The effect of dietary phytase supplementation on the N-balance of growing pigs

Veronika Halas¹, Mat Winkelmolen², Beáta Kiss¹, László Babinszky¹

¹ Department of Animal Nutrition. Kaposvár University, Hungary
²Animal Nutrition Group. Wageningen University and Research Centre, The Netherlands

Corresponding author: Dr. Veronika Halas. Department of Animal Nutrition, Faculty of Animal Science, Kaposvár University, P.O. Box 16, H-7400 Kaposvár, Hungary – Tel./Fax: +36 82313562 - Email: halas.veronika@ke.hu

ABSTRACT - Some studies suggest that dietary phytase enhance the growth rate of pigs fed P-adequate diets. This may be due to an increased N digestibility and/or improved protein gain. The aim was to study the effect of dietary phytase supplementation on the N-balance of growing pigs upon protein limiting condition. A total of 24 hybrid individually kept barrows (25kg BW) were assigned into 4 treatments. Diet in AP0 (AP: adequate protein) contained 190g/kg crude protein and no phytase supplementation, diets in RP0, RP500 and RP1000 (RP: reduced protein) contained 160g/kg crude protein and 0, 500 and 1000 FTU/kg phytase supplementation, respectively. The balance trial consisted of 7 days adaptation and 5 days collection, during which the feces and urine were collected quantitatively. Additional phytase to low protein diets increased the N-retention of the pigs (P<0.05). Supplementation of 500 FTU/kg (PR500) resulted similar N-retention as in group AP0 (P>0.05). Dietary treatments did not affect the digestibility of protein, however, 500 FTU/kg phytase supplementation increased the efficiency of N-retention. Our results show that the protein content of the feed for pigs of 20-30kg can be reduced from 190 to 160 g/kg if the diet is supplemented with 500 FTU/kg phytase without weakening the N-balance of pigs.

Key words: Phytase, Protein restriction, N-balance, Growing pig.

Introduction - In order to improve the bioavailability of P originated from vegetable feed ingredients the nutritionists have increasingly used microbial phytase supplementation in pig feeding. However, some studies report phytase enhancing performance in pigs offered P-adequate diets (Beers and Jongbloed, 1992; Selle et al., 2003). Selle and Ravindran (2008) summarized data from pig studies and reported enhanced ileal digestibility of amino acids by microbial phytase. In vitro data also suggests that phytase has the potential to bind substantial proportion of dietary protein (Kies et al., 2006). Therefore phytase may increase protein digestibility and probably improve protein gain thus results in a better pig performance particularly when added to low protein diet. The aim of the trial was to study the effect of dietary phytase supplementation on the N-balance of growing pigs upon protein limiting condition.
Material and methods - A total of 24 hybrid barrows with initial body weight of 25±1.8kg were used. During the N-balance trial the animals were kept individually in pens (80x80cm) in which the free movement of them was not restricted at all, including the sample collection period. Free access to water was allowed during the complete trial.

Four dietary treatments (6pigs/treatment) were used as follows: the diet in the first treatment had adequate protein (AP) level (190g/kg) according to the NRC (1998) recommendations and no phytase supplementation (AP0). In the second treatment the feed contained reduced protein (RP) level (160g/kg) and no phytase supplementation (RP0). The reduced protein level was achieved by changing 84g/kg of soybean meal with corn, and the essential amino acid (methionine, threonine and tryptophan) content of the diets were formulated according to ideal protein concept. The basal diet in the third and fourth treatments was identical with the diet in the second treatment, contained reduced protein level (160g/kg) but supplemented with 500 FTU/kg (RP500) and 1000 FTU/kg phytase (RP1000), respectively. All diets contained 5g/kg total P according to NRC (1998) recommendation.

A 7 days adaptation period was followed by 5 days collection during which the feces and urine were collected quantitatively. Feces were collected in nylon bags, weighed and frozen immediately after collection. The urine samples were collected and conserved by 50% H₂SO₄. The animals were weighed individually at the beginning of adaptation and at the beginning and the end of the collection period. The daily digestible energy (DE) intake supplied 2.6 times of the maintenance DE requirement of the pigs (450MJ/kg⁰.⁷⁵/day according to NRC, 1998). The daily proportion of the feed was offered in two equal parts at 8.00 and 15.00.

The nutrient content, including crude protein (N), crude fat, crude fibre, crude ash, Ca and P content were determined according to AOAC (2000) procedure.

The effects of dietary treatments on the N-balance data were analyzed by one-way ANOVA (SAS, 2004). Pair-wise comparisons according to LSD test were applied when the means of treatments differed significantly at 5% level in the analysis of variance (SAS, 2004).

Results and conclusions - Pigs fed with low protein diets had significantly lower average daily gain and higher feed conversion than pigs fed diet with adequate protein level (P<0.05). Dietary phytase supplementation (1000 FTU/kg) enhanced significantly (P<0.05) the growth rate of pigs and the efficiency of feed conversion (data are not shown).

The effect of dietary treatments on the N-balance of pigs is shown in Table 1. There was feed refusal in the group fed low protein diet contained no phytase (RP0), thus it resulted a lower N-intake compared pigs fed phytase supplementation (P<0.01). Neither the fecal, the urinary nor the total N-excretion was different among dietary treatments, however, in case of low protein diets the phytase supplementation increased the retained N (P<0.01). Additional 500 FTU/kg phytase was more efficient than 1000 FTU/kg to increase the N-balance; 500 FTU/kg supplementation to low protein diet (RP500) resulted similar N-retention as in group AP0 (P>0.05). Dietary treatments did not affect the digestibility of N. Addition of 500 FTU/kg phytase to the low protein diet increased the efficiency of N-retention. Our results show that the protein content of the feed can be reduced if the diet is supplemented with 500 FTU/kg phytase without weakening the N-balance of growing pigs.
Table 1. Effect of dietary phytase supplementation on the N-balance of growing pigs.

| T R E A T M E N T S | AP0 | RP0 | RP500 | RP1000 | RMSE² | P-value |
|-------------------|-----|-----|-------|--------|-------|---------|
| N-intake g/kg⁰.⁷⁵/d | 12.7ᵃ | 10.0ᶜ | 11.3ᵇ | 11.3ᵇ | 0.79  | <0.01   |
| N-excretion via feces | "   | 1.52 | 1.38  | 1.26   | 1.46  | 0.37    | ns      |
| N-excretion via urine | "   | 2.89 | 2.79  | 2.62   | 2.83  | 0.37    | ns      |
| Total N-excretion | "   | 4.41 | 4.17  | 3.87   | 4.29  | 0.46    | ns      |
| N-retention | "   | 8.32ᵃ | 5.81ᶜ | 7.42ᵃᵇ | 6.98ᵇ | 0.79    | <0.01   |
| N digestibility | %   | 0.879 | 0.861 | 0.889  | 0.871 | 0.036   | ns      |
| N-intake efficiency³ | g/g | 0.652ᵃ | 0.580ᵇ | 0.657ᵃ | 0.620ᵃᵇ | 0.044  | 0.02    |
| N-absorbed efficiency⁴ | g/g | 0.743ᵃ | 0.673ᵇ | 0.739ᵃ | 0.712ᵃᵇ | 0.037  | 0.02    |

ᵃ,ᵇ,ᶜ: P<0.05; ns: not-significant (P>0.05).

¹AP0=190g/kg of protein and 0 FTU/kg of phytase suppl.; RP0=160g/kg of protein and 0 FTU/kg of phytase suppl.; RP500=160g/kg of protein and 500 FTU/kg of phytase suppl.; RP1000=160g/kg of protein and 1000 FTU/kg of phytase suppl.;

²Root mean square error;

³N-intake efficiency = N-retention/N-intake;

⁴N-absorbed efficiency = N-retention/(N-intake–N-excretion via feces).

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