of growth: control and two restricted/realimentd were separated. Table 2 shows that “b” (growth coefficient) is generally higher (by 3-6%) in pigs from group F₅₀ than in controls, except Ca, which indicates that compensatory retention of minerals takes place. In F₈₀ pigs, the growth coefficients were on similar levels or slightly lower as compared with control pigs, indicating that restriction prolonged up to 80 kg was too severe and the animals could not compensate deposition of body components. This suggests that the intensity of the compensatory response with regard to mineral retention depends on the duration of previous restriction.

Table 2. Relationship between protein (in kg) and mineral (Y) content in the body during growth of pigs from 25 to 105 kg as expressed by the formula: $Y = a * \text{protein}^b$

Minerals	Group of pigs	a	b	R ²
P, g	Basal (B)	19.3 ± 4.06	1.175 ± 0.08	98.1
	Compensatory F ₅₀	17.0 ± 3.55	1.213 ± 0.08	98.2
	Compensatory F ₈₀	18.9 ± 8.45	1.164 ± 0.17	98.2
Ca, g	Basal (B)	38.8 ± 6.97	1.134 ± 0.07	98.2
	Compensatory F ₅₀	40.8 ± 7.88	1.117 ± 0.08	97.9
	Compensatory F ₈₀	52.1 ± 7.60	1.013 ± 0.06	98.5
Mg, g	Basal (B)	1.7 ± 0.41	1.025 ± 0.09	95.9
	Compensatory F ₅₀	1.6 ± 0.26	1.052 ± 0.06	98.2
	Compensatory F ₈₀	2.1 ± 0.49	0.944 ± 0.09	94.8
Zn, mg	Basal (B)	76.9 ± 14.82	1.167 ± 0.07	98.7
	Compensatory F ₅₀	62.5 ± 18.80	1.237 ± 0.12	96.7
	Compensatory F ₈₀	72.9 ± 12.24	1.181 ± 0.07	98.6

The values of growth coefficients also indicate that the amount of deposited minerals increased at a faster rate (“b”>1) than the amount of protein, which is in agreement with earlier results reported by Rymarz et al. (1982). Correlation between the mineral and protein content in the body was high and ranged from 94.8 for Mg to 98.7 for Zn. This confirms earlier findings that accretion of protein and minerals is closely connected, and the ratio of daily mineral/protein deposition was the same for all treatments in the investigated growth period. This ratio was the highest for Ca/protein (average 0.060), lowest for Zn/protein (average 0.00012) and rose with increasing body weight of pigs.

CONCLUSIONS

Pigs with temporarily restricted growth showed a compensatory response with regard to protein as well as P, Ca and Mg deposition. This response in both protein and minerals depended on the duration of previous restriction and was full only in those pigs that were restricted up to 50 kg body weight. Compensatory mineral gains in the body were closely related to protein gain. The daily mineral/protein deposition ratio was the same in all groups.

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STRESZCZENIE

Zależności między odkładaniem białka i składników mineralnych u świń żywionych w sposób ograniczony i podczas realimentacji

Zależności między odkładaniem białka i składników mineralnych określono na 54 świnich podzielonych na grupę kontrolną i dwie grupy żywione restrykcyjnie (do 50 lub 80 kg m.c.). Świnie z grupy kontrolnej były żywione dietą standardową (B), z grup restrykcyjnych dietę B z 20% dodatkiem suszu z traw. Podczas realimentacji świnie z obydwóch grup restrykcyjnych otrzymywały dietę B. Zwierzęta ubito przy masie ciała 25, 50, 80 i 105 kg. U świń żywionych restrykcyjnie stwierdzono reakcję kompensacyjną w odkładaniu białka oraz P, Ca i Mg. Kompensacja zależała od długości okresu restrykcji i była pełna tylko u świń żywionych restrykcyjnie do m.c. 50 kg. Alometryczne równania wykazały, że zawartość składników mineralnych w ciele wzrasta szybciej ($b'' > 1$) niż zawartość białka. Kompensacyjny przyrost składników mineralnych w ciele był ściśle zależny od przyrostu białka, a proporcja dziennego odłożenia składników mineralnych do białka była taka sama w badanych grupach.