

Comparative effects of *Aspergillus fumigatus* and *A. niger* phytases on phosphorus and calcium digestibilities and phosphorus faecal excretion in the growing pig

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ABSTRACT

Phytases may ameliorate phytic-P antinutritional properties. The aim of the present work was to evaluate comparatively the effects of *Aspergillus fumigatus* (AFP) and *A. niger* (ANP) phytases included in a growing pig phytate rich diet (rape seed, maize and barley) at the level of 500 U/kg. The phytic-P rich diet systematically induced hypophosphataemia, hypercalcaemia and hyperphosphatasaemia. Mean phosphataemia was increased and mean phosphatasaemia and calcaemia were decreased by the ingestion of AFP or ANP. The apparent digestibility of P was significantly higher for the AFP diet (52.8%) than for the ANP diet (46.5 %) or the control diet (30.8%). The improvement in Ca digestibility by AFP and ANP was not statistically significant. AFP and ANP significantly decreased the P concentration in faeces by 33 and 17 %, respectively.

KEY WORDS : phytases, *Aspergillus fumigatus*, phosphorus, digestibility, pig

INTRODUCTION

Phytic-phosphorus (*myo*-inositol-hexaphosphate) which represents about 75% of the phosphorus (P) content of feed ingredients of plant origin has a very low bioavailability for monogastric animals (Reddy et al., 1982). The utilization of phytases can reduce P pollution by animal excreta (Jongbloed et al., 1991; Simões Nunes, 1993). Furthermore, improved nutrient digestibility in animals fed supplemental phytase has been reported (Kornegay and Qian, 1996). The aim of the

present experiment was to comparatively evaluate the effects of *Aspergillus fumigatus* phytase (AFP) and *A. niger* phytase (ANP) on the growing pig P and Ca digestibilities, and on the faecal concentration of P.

MATERIAL AND METHODS

Three diets were used: a basal phytic-P rich diet (A) and this diet supplemented with 500 U/kg of either AFP (B) or ANP (C). The main components of the basal diet were: rapeseed meal (30%), maize (50%) and barley (13%). No mineral P was added to the diets. The basal diet had a crude protein content of 15.5%, an estimated digestible energy of 13.56 MJ/kg, and Ca and P concentration of 0.68% and 0.52%, respectively. The endogenous phytase activity was 26 units. The observed dietary inclusion levels of phytase were 525 ± 28 and 578 ± 43 U/kg for diets B and C respectively.

Eight growing pigs (Large-White x Landrace x Piétrain castrated males, 30 ± 1.2 kg) were used. They were fitted with a permanent cannula in the brachiocephalic trunk allowing non-painful kinetic blood withdraw. After recovery from surgery they were fed during successive 15 days periods, under a Latin square design, the diets A, B and C. The feed was distributed in a mash form in two daily meals (8.00 and 15.00 h) of 1000 g each and the animals had free access to drinking water. Blood was withdrawn twice a day (10.00 and 16.00 h) for the determination of P, Ca and alkaline phosphatase (ALP) concentrations. The faeces were quantitatively sampled during the last 4 days of each of the 15 days periods and the apparent digestibilities of DM, N, P and Ca were determined. The digestibility of Ca was not corrected for the calcium taken in with the drinking water.

RESULTS

AFP and ANP supplements had clear and significant effects on the blood concentrations of P, ALP and Ca. Mean phosphataemia was increased and mean ALP and calcaemia were decreased by the ingestion of the diets B and C (Table 1).

The faecal apparent digestibilities of DM and N were not modified by AFP or ANP. The digestibility of P was strongly improved by both phytases (Table 1). However, the effect of AFP was significantly higher than that obtained with ANP. The improvement represented 22 percentage units for AFP and 15.7 percentage units for ANP. Both phytases increased the Ca digestibility (3.9 for AFP and 2.8% for ANP). However, these differences were not statistically significant. In our experimental conditions AFP and ANP dietary supplementation decreased the P concentration in faeces of the growing pig by 33 and 17%, respectively, (Table 1).

TABLE 1

Effects of *Aspergillus fumigatus* (AFP) and *A. niger* (ANP) phytases on the catheterized growing pig phosphataemia, calcaemia, phosphatasaemia, P faecal concentration (PFC), and dry matter (DM), nitrogen (N), P and Ca digestibilities (% of the intake). A – basal diet, B – diet A supplemented with 500 U/kg of AFP and C – diet A supplemented with 500 U/kg of ANP

Parameters	A	B	C
Phosphataemia, mg/dl	6.66 ± 0.69 ^{1ac}	8.33 ± 0.93 ^b	7.46 ± 1.31 ^{bf}
Phosphatasaemia, U/l	196 ± 36 ^c	158 ± 33 ^d	165 ± 29 ^d
Calcaemia, mg/dl	11.9 ± 0.91 ^c	10.6 ± 0.77 ^f	11.1 ± 0.69 ^{ef}
PFC, % of faeces ash	14.97 ± 1.06 ^{2a}	10.01 ± 0.97 ^b	11.31 ± 0.60 ^b
Digestibility DM	83.2 ± 1.4 ²	84.3 ± 1.2	83.7 ± 2.3
N	81.8 ± 0.37	82.1 ± 0.42	82.5 ± 0.63
P	30.8 ± 2.03 ^a	52.8 ± 1.87 ^{bc}	46.5 ± 1.87 ^{bd}
Ca	43.3 ± 3.61	47.2 ± 2.61	46.1 ± 2.71

¹ mean ± SD of 98 determinations

² mean ± SD of 16 determinations

a, b, c – values with different superscript letters are significantly different

a – b, P < 0.001

c – d, P < 0.01

e – f, P < 0.05

DISCUSSION

The consumption of the phytate-P rich diet systematically induced hypophosphataemia, hypercalcaemia and hyperphosphatasaemia. The normal blood P, Ca and ALP levels were restored by AFP and by ANP.

It is now generally accepted that phytase can reduce the P faecal load in the environment by improvement of phytic-P bioavailability (Harper et al., 1997). AFP included in the diet at a level of 500 U/kg strongly increased P digestibility of growing pigs (+22 percentage units) and accordingly reduced the P excreta load. This AFP effect was greater than that of ANP (+15.7 percentage units). In the present study Ca digestibility was improved (non significantly) by 3.9 percentage units by the addition of AFP to the diet and by 2.8 percentage units by addition of ANP. Recently, Ca digestibility in the growing pig has been variously reported to be significantly influenced (Kemme et al., 1997) or not influenced (Han et al., 1997) by phytases.

Neither AFP nor ANP significantly affected DM or N digestibilities. Taking into account the effects of phytates on proteins, including digestive enzymes, the growth rate improvements observed with phytases may come not only from an increased availability of P and other minerals, but probably also from that of amino acids. Because of the hindgut influence on amino acid availability, the effects of phytases on such parameters should be measured at the ileal level.

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