VARIABILITY BETWEEN WHEAT DRY DISTILLERS GRAINS WITH SOLUBLES SAMPLES INFLUENCE THE EFFECTIVENESS OF EXOGENOUS ENZYMES WHEN FED TO BROILER CHICKENS

V. Pirgozliev*, I. Whiting*, S. P. Rose*, S. G. Ivanova[1], G. Staykova[1], A. M. Amerah[2]

The National Institute of Poultry Husbandry (NIPH), Harper Adams University, Shropshire, TF10 8NB, UK

[1]Agricultural Institute, Shumen, 3 Simeon Veliki blvd., 9700, Bulgaria

[2]Danisco Animal Nutrition, Wiltshire, SN8 4AN, UK

Corresponding author: vpirgozliev@harper-adams.ac.uk

Abstract

A study was conducted to investigate the effects of supplementary enzyme on growth performance, N-corrected metabolisable energy (AMEn) and total tract dry matter (DMR) and nitrogen (NR) retention in broilers fed diets containing two different wheat dry distillers grains with solubles **(**DDGS) samples. A total of 40 male Ross 308 broilers were allocated to 4 dietary treatments in a randomized block design with 5 replicates per treatment, from 7 to 21 d post hatching. The experiment consisted of a 2 × 2 factorial arrangement of treatments with 2 DDGS samples at 2 dietary levels (0 or 150 g/kg) and 2 dietary levels of supplementary enzyme (0 or 100 g/tonne, providing 1220 units xylanase and 152 units of β-glucanase /kg diet). Titanium dioxide was included in the diets as an indigestible marker. Growth was measured throughout the experiment and excreta were collected on the last day of the study at 21d age. Feeding DDGS did not influence (P>0.05) AMEn, AMEn intake, DMR and NR. However, enzyme supplementation improved (P<0.05) AMEn, AMEn intake, DMR and NR. There was a DDGS × enzyme interaction (P<0.05) on weight gain, feed conversion and energy conversion ratios, with greater enzyme effect in the DDGS sample that had a higher polysaccharide content. Thus the composition of DDGS should be considered when evaluating the use of fibre degrading enzymes for broiler diets.

Key Words: wheat DDGS; broilers; growth performance; enzyme; ME

Introduction

Distillers dried grains with solubles (DDGS) from wheat and maize has the potential to be used by the poultry industry even though it is high in fibre (Ivanova et al., 2013, 2014). Most of the research, however, was done on DDGS produced from maize, and there is a dearth of information on the nutritive value of DDGS produced from wheat (Cozannet *et al*., 2010; Whiting, 2016). Fibre degrading enzymes could be used although their effects may differ between wheat DDGS samples due to their variable chemical compositions (Whiting, 2016). There is a need to know whether any beneficial effects of fibre degrading enzymes are the same for different wheat DDGS samples. The objectives of the experiment were to determine the N corrected apparent metabolisable energy (AMEn) and nutrient utilisation coefficients in diets containing two different wheat DDGS samples, and to compare the growth performance of broilers fed those diets with and without enzyme supplementation.

Materials and methods

This report is focused on the comparison of the feeding value for broilers of two wheat DDGS samples, A and B, when fed as a part of complete diet. Both DDGS samples were previously evaluated for metabolisable energy and proximate composition (Pirgozliev et al., 2015a; Whiting, 2016). The main difference between the two DDGS samples was in their polysaccharide composition. Sample A contained 53 and 181 g/kg DM of soluble and non-soluble non-starch polysaccharides (NSP), and 28 g/kg of total starch. Sample B had 32 and 222 g/kg DM of soluble and non-soluble NSP, and 74 g/kg of total starch. The total polysaccharide content, including NSPs and starch, was 262 and 328 g/kg DM, for samples A and B, respectively.

Two diets containing 150 g/kg of each of the two experimental wheat DDGS samples were made (Table 1). Each diet was then split into two batches and one of them was supplemented

with 100 g/tonne of a commercial enzyme (Axtra XB, Danisco Animal Nutrition, Marlborough, UK), resulting in 4 diets in total. The enzyme preparation was based on 1220 units xylanase and 152 units of β-glucanase /kg diet produced by *Trichoderma reesei*.

All procedures were approved by the Animal Experimental Committee of Harper Adams University. Male Ross 308 broiler chickens were obtained from a commercial hatchery. At seven days of age 40 chicks were allocated to 20 small pens, two birds in each pen. Feed and water was offered *ad libitum* to birds throughout the experiment. Each diet was offered to birds in 5 pens in a randomised block design. Room temperature and lighting regime met commercial recommendations. At 20d age, the solid floor of each pen was replaced with a wire mesh and excreta samples were collected over night from each pen and immediately dried at 60◦C and then milled.

Diets and dry excreta samples were analysed for dry matter (DM), crude protein (CP), and gross energy (GE). DM was determined by drying of samples in a forced draft oven at 105◦C to a constant weight. CP (6.25 X N) was determined by the combustion method (AOAC, 2000) using a Leco (FP-528 N, Leco Corp., St. Joseph, MI). The GE value of samples was determined in a bomb calorimeter (model 6200; Parr Instrument Co., Moline, IL).

The AMEn, and nutrient utilisation coefficients were calculated as described by Lammers et al. (2008). The energy conversion ratio (ECR) was also determined as the AMEn ingested to achieve the weight gain over the period of 7 to 21 d of age. The ECR describes the relative efficiency of the use of metabolisable energy for growth, implicit that a more efficient energy use towards growth is related to a lower ratio.

Statistical analyses were performed using the Genstat 16 statistical software package (IACR Rothamstead, Hertfordshire, England). A randomised block analysis of variance was performed and a 2 x 2 factorial structure was used to investigate the main treatment factors

(enzyme x DDGS sample) and their interaction. Differences were reported as significant at P < 0.05 and trends were noted when the P value was near to 0.1.

Results and discussion

The experimental results are presented in Table 2. Similar weight gains and feed efficiency have been previously reported (Vilarino et al., 2007; Youssef et al., 2008) when feeding broilers with comparable level of dietary wheat DDGS inclusion. The ECR data was also in line with previous reports using wheat based diets (Pirgozliev et al., 2015 b). The overall feed intake for the study period was 936 g/DM per bird and was not influenced (P>0.05) by the DDGS or enzyme supplementation (Table 2). Feeding Axtra XB improved (P<0.05) dietary AMEn, AMEn intake, DMR and NR coefficients. However, there was DDGS sample by enzyme interaction (P<0.05) regarding WG, FCR and CCR, as the birds fed diet containing DDGS sample B, but not sample A, benefitted (P<0.05) from the enzyme supplementation.

The main difference between the two DDGS samples was the polysaccharide content. The NSP have a structural function as the main components of plant cell walls, and the majority of NSP in wheat (thus in wheat DDGS) are pentosans (Annison, 1991). The anti-nutritive properties of wheat pentosans and their negative influence on growth performance of poultry have been well documented (Pirgozliev *et al.*, 2015c). Starch is considered as the main energy source in poultry diets, but processes such as heating can considerably change the starch properties and produce starch with some amount of structural alteration, also known as resistant starch, that is not available to poultry (Englyst, 2000). This undigested polysaccharide fraction is probably fermented by the microflora in the distal parts of the gastrointestinal tract and so contributes little to the energy supply to the bird (Annison *et al.*, 1968). The effect of the enzyme addition on the improvement of WG, FCE and CCR of

sample B, but not of sample A, that was not followed by similar changes in AMEn suggests that enzyme was able to convert the polysaccharide content of the DDGS to an available energy source. Xylanase increases the access of digestive enzymes to substrates by disrupting the cell wall matrix (Parkkonen et al., 1997), suggesting that the mixture of xylanase and β-glucanase in this study may also increase the access of pancreatic enzymes to nutrients that may be trapped by fibres.

The results indicate that the nutritional value of wheat DDGS samples may vary when fed to broilers. The observed DDGS sample by enzyme interaction indicates that the greatest response to enzyme supplementation was in the DDGS sample with the highest polysaccharide content. The polysaccharide composition of DDGS should be considered when evaluating the use of fibre degrading enzymes in broiler diets.

References

Annison G. 1991. Relationship between the levels of nonstarch polysaccharides and apparent metabolisable energy of wheat assayed in broiler chickens. Journal of Agricultural Food Chemistry 39, 1252–1256.

Association of Official Analytical Chemists (AOAC) 2000. Official methods of analysis, 17th edition. AOAC, Gaithersburg, MD, USA.

Cozannet, P., M. Lessire, C. Gady, J.P. Metayer, Y. Primot, F. Skiba and J. Noblet. 2010. Energy value of wheat dried distillers grains with solubles in roosters, broilers, layers, and turkeys, Poultry Science 89, 2230–2241.

Englyst, K.N., G.J. Hudson and H.N. Englyst. 2000. Starch analysis in food. In

Encyclopaedia of Analytical Chemistry (ed. RA Meyers), pp. 4246-4262. John Wiley and Sons, Chichester, UK.

Ivanova, I., V. Georgieva and M. Lalev. 2013. Effect of wheat dry distiller's grain in compound feeds for broiler chickens on productive and slaughter traits, Bulgarian Journal of Agricultural Science 19, 102–108.

Ivanova, I., M. Lalev, V. Georgieva, N. Mincheva, M. Oblakova and P. Hristakieva. 2014. Effect of three dietary levels of corn dried distillers grains with solubles as compound feed ingredient on production traits of broiler chickens, Union of Sientists, Stara Zagora, Volume IV, Number 5, Animal studies & Veterinary medicine

Lammers, P.J., B. J. Kerr, M. S. Honeyman, K. Stalder, W. A. Dozier III, T. E. Weber, M. T. Kidd and K. Bregendahl. 2008. Nitrogen-corrected apparent metabolizable energy value of crude glycerol for laying hens, Poultry Science, 87, 104–107.

Parkkonen, T., A. Tervila-Wilo, M. Hopeakoski-Nurminen, A. Morgan, K. Poutanen and K. Autio. 1997. Changes in wheat microstructure following in vitro digestion. Acta Agriculturae Scandinavica, Section B Soil Plant Science 47, 43–47.

Pirgozliev, V., I. Whiting, J. Wilson, S.P. Rose, M.W. Mirza, S.G. Ivanova and D.M. Kanev. 2015a. Nutrient availability of wheat distillers dried grains with solubles (DDGS) for broilers, Zivotnovudni Nauki, 4: 17-24

Pirgozliev, V., D. Bravo, M.W. Mirza and S.P. Rose. 2015b. Growth performance and

endogenous losses of broilers fed wheat based diets with and without essential oils and xylanase supplementation, Poultry Science, 94: 1227-1232

Pirgozliev, V., S.P. Rose, T. Pellny, A.M. Amerah, M. Wickramasinghe, M. Ulker, M. Rakszegi, Z. Bedo, P.R. Shewry and A. Lovegrove. 2015c. Energy utilization and growth performance of chickens fed novel wheat inbred lines selected for different pentosan levels with and without xylanase supplementation, Poultry Science 94, 232–239.

Vilarino, M., J.M. Gauzere, J.P. Metayer and F. Skiba. 2007. Energy value of wheat-DDGS in adult cockerels and growth performances of broiler chickens. Pages 83-86 in 16th European Symposium on Poultry Nutrition, Strasbourg, France. World Poultry Science Association, French Branch, Tours, France.

Whiting I. 2016. The use of wheat-distillers dried grains with solubles (DDGS) as a feed for laying hens, PhD Thesis Harper Adams University

Youssef, I., C. Westfahl, A. Sünderb, F. Liebert and J. Kamphues. 2008. Evaluation of dried distillers' grains with solubles (DDGS) as a protein source for broilers, Archives of Animal Nutrition 62, 404–414.

Table 1 *Ingredient composition (g/kg, as-fed) of the experimental diets*

Dietary ingredients (kg/100kg)		
Wheat	51.33	51.33
Wheat DDGS # A	15.00	-
Wheat DDGS # B	-	15.00
Soybean meal (48)	21.88	21.88
Soybean meal (full fat)	4.20	4.20
Vegetable oil	3.79	3.79
Monocalcium phosphate	1.26	1.26
Limestone	1.05	1.05
NaCl	0.21	0.21
Lysine	0.34	0.34
Methionine	0.34	0.34
Threonine	0.13	0.13
NaHCO3	0.13	0.13
Vitamin mineral premix[1]	0.34	0.34
	100	100
Calculated analysis (as fed)		
ME MJ/kg	12.77	12.58
Crude Protein g/kg	231.0	222.0
Crude Fat g/kg	6.1	6.2
Ca g/kg	7.7	8.0
Available P g/kg	5.3	5.4
Lysine g/kg	13.8	13.8
Methionine + Cystine g/kg	9.7	9.6

[1]The vitamin and mineral premix contained vitamins and trace elements to meet the breeder's recommendations (Aviagen Ltd., Edinburgh, UK). The premix provided (units/kg diet): retinol, 12,000 IU; cholecalciferol, 5,000 IU; α-tocopherol, 34 mg; menadione, 3 mg; thiamine, 2 mg; riboflavin, 7 mg; pyridoxine, 5 mg; cobalamin, 15 µg; nicotinic acid, 50 mg; pantothenic acid, 15 mg; folic acid, 1 mg; biotin, 200 µg; 80 mg Fe as iron sulfate (30%); 10 mg Cu as a copper sulfate (25%); 100 mg Mn as manganous oxide (62%); 80 mg Zn as zinc oxide (72%); 1 mg I as calcium iodate (52%); 0.2 mg Se as sodium selenite (4.5%); and 0.5 mg Mo as sodium molybdate (40%).

Table 2 *The effect of DDGS sample and enzyme supplementation of diets fed to broiler chickens on feed intake (FI), body weight gain (WG), feed conversion ratio (FCR), N-corrected apparent metabolisable energy (AMEn), AMEn intake, energy conversion ratio (CCR), total tract dry matter (DMR) and nitrogen (NR) retention coefficients*[1]

DDGS	Enzyme	FI (g DM/b)	WG (g/b)	FCR (g:g)	AMEn (MJ/kg DM)	AMEn int (MJ)	ECR	DMR	NR
A	no	936	694^{ab}	1.351^{a}	13.38	0.90	18.07^{ab}	0.694	0.584
B	no	919	643^{a}	1.435^{b}	13.26	0.87	19.03^{b}	0.692	0.581
A	yes	934	687^{ab}	1.365^{ab}	13.68	0.91	18.67^{ab}	0.709	0.613
B	yes	956	725^{b}	1.323^{a}	13.49	0.91	17.72^{a}	0.703	0.611
s.e.m.[2]		14.8	17.2	0.0174	0.097	0.014	0.355	0.0044	0.0100
Main effects									
DDGS									
A		935	690	1.358	13.53	0.90	18.37	0.702	0.598
B		938	684	1.379	13.38	0.89	18.37	0.697	0.596
Enzyme									
	no	65.4	669	1.393	13.32	0.88	18.55	0.693	0.583
	yes	66.2	706	1.344	13.59	0.91	18.19	0.706	0.612
s.e.m.[2]		10.4	12.1	0.0246	0.069	0.009	0.251	0.0031	0.0071
Probabilities									
DDGS		0.867	0.718	0.411	0.140	0.427	0.993	0.349	0.811
Enzyme		0.258	0.051	0.066	0.020	0.045	0.339	0.012	0.012
Interaction		0.207	0.023	0.025	0.721	0.360	0.020	0.633	0.982

^{a,b,c} Within diets mean values in a column not sharing a common superscript are significantly different.
[1]Each value represents the mean of five replicates.
[2]Pooled standard error of mean.