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The effect of novel xylanase on feeding value of diet containing cereal by-products for broilers

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Abstract. *Effects of exogenous xylanase on N-corrected dietary apparent metabolisable energy (AMEn), coefficients of dry matter (DMR) and nitrogen retention (NR), fat digestibility (FD), and gastrointestinal tract (GIT) development were examined. Birds' growth performance was also measured. Birds were fed one of two mash diets. A control diet was prepared that had major ingredients of 404.2 g/kg wheat and a mixture of important home produced cereal by-products (including 145.0 g/kg wheat DDGS, 90.0 g/kg oat feed, 60.3 g/kg wheat feed), and contained 213 g/kg CP and 12.64 MJ/kg metabolisable energy. Each diet was fed to sixteen pens with two Ross 308 male broilers following randomisation. Xylanase supplemented diet had higher (P<0.05) N-corrected apparent metabolisable energy (AMEn), and also higher (P<0.001) DMR and NR. There were no significant differences (P>0.05) in growth performance, although feeding xylanase decreased (P<0.05) the weights of the total GIT of the birds. It can be concluded that supplementary xylanase gave a small improvement (3.5% increase in AMEn) in the feeding value of the cereal by-product diet but this did not result in an improvement in growth performance.*

Keywords: cereal by-products, chickens, xylanase, metabolisable energy

Introduction

There is an increasing demand for the use of whole grain cereals in Europe. With the increased scarcity, the poultry industry may be required in the future to use an increasing amount of cereal by-products in their feed formulations. The by-product will not only be derived from human food production but also be sourced from bioethanol production. The increase of bioethanol production resulted in more available distillers dried grains with solubles (DDGS) for animal feed (Kanev et al., 2013; Pirgozliev et al., 2015). Traditionally fed to ruminants, this abundant and competitively priced co-product of bioethanol production can be also used in poultry diet formulations (Kanev et al., 2014, 2016). Most cereal by-products have a high non-starch polysaccharides (NSP) content and so are the main reason for the reduced nutrient digestibility and growth performance of broilers (Ivanova et al., 2013; Whiting et al., 2016). Exogenous fibre degrading enzymes, e.g. xylanases, are now well accepted as a class of feed additives in diet formulations for poultry to overcome the negative effects of NSP, and to improve utilisation of dietary nutrients and birds performance. However, it is well recognised that bird's responses to xylanase addition are not entirely predictable and may depend upon the level of dietary substrate (Ravindran and Son, 2011).

The objective of this experiment, therefore, was to determine the effect of supplementary novel xylanase, an enzyme that hydrolyses NSP, on dietary N-corrected metabolisable energy (AME), nutrient utilisation and gastrointestinal tract development when a high cereal by-product diet was fed to broilers. The overall feed intake, weight gain and feed conversion efficiency of the birds were also measured.

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Material and methods

A control diet was prepared that had major ingredients of 404.2 g/kg wheat and a mixture of important home produced cereal by-products (including 145.0 g/kg wheat DDGS, 90.0 g/kg oat feed, 60.3 g/kg wheat feed), and contained 213 g/kg CP and 12.64 MJ/kg metabolisable energy (Table 1). The diet was then split into two batches and one of them was supplemented with xylanase (Kerry Ingredients and Flavours, Osberstown, Naas, Co. Kildare, Ireland) resulting in two diets in total. The determined activity of the enzyme was xylanase (EC 3.2.1.8) 6100 units/kg diet (ESC Standard Analytical Method SAM036 at pH 5.3 and 50°C, using 1.2% BSA in the extraction; determined by Enzyme Services & Consultancy, Ystrad Mynach, UK), and there were some additional pectinase, amylase and α-galactosidase activities. The enzyme preparation was based on enzyme produced by *Aspergillus niger*. The enzyme was in a liquid form and was sprayed on the top of diet. The dry matter content of diet C was adjusted by spraying the same amount of water per kg of diet. After spraying the diets were thoroughly mixed in a horizontal mixer. Diets were free of coccidiostat, antimicrobial growth promoters, prophylactic and other similar additives.

All procedures were approved by The Animal Experimental Committee of Harper Adams University. Male Ross 308 broiler chickens were obtained from a commercial hatchery. During the pre-study period, from day old to 7 days of age, the birds were reared in a single floor pen and fed proprietary wheat-based diet without coccidiostats or antimicrobial growth promoters, prophylactic or other similar additives. At the beginning of the study, at 7 days of age, 64 chicks were allocated to 32 small pens with 0.160 m^2 solid floors area, two birds in each pen, within a controlled environment room.

Table 1. Diet formulation (g/kg 'as-fed') of the diets

Ingredient	Composition, %
Wheat	40.42
SBM (CP=48%)	2.7
Full fat Soya meal	12.75
Maize gluten meal	3.5
Wheat DDGS	14.5
Oat feed	9.0
Wheat feed	6.03
Soya oil	6.5
Lysine	0.60
Methionine	0.68
Threonine	0.24
Monocalcium phosphate	1.0
Limestone	1.4
Sodium chloride	0.28
Vitamin/mineral premix	0.4
Calculated composition	100
ME, MJ/kg	12.64
Protein, g/kg	213
Soluble NSP, g/kg	36
Insoluble NSP, g/kg	95
Lysine, g/kg	12.3
Methionine + Cysteine, g/kg	0.93
Calcium, g/kg	8.3
Available phosphorus, g/kg	4.6
Sodium, g/kg	1.7
Determined values (as fed)	
DM, g/kg	879
GE, MJ/kg	18.27
CP, g/kg	181
Fat, g/kg	109

* Vitamin and mineral premix provided (units kg^{-1} feed): µg: retinol 2160, cholecalciferol 75; mg: alpha-tocopherol 25, menadione 1.5, riboflavin 5, pantotenic acid 8, cyanocobalamin 0.01, pyridoxine 1.5, thiamine 1.5, folic acid 0.5, niacin 30, biotin 0.06, I 0.8, Cu 10, Fe 80, Se 0.3, Mn 80, Zn 80. Diets were not supplemented with coccidiostat

Each diet was fed at random to 16 pens from 7 to 21d ages. Room temperature and lighting program followed commercial recommendations (Aviagen Ltd., Edinburgh, UK). Access to the feed and the water was *ad libitum*.

During the last four days of the experiment, from 17 to 21 d age, the solid floor of each pen was replaced with a wire mesh and all excreta were collected and immediately dried at 60°C and then milled. Feed intakes were also measured for the same period.

On the last day of the study, at 21d age, the two birds in each pen were weighed and killed by cervical dislocation. The empty weights of total gastrointestinal tract (GIT) including proventriculus and gizzard, pancreas and small intestine, of each bird were determined, according to the procedures described by Amerah and Ravindran (2008).

Excreta were oven-dried in forced draft oven at 60°C to constant weight, weighed, and milled to pass through a 0.75 mm mesh. The gross energy, nitrogen and oil in feed and excreta were determined as previously described (Whiting et al., 2016). The dietary N-corrected apparent metabolisable energy (AMEn) was calculated as described by Hill and Anderson (1958). The coefficients of total tract fat dry matter (DMR) and nitrogen retention (NR), and fat digestibility (FD) were determined as the difference between the respective nutrient intake and nutrient excreted divided by the intake.

Statistical analyses were performed using the Genstat statistical software package (Genstat 15th release 3.22 for Windows; IACR, Rothamstead, Hertfordshire, UK). All studied variables were compared statistically by ANOVA. In all instances, differences were reported as significant at $P \leq 0.05$. Tendencies towards significance ($P < 0.1$) were also reported.

Results and discussion

All birds remain healthy throughout the study period and there was no mortality. There was no effect ($P > 0.05$) of treatment on daily feed intake and weight gain of the birds (Table 2). However, bird fed xylanase supplemented diet tended ($P = 0.068$) to have an improved feed efficiency when compared to the control fed birds. Birds fed xylanase had reduced total GIT weight ($P < 0.05$) compared to the birds fed control diet.

The study evaluated the efficacy of supplementary novel xylanase enzyme on growth performance, energy and nutrient availability and GIT development when cereal by-product containing diet was fed to broilers. The data demonstrate that young broilers are sensitive to dietary supplementation with exogenous xylanase.

The most noticeable response to dietary enzyme preparation was in increasing DMR by 5.5%, followed by reducing total GIT by 4.8%, and increasing NR and AMEn by 4.4% and 3.5%, respectively. The growth of the birds did not differ between diets and was in the expected range for broilers reared in similar environment and fed mash diets (Karadas et al., 2014; Pirgozliev et al., 2015). In agreement with improved AMEn and nutrient utilisation, birds fed xylanase supplemented diet tended to improve FCE. This is in line

Table 2. The effect of experimental diets on growth performance and total digestive tract (GIT) of broilers

	FI, g DM/b/d	WG, g/b/d	FCE, g:g	Total GIT, g
Control	53.2	46.5	0.875	69.0
Xylanase	52.6	47.0	0.895	65.7
SEM (df=31)	1.15	0.83	0.0069	1.01
P value	0.709	0.698	0.068	0.033
CV, %	8.7	7.1	3.1	6.0

Each mean represents values from 16 replicate pens of 2 chicks each; Bird performance was determined from 7 to 21 d age; There is statistically significant difference between treatments when $P \leq 0.05$.

Table 3. The effect of experimental diets on N-corrected apparent metabolisable energy (AMEn), dry matter (DMR), and nitrogen retention (NR), and fat digestibility (FD)

	AMEn, MJ/kg DM	DMR	NR	FD
Control	13.53	0.607	0.585	0.819
Xylanase	14.01	0.642	0.611	0.828
SEM (df=31)	0.115	0.0061	0.0042	0.0102
P value	0.010	<0.001	<0.001	0.549
CV, %	3.3	3.9	2.8	4.9

Each mean represents values from 16 replicate pens of 2 chicks each; Dietary AMEn, DMR, NR and FD were determined between 17 and 21 d age; There is statistically significant difference between treatments when $P \leq 0.05$.

with Annison and Choct (1991), who reported reduced bird performance, dietary energy and nutrient availability when high NSP diets were fed to poultry. High dietary NSP content is also associated with high digesta viscosity (Annison and Choct, 1991). Dietary NSP, especially the water-soluble fraction has a significant capacity to attract and hold water and could directly interact with water molecules to form a large network or mesh-like structure, thereby increasing the viscosity of digesta. Although not determined, the increased digesta viscosity may be the reason for the reduced dietary energy and nutrient utilisation in birds fed unsupplemented control diet. The detrimental impact of high intestinal viscosity on dietary nutrient digestibility and absorption is well documented (Annison and Choct, 1991). The viscous properties have adverse effects on the diffusion and convective transport of pancreatic enzymes, substrates and the end products of the digestion process (Isaksson et al., 1982; Johnson et al., 1984). Xylanase is known to have the ability to degrade NSP in plants (Choct et al., 1999), thus supporting the assumption that reduction in digesta viscosity may explain the observed improvements in dietary energy and nutrient utilisation.

After exogenous xylanase supplementation the weight of the GIT decreased by 4.8%, which is in the range of values reported by Wu et al. (2004), when feeding a mixture of phytase and xylanase to broilers. In general, if the efficiency of digestion is consistently suboptimal, whether due to ingredient quality, microbial interaction of anti-nutritive factors, the GIT responds by increasing in both size (surface area) and digestive enzyme output (Bedford 2006).

Conclusion

The addition of a commercial xylanase enzyme preparation gave only a relatively small (3.5%) increase dietary available energy in the high cereal by-product diet and there was no evidence of an effect on growth performance of broiler chickens. Further research is warranted to understand how to efficiently include high levels of cereal by-products in broiler diets.

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