Proceedings 4th World Rabbit Congress, 10-14 October 1988, Budapest Hungary, Vol. 2, 449-457

EFFECT OF VARYING CALCIUM INTAKE ON THE PARAMETERS OF CALCIUM AND PHOSPHORUS METABOLISM OF GROWING ANGORAS

Fébel, H. - Régius, Á.

Research Center for Animal Breeding and Nutrition,
Institute for Animal Nutrition, H-2053 Herceghalom

Introduction

A review of the literature reveals little quantitative or even qualitative information on the mineral metabolism of rabbits. In experiments on calcium tolerance of rabbits it was noted that high levels of calcium (to 4,5 % calcium diet) do not apparently effect performance of young growing rabbits (Chapin and Smith, 1967b). But raising the calcium level of a 0,37 % phosphorus diet to 5 % to give a 14:1 Ca:P ratio depressed the growth rate. It appeared that the rabbits were much more tolerant of high calcium and normal phosphorus levels than vice versa (Chapin and Smith, 1967a).

In a preliminary trial Chapin and Smith (1967) found that a dietary calcium level of 0,22 % would support maximum gain in weight but a higher calcium levels of 0,35 to 0,4 % were required for maximal bone calcification (Chapin and Smith, 1967). Information on the interrelationships and antagonisms between minerals is particularly scanty.

The work reported here was designed to study the effects of varying calcium intake on calcium and phosphorus metabolism of young growing Angora rabbits.

Materials and Methods

Fifteen male Angora rabbits, aged 4 weeks were used. The animals were housed individually in metabolism cages. The animals were introduced to the experimental diets in the pre-experimental period lasting 2 weeks. Than the experimental period followed lasting 6 weeks (to 12 weeks of age). The feed was offered ad libitum. The rabbits were divided into three treatment groups (denoted A, B, C) five rabbits per treatment. The basal diet contained 9,0 g calcium/kgDM and 4,5 g phosphorus/kg DM (Ca:P ratio 2:1). Desired calcium levels were obtained by adding calcium carbonate to the basal diet. The concentration of calcium in the diet of groups B and C was 13,6 and 19,4 g calcium/kg DM respectively. For the study of calcium and phosphorus metabolism faeces and urine were collected in the experimental period for 5 days weekly. Faecal and urine samples were subsequently analyzed for their calcium and phosphorus content. Each sample was dry ashed at 550 ^{o}C. The ash was extracted with 10 % HCl. Calcium determination was made by atomic absorption spectrophotometry while a colorimetric method was used for phosphorus.

Blood samples were taken from the marginal ear veins of the rabbits at the start of the experimental period and at 20-days intervals for calcium, inorganic phosphorus and alcalic phospatase activity analyses. At the end of the test period (at 12 weeks of age) the rabbits were killed and the left femur removed, and dissected free of soft tissues. Femur were weighed immediately, dried at 60^{o}C to a constant weight, ether-extracted and dried. The bones were then ashed at 550 ^{o}C, and bone analyses for moisture, total ash, calcium and phosphorus were done. Standard methods were used for determining significance by *t* tests.

Results

The amount of the urine volume (ml/day) was not affected by the calcium concentration of the diet. The concentration of calcium in the urine, however, increased significantly in groups B and C where the animals were fed the higher calcium diet (Fig. 1.). As seen in this figure that urinary phosphorus excretion, however, decreased significantly as the calcium content of the diet increased.

The results for faecal excretion of calcium and phosphorus are summarized in Fig. 2. Faecal calcium values were on the same level in group A between weeks 1 and 5, but the amount of excreted calcium in the faeces increased int the 6th week. In the calcium content of the faeces, however, a significant increase was observed as dietary calcium was increased, and faecal calcium excretion tended to increase with time.

It should be noted, however, that the phosphorus content of the faeces showed a slight increase as the calcium concentration of the diet increased.

From the records of calcium and phosphorus content of the urine and the faeces it was possible to calculate the amount of renal excretion of calcium and phosphorus. Fig. 3. presents the renal excretion of calcium and phosphorus in relation to the total excreted calcium and phosphorus. Most of the calcium was excreted via the urine independent of calcium intake . In the beginning of the experimental period 75 % of the total excreted calcium was excreted in the urine. Although renal calcium excretion later tended to decrease because its value was about 15 % smaller.

In the case of phosphorus excretion, the major route of excretion was the faeces. The amounts of the faecal loss, however, were different among the groups.

Rabbits fed the higher calcium diet in week 1 and 3 of the study retained significantly more calcium than the rabbits given the diet A. In contrast, calcium retention, expressed as percentage of calcium intake, was smaller for groups B and C than group A. The average phosphorus intake was similar among treatment groups in every case during the experimental period. Bot phosphorus retention and phosphorus retention, expressed

as percentage of phosphorus intake significantly increased in groups B and C in the 2nd week of the experimental period. Raising the levels of calcium intake, however, the amount of phosphorus retained of rabbits did not change significantly in the other cases.
The plasma concentration of inorganic phosphorus was unaffected by the treatments. The average serum concentration of calcium showed slight changes. The serum concentration of calcium ranged from 3,23 to 3,57 mmol/l in group A and from 3,27 to 3,57 mmol/l in group B. The concentration of calcium was higher for group C (ranged from 3,52 to 3,77 mmol/l) than groups A and B. There were no significant differences due to the treatment in the alcalic phosphatase activity during the 6-week period of the study. No differences were observed in moisture, total ash, calcium and phosphorus content of the femur.

Discussion

The certain parameters of calcium and phosphorus metabolism of young growing Angoras fed varying dietary calcium level were investigated. From the results concerning calcium metabolism it can be established that the calcium content of the faeces was significantly higher at the animals of groups B and C as well as the faecal calcium excretion showed a gradually rising tendency during the experimental period. In the ratio of calcium intake of the rabbits fed the higher calcium diet, however, was considerably more than the amount of excreted calcium in their faeces. These changes could produce an incerased calcium absorption from the intestine at the animals of groups B and C. In earlier experiments on calcium and phosphorus metabolism of rabbits (Carstensen, 1984, Kamphues et al., 1986) it was noted that the rabbits are apparently highly efficient at absorbing calcium from its diet, and absorption rates of calcium increased linearly with forced calcium intakes. The authors suggested that calcium absorption from the intestine is not regulated by the requirements of the rabbits.
The higher amounts of absorbed calcium were excreted via the urine mainly with constant urine volumes. According to Kennedy's hypothesis, the renal homeostatic mechanism acts on the calcium

balance to increase calcium excretion in the urine. Cheeke and Amberg (1973) demonstrated that in the rabbit the kidney appears to play a major role in maintaining calcium homeostasis. This proposal is adequate explanation for our observations that in groups B and C excreted more calcium in the urine during the experimental period than in group A. Increases in urinary calcium excretion in response to greater calcium intakes, may be due to an increased glomerular calcium filtration and decreased calcium reabsorption in distal tubules and collecting ducts. With forced calcium intake there was a tendency for higher calcium concentrations in the plasma. This phenomenon was in conformity with the experiences of others (Chapin and Smith, 1967, Kamphues et al., 1986). The bones of all groups contained equal contents of calcium and phosphorus. Alcalic phosphatase activity of serum was unaffected by the treatments. These data demonstrated that the rabbits could maintain calcium homeostasis and the animals could adapt to an increased intake of calcium.

A different machanism existed when phosphorus metabolism was considered. In the case of phosphorus excretion, the major route of excretion was the faeces. The treated rabbits tended to have higher phosphorus concentration in the faeces and smaller concentration in the urine. In contrast, phosphorus retention did not decrease, futhermore there were no significant differences in phosphorus content of the bones and in plasma inorganic phosphorus value between the groups.
These results can be explained by increased tubular phosphorus reabsorption in the kidney which was closely related to decrease of urinary phosphorus excretion.

According to the results of our experiment, the calcium and phosphorus metabolism of growing Angoras is significantly influenced by raising Ca:P ratio of 2:1 to 4,5:1.
On the basis of observed changes we can obtain that although the rabbits could adapt to an increased intake of calcium, great attention should be paid to the calcium supply in the diet of Angoras. The higher calcium content than 9,0 g calcium/kg DM (Ca:P ratio 2:1) must be avoided in the food of Angoras.

References

1. Carstensen, P. (1984): Untersuchungen zum Kalziumstoffwechsel ausgewachsener Kaninchen. Inaugural-Dissertation, Hannover.

2. Chapin, R.E. and Smith, S.E. (1967): Calcium requirement of growing rabbits. J.Anim.Sci. 26. 68.

3. Chapin, R.E. and Smith, S.E. (1967a): High phosphorus diets fed to growing rabbits. Cornell Vet. 57. 492.

4. Chapin, R.E. and Smith, S.E. (1967b): Calcium tolerance of growing and reproducing rabbits. J.Anim.Sci. 26. 905.

5. Cheeke, P.R. and Amberg, J.W. (1973): Comparative calcium excretion by rats and rabbits. J.Anim.Sci. 37. 450.

6. Kamphues, J., Carstensen, P., Schroeder, D., Meyer, H., Schoon, H.A., and Rosenbruch, M. (1986): Effekte einer steigenden Calcium- und Vitamin D- Zufuhr auf den Calciumstoffwechsel von Kaninchen. J.Anim. Physiol. Anim. Nutr. 56. 191.

7. Kennedy, A. (1965): The urinary excretion of calcium by normal rabbits. J.comp. Pathol. 75, 69.

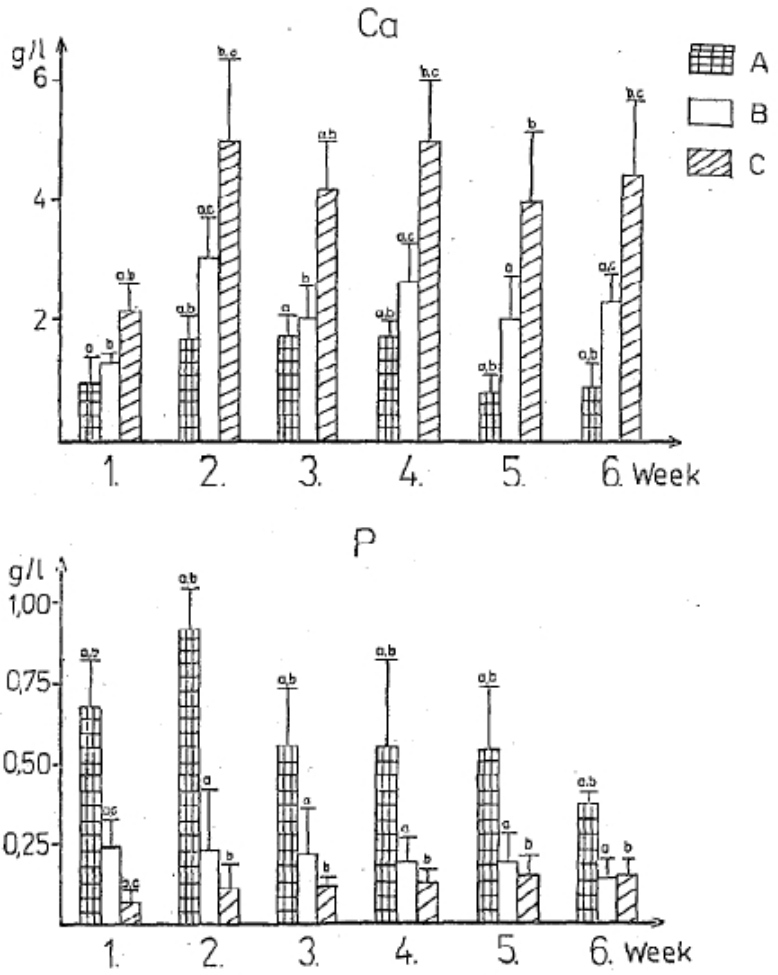

Fig. 1. Ca and P concentration of urine (g/l/5d)

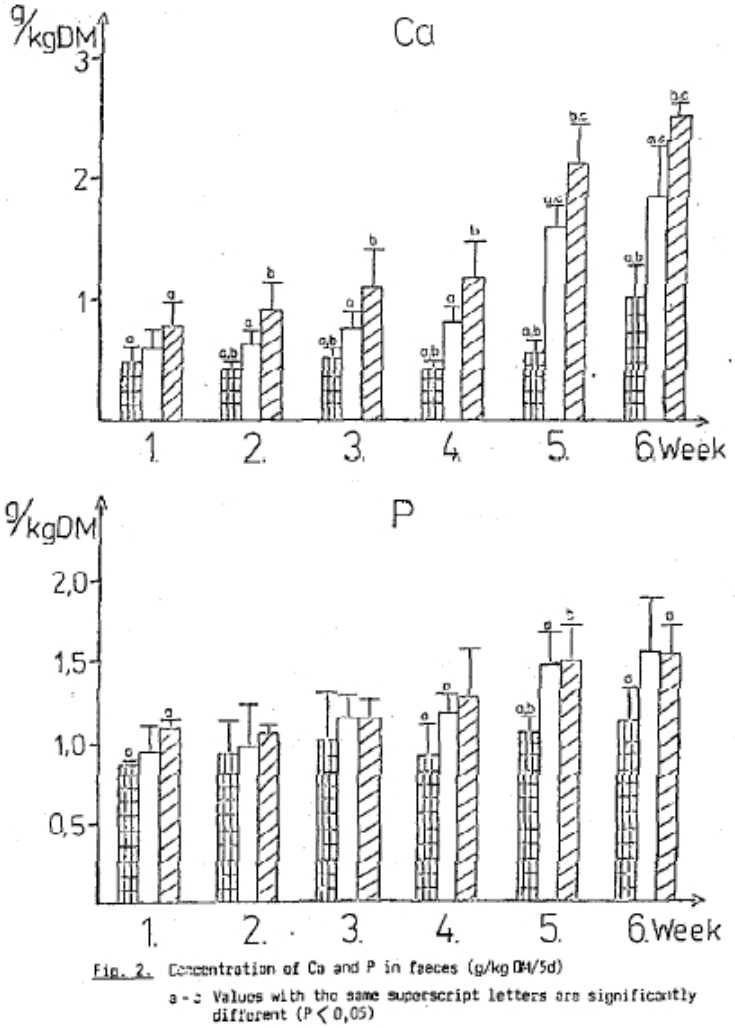

Fig. 2. Concentration of Ca and P in faeces (g/kg DM/5d)

a - c Values with the same superscript letters are significantly different ($P < 0,05$)

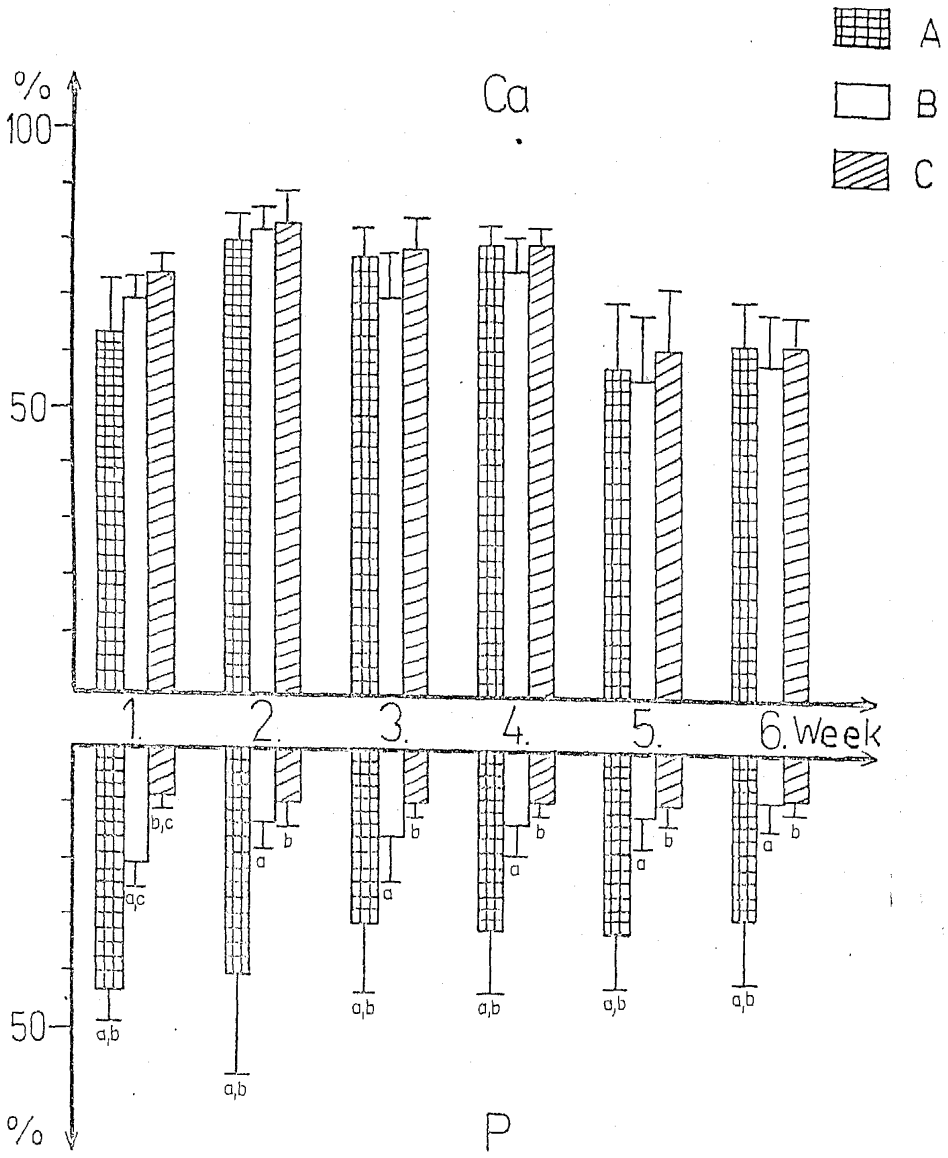

Fig. 3. Renal excretion in relation to total excreted Ca and P

a - c Values with the same superscript letters are significantly different ($P < 0,05$)

Proceedings 4th World Rabbit Congress, 10-14 October 1988, Budapest Hungary, Vol. 2, 449-457

EFFECT OF VARYING CALCIUM INTAKE ON THE PARAMETERS OF CALCIUM AND PHOSPHORUS METABOLISM OF GROWING ANGORAS

Fébel, Hedvig (Ms) and Régius, Ágnes (Ms)
Research Center for Animal Breeding and Nutrition
Institute for Animal Nutrition H-2053 Herceghalom

A study was undertaken to determine the effect of increasing Ca intake on Ca and P metabolism of young growing Angora rabbits. Fifteen male Angora rabbits, aged 4 weeks were used in a balance trial (duration: 8 weeks). The rabbits were divided into three groups (denoted A, B, C) five rabbits per treatment. Animals in group A were given a basal diet containing 9,0 g Ca/kg DM and 4,5 g P/kg DM (Ca:P ratio 2:1). Ca:P ratio in the diet of groups B and C was 3:1 and 4,5:1 respectively. The amount of the urine volume was not affected by increasing Ca intake. The concentration of Ca in the urine, however, increased at the higher Ca intake but urinary phosphorus excretion decreased. Faecal Ca excretion was significantly higher in groups B and C, and a slight increase was observed in the P content of the faeces. Independent of Ca intake most of the Ca was excreted via the urine (60-80 % of the total excreted Ca). In the case of P excretion, the major route of excretion was the faeces. Ca retention, expressed as percentage of Ca intake, decreased. P retention was not affected by increased Ca intake. The average serum concentration of Ca showed slight changes.

The authors on the basis of changes obtained that althogh the rabbits could adapt to an increased Ca intake, the higher Ca content than 9,0 g Ca/kg DM (Ca:P ratio 2:1) must be avoided in the food of young Angoras.

EFFEKTE DER VERSCHIEDENEN CALCIUM-ZUFUHR AUF DEN CALCIUM- UND PHOSPHORSTOFFWECHSEL VON JUNGEN ANGORAKANINCHEN

Fébel, Hedvig (Fr.) und Régius, Ágnes (Fr.)
Forschungszentrum für Tierzucht und Tierernährung,
Institut für Tierernährung, H-2053 Herceghalom

Die Verfasser haben die Effekte einer steigenden Calcium-Zufuhr auf den Calcium- und Phosphormetabolismus bei den jungen Angorakaninchen (4-12 Lebenswoche) untersucht. Die Untersuchungen wurden an insgesamt 15 männlichen Angorakaninchen (Versuch A: 5 Tiere, 9 g Ca und 4,5 g P/kg TS, das Verhältnis von Ca und P ist 2:1; Versuch B: 5 Tiere, das Verhältnis von Ca und P ist 3:1; Versuch C: 5 Tiere, das Verhältnis von Ca und P ist 4,5:1) durchgeführt. Die steigende Ca-aufnahme hat die tägliche Harnmengeproduktion nicht beeinflusst, aber die renal exkretierte Ca-Menge ehöhte sich, während der P-Gehalt des Harnes sich vermindert hat. Die durch Kot exkretierte Ca-Menge war in der Gruppe B und C signifikant höher, was dem P-Gehalt des Kotes anbelangt, es wurde eine geringfügige Erhöhung beobachtet. In allen 3 Gruppen wurde die gesamtentleerte Menge von Calcium vorwiegend (60-80 %) renal exkretiert, demgegenüber die Hauptrichtung der P-Exkretion der Kot war. Die steigende Ca-Aufnahme hat die relative Ca-Retention reduziert, aber die P-Retention blieb unbeeinflusst. Die grössere Ca-Aufnahme hat den Ca-Gehalt des Serums ein bisschen steigert.

Aufgrund der Ergebnisse des Experimentes kommen die Verfasser zu der Schussforderung, dass - obwohl die Tiere die breitere Ca:P Verhältnisse kompensieren können - in den Futtern der jungen Angorakaninchen eine höhere Menge von Calcium als 9 g/kg TS (das Verhältnis von Ca und P ist 2:1) vermeiden soll.