

Effect of dietary phytase on performance, metabolisable energy and endogenous losses of broiler chickens

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Abstract

A growth study was conducted to compare the effects of supplementary dietary phytase (0, 250, 500 and 2500 U/kg) on the performance, endogenous losses and nitrogen corrected apparent metabolisable energy (AMEn) of the diets for broiler chickens. Four hundred and eighty female Ross broilers, were reared in 32 floor pens. Birds were fed four nutritionally complete, but low in phosphorus maize-soy diets to 28 days of age. Performance and AMEn were positively related to the phytase concentration of the diet. Dietary phytase also reduced the excretion of endogenous losses in a quadratic fashion, the lowest level seeming to increase losses followed by dramatic reductions with further increments. There was a negative relationship ($P < 0.001$) between the AMEn and the excreted sialic acid (mg/kg liveweight/day). It is concluded that low levels of phytase increases performance in birds fed P-deficient diets through the increased provision of P whereas higher doses may support even better performance via a reduction in endogenous losses.

Introduction

The utilisation of P from plant-based feed ingredients by poultry is poor as approximately 60-70% of the P in plants is in the form of phytate-P. Phytate is a polyanionic molecule with six phosphate groups and is capable of forming insoluble complexes with divalent cations, reducing their availability for poultry. Poultry lack effective endogenous phytases necessary to release the phosphate moieties from the inositol ring, and thus phytate-P is poorly available for poultry (Selle *et al.*, 2000). Furthermore, phytate reduces the availability of amino acids and can increase endogenous losses, compromising the performance and health of birds (Cowieson *et al.*, 2004). The detrimental effects of phytate in the diets of poultry can be ameliorated by the addition of phytase to the ration, improving bird performance. A recent study (Pirgozliev *et al.*, 2005) showed that dietary phytase reduced endogenous losses and increased metabolisable energy of the diets. In addition, in diets that contain phytase, there is a reduced requirement for supplementation with phosphate, with potential environmental benefits.

The aim of this experiment was to compare the effects of an evolved *E. coli* phytase on the performance, endogenous losses and nitrogen corrected apparent metabolisable energy (AMEn) of the diets, when fed to broiler chickens.

Materials and Methods

Four hundred and eighty female Ross broilers, were reared in 32 floor pens. Birds were fed four nutritionally complete (13.17 MJ/kg ME, 220 g/kg CP), low in P (23g/kg available) maize-soy diets and performance characteristics were determined from 0 to 28 days of age. The concentration of exogenous phytase was 0, 250, 500 and 2500 IU/kg diet respectively. Each treatment was replicated eight times in a randomised block design.

During the fourth week of the experiment, 64 birds were selected, two from each floor pen, and placed in thirty-two metabolic cages (2 birds in a cage). For the following five days birds were fed the respective experimental diets. After the acclimatisation period the AMEn of the diets were determined by total collection for 24 hours. Endogenous losses in the excreta, measured as sialic acid (SA), were determined (Jourdain *et al.* 1971). Statistical analyses were

performed using the Genstat VII statistical software package.

Results and Discussion

Increased phytase concentration in the diets improved feed intake (FI), weight gain (WG) ($P < 0.001$) and tended to improve the feed conversion efficiency (FCE) ($P = 0.103$) (Table). The AMEn of the diets also increased with phytase concentration ($P = 0.066$), but only the higher doses of phytase improved this parameter. This was in accord with a previous work (Pirgozliev *et al.*, 2005). Dietary phytase affected endogenous losses in a similar way, measured as sialic acid in the excreta. Sialic acid excretion (mg/kg liveweight) initially increased with 250 U/kg then decreased ($P < 0.05$) when phytase concentration in the diets increased. The reduction in SA losses is in agreement with previous studies (Cowieson *et al.*, 2004; Pirgozliev *et al.*, 2005).

It is interesting that the apparent increment in endogenous losses with the lowest dose of phytase was not accompanied by a reduction in gain or intake, but by an improvement as would be expected in a P-deficient diet. This performance improvement at 250 units is clearly unrelated to any reduction in endogenous losses since the reverse seems to be the case. Higher dosages of phytase (500U/kg and above) yielded the expected reductions in endogenous losses that have been reported previously. The further improvements in gain and intake with 500 and 2500 units compared with the 250U dose may be related to reduced endogenous losses however, suggesting that there may be a minimum dosage of phytase required before endogenous losses are minimised. Nevertheless there was a significant negative relationship ($r^2 = 0.34$, $P < 0.001$) between the AMEn and the excreted sialic acid (mg/kg liveweight/d).

Sialic acid is an endogenous component of gastrointestinal mucin used as an indicator of mucin production. The decrease in the quantity of sialic acid excreted by the birds given diets with higher phytase concentration suggests also that a lower quantity of mucin was excreted (Larsen *et al.*, 1993). Mucins are high-molecular-weight glycoproteins that are a major component of the mucous layer, which protects the gastrointestinal tract from chemical, enzymatic, mechanical and microbial damage (Byrd *et al.*, 2000). Mucin is rich in amino-acids so increased mucin excretion is nutritionally very expensive and inevitably leads to increased endogenous loss (Nyachoti *et al.*, 1997). If it is assumed that there is a balance between excretion and synthesis of gastrointestinal mucin, dietary phytase will reduce the excretion and as a consequence the synthesis of mucin. It will thus allow and increased availability of energy for the birds. This is supported by the observation of the negative relationship between metabolisable energy and excreted sialic acid. In addition, increased dietary enzyme concentration decreased the concentration of sialic acid. Increased concentration of sialic acid is often associated with health problems such as cellular senescence, bacterial infections (e.g. campylobacter), certain pathological conditions and osmotic fragility. The reduction in sialic acid concentration with increasing enzyme concentration suggests that microbial phytase may also benefit the health of the birds.

Conclusions

Whilst low doses of dietary phytase may increase endogenous losses, performance is nevertheless improved, perhaps through the provision of P which is limiting growth more so than endogenous losses. Higher activities of phytase reduced the excretion of endogenous losses and improved AMEn and thus further growth performance. It can be concluded that the decreases in secretions from the gastrointestinal tract in the presence of phytase is a mechanism involved in the mode of action of dietary phytases.

Table. Effect of dietary phytase on performance, AMEn and sialic acid excretion of broilers

Phytase conc IU	0	250	500	2500	P	Lsd
FI bird kg	1.493	1.616	1.676	1.757	<0.001	0.1018
WG kg	1.009	1.108	1.143	1.231	<0.001	0.0513
FCE	0.676	0.686	0.682	0.703	0.103	0.0217
AMEn(DM)	14.605	14.369	14.737	14.785	0.066	0.0327
SA mg/g sample	1.091	1.215	1.034	1.046	0.100	0.1582
SA mg/kg bird day	13.56	16.28	12.56	12.27	0.002	1.997

Regression equations

FI(g)=1580+0.079 Phytase concentration $r^2=0.28$, $P=0.001$, SE=123

WG(g)=1068+0.070 Phytase concentration $r^2=0.55$, $P<0.001$, SE=64.3

FCE=0.677+0.00001 Phytase concentration $r^2=0.12$, $P=0.033$, SE=0.0251

AMEn(DM)=15.725-0.081 Sialic acid mg/kg/b/d $r^2=0.34$, $P<0.001$, SE=0.269

Sialic acid mg/kg/b/d=14.41-0.001 Phytase concentration $r^2=0.12$, $P=0.042$, SE=2.34

$P<0.05$ – statistically significant difference

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