Proceedings of the

4-7 july **2000** – Valencia Spain

These proceedings were printed as a special issue of WORLD RABBIT SCIENCE, the journal of the World Rabbit Science Association, Volume 8, supplement 1

ISSN reference of this on line version is 2308-1910
(ISSN for all the on-line versions of the proceedings of the successive World Rabbit Congresses)

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Volume C, pages 277-281

EFFECT OF EXOGENOUS PHYTASE ON PHOSPHORUS AND NITROGEN DIGESTIBILITY IN GROWING-FINISHING RABBITS

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ABSTRACT

The influence of supplementation of a basal diet with increasing levels (1000, 2000 or 3000 ftu/kg) of an exogenous phytase on phosphorus and nitrogen digestibility was investigated. Forty New Zealand x Californian rabbits (ten per diet) weighing 1776 ± 155 (SE) g were used. The supplementation up to a level of 2000 ftu/kg of exogenous phytase increased significantly phosphorus and nitrogen digestibility by 24 and 7%, respectively. No significant improvements in digestion efficiency were detected beyond this level. Phosphorus digestibility (%) in the basal diet was 31.2 ± 2. This value is higher than that calculated (17%) on the basis of published data for swine and poultry for this diet. The results indicate that the capacity of phytase of endogenous origin (caecal microflora) to cleavage phytic phosphorus is limited in the rabbit. As a consequence, exogenous enzyme supplementation improves phosphorus utilization in this species.

INTRODUCTION

Phosphorus (P) contained in vegetable ingredients is predominantly in the form of phytate P. A variable proportion of the P contained in this type of feeds (one third as average) is digested by pigs and poultry. Phytate has the potential to bind P, Ca and trace minerals and also amino acids, decreasing their availability (Touchburn et al., 1999). Supplementing exogenous phytase to poultry and swine diets has resulted in improved P and Ca retention and often in an increase in crude protein and amino acid digestibility (Sauveur, 1989; Cromwell et al., 1995; Baker, 1998; Kornegay, 1999; García-Rebollar and Mateos, 1999). A similar level of response to exogenous phytase supplementation is not expected in ruminants because of the abundant production of phytase by rumen microorganisms.

There is a lack of information about the availability of P for rabbits. Most of researchers and nutritionists accept that rabbits are able of utilizing phytate P at the same extent than ruminants, because of the presence of microbial phytases at the caecum and the recycling of P through caecotrophy. Therefore, most authors recommend the utilization of total rather than available or digestible P values to formulate practical diets for rabbits (Mateos and De Blas, 1998). However, in rabbits a fraction of the digesta does not enter in the caecum. As a consequence, part of the dietary P might not be available for the animal. The aim of this study was to determine the response in P and crude protein digestibility to the inclusion of an exogenous phytase obtained from *Aspergillus niger* (NATUPHOS®, 5000 ftu/g) in diets for growing-finishing rabbits.

MATERIALS AND METHODS

Diets

A basal diet (F1) was formulated to meet or exceed all the essential nutrient requirements of growing rabbits (De Blas and Mateos, 1998) and to contain a high proportion of total P as phytate. Its ingredient and chemical composition are shown in Tables 1 and 2, respectively. Three other diets (F2, F3 and F4) were manufactured by adding 1000, 2000 or 3000 ftu/kg of exogenous phytase to the basal diet, respectively.

Table 1. Ingredient composition of experimental diets (%)

	Diets
Ingredient (%)	
Corn	31.9
Lard	3.4
Sunflower meal, 28% CP	27.5
Wheat straw	4.4
Soybean hulls	25.0
Grape seed meal	3.9
L-Lysine HCl	0.15
L-Threonine	0.06
Calcium carbonate	1.02
Sodium chloride	0.50
Sepiolite	2.00
Vitamin/mineral premix	0.20
Robenidine premix	0.10

Table 2. Chemical composition of experimental diets (% DM)

	Diets
Chemical analysis	
Dry matter	90.4
Total phosphorus	0.42
Phytate phosphorus	0.31
Crude protein	18.6
Neutral detergent fibre	39.2
Acid detergent fibre	23.4
Acid detergent lignin	5.48

Digestibility trial

A group of 40 New Zealand x Californian growing-finishing rabbits (10 per diet) from 50 to 60 days of age, weighing 1776 ± 155 (SE) g, was selected at random to determine the apparent faecal digestibility of dry matter, phosphorus and crude protein. No control of sex or

litter was done. Following a one week period of adaptation, the feed intake (ad libitum access) and the total faecal output (caecotrophy was not prevented) were recorded for each rabbit over a four-day experimental period (EGRAN, European reference method, 1995). During the trial, rabbits were housed in a building in which the temperature was partially controlled (average room temperature 22.6 ± 2.8º C). A cycle of 12 h of light and 12 h of dark was used throughout the trial. Animals were handled according to the principles for the care of animals in experimentation published by the Spanish Royal Decree 223/88.

Analytical methods

Dry matter (DM) was determined on duplicate samples by heating at 103ºC for 24 h. Organic matter was determined by ashing at 550ºC for 5 h. Neutral detergent fibre, acid detergent fibre and acid detergent lignin were determined according to the sequential procedure of Van Soest et al., 1991. Procedures of the Association of Official Analytical Chemists (1995) were used for crude protein (N Kjeldhal and autoevaluation distillation unit Kilab nitrolab-auto: 954.01) and for phosphorus (photometric method: 965.17). Phytate P concentration and phytase activity of the diets were measured as described by Simons et al. (1990)

Statistical analysis

The results were analyzed as a completely randomized design with type of diet as main effect, using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 1990). Orthogonal contrasts were made for mean comparisons.

RESULTS AND DISCUSSION

Phytase activity was not detected in the control diet (F1) and was slightly lower than expected (2750 vs 3000 ftu/kg) in diet F4.

The effect of level of inclusion of exogenous phytase on dietary digestibility is shown in Table 3. Type of diet had no influence on dry matter digestibility, although it tended to increase slightly and linearly with phytase addition to the diet. The results also showed that efficiency of digestion of crude protein increased significantly (by 4.6 percentage units) with phytase addition, until a level of 2000 ftu/kg was reached. Beyond this level inclusion of exogenous phytase did not improve crude protein digestibility. Similar effects have been described in pigs and poultry (Touchburn et al., 1999; Kornegay, 1999) and are probably related to the binding of phytate to amino acids of dietary or endogenous origin.

Phosphorus digestibility in the basal diet was 31.2%. This value indicates that rabbits are able to utilize vegetable P more efficiently than pigs and poultry: around 17%, according to the ingredient composition of this diet and the average values given by FEDNA (1999). This result indicates a higher efficiency of P digestion in rabbits than in pigs or poultry. The difference might be related to the presence of microbial phytases in the caecum which would hydrolize phosphorus bound to phytate in the fraction of digesta which enters in the caecum. As a result, free phosphoric acid would be rendered available to the animal after re-ingestion of caecal contents through caecotrophy. Furthermore, re-ingestion of microbial phytases might contribute to digest dietary P at the upper digestive tract.

Table 3. Effect of inclusion of exogenous phytase in the diet on faecal apparent digestibility of dry matter, phosphorus and crude protein

	Diets					Probability of contrasts[b]		
	F1	F2	F3	F4				
Phytase addition (ftu/kg)	0	1000	2000	3000	SEM[a]	1	2	3
Digestibility								
Dry matter	0.554	0.560	0.568	0.571	0.0093	NS[c]	NS	NS
Phosphorus	0.312	0.346	0.388	0.389	0.0170	0.005	0.047	NS
Crude protein	0.657	0.662	0.703	0.688	0.0092	0.013	0.008	NS

[a] SEM = Standard error of means (n = 10)
[b] Contrast 1: diet F1 vs (F2 + F3 + F4); Contrast 2: diet F2 vs (F3 + F4); Contrast 3: diet F3 vs F4
[c] NS = non significant (P > 0.05)

Also, phytase supplementation improved further P digestibility, indicating that activity of endogenous microflora producing phytase or that accessibility of substrate is limited.

The response of dietary P digestibility to exogenous phytase addition was significant up to a level of 2000 ftu/kg. Phosphorus digestibility was 24.3% higher in diet F3 than in diet F1. This increase is similar to that observed in pigs (Kemme et al., 1997) and poultry (Niekerk and Reuvenkamp, 1997), but requires a higher amount of enzyme to be reached. Further studies are required to find the optimal level of phytase supplementation in rabbits.

CONCLUSIONS

From this study it can be concluded that addition of exogenous phytase to rabbit diets improves P and nitrogen utilization by rabbits and therefore reduces mineral output to the environment. The results also indicate that P digestibility in rabbits is intermediate among that in ruminants and other monogastric species (swine and poultry) and might enhance the interest of formulating diets on digestible P basis.

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