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Determination in broilers and turkeys of true phosphorus digestibility and retention in wheat distillers dried grains with solubles without or with phytase supplementation

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ABSTRACT

Wheat distillers dried grains with solubles (wheat-DDGS) is a viable source of phosphorus (P) for poultry. Two experiments were conducted to determine the true ileal P digestibility (TPD) and true total tract P retention (TPR) of wheat-DDGS without or with phytase supplementation for broilers and turkeys. In experiment 1 (broilers), wheat-DDGS inclusion linearly decreased ($P < 0.05$) dietary ileal DM digestibility and total tract DM and P retention. The coefficient of TPD without or with phytase for broilers was 0.94 or 0.96, respectively. The coefficient of TPR was 0.92 and 0.94 without or with phytase, respectively. In experiment 2 (turkeys), wheat-DDGS inclusion linearly decreased ($P < 0.05$) dietary ileal DM digestibility and total tract DM retention. The coefficient of TPD of wheat-DDGS for turkeys was 0.76 or 0.82 without or with phytase, respectively. The coefficient of TPR of wheat-DDGS without or with phytase was 0.71 and 0.82, respectively. Phytase had no effect ($P > 0.05$) on dietary ileal DM digestibility, total tract DM retention, ileal P digestibility and total tract P retention for broilers and turkeys. Phytase had no effect ($P > 0.05$) on TPD and TPR for broilers and turkeys. It was concluded that wheat-DDGS is a valuable dietary source of digestible P for broilers and turkeys.

1. Introduction

Wheat distillers dried grains with solubles (wheat-DDGS) is the co-product of bioethanol produced from wheat grain by the dry-grind process. It is possible to use wheat-DDGS as a source of metabolisable energy and amino acids (AA) for broilers and turkeys (Bandegan et al., 2009; Bolarinwa and Adeola, 2012), but the value of wheat-DDGS as a source of phosphorus (P) for poultry has not been investigated. Wheat-DDGS has the potential to be a good source of digestible P for poultry because substantial concentrations of phytate P are hydrolysed by the action of yeast phytase during the fermentation process in bioethanol production (Liu, 2011).

The use of exogenous phytase in poultry diets is not new and a plethora of studies have documented the efficacy of exogenous phytase in releasing phytate P and improving P digestibility for poultry. Martinez Amezcua et al. (2004) noted that up to 25% of the total P in maize-DDGS may be bound to phytate. As such, there is an opportunity to improve P

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Table 1
Ingredient and chemical composition of experimental diets to determine the phosphorus digestibility and retention in wheat distillers dried grains with solubles for broilers and turkeys.

Item	Wheat distillers dried grains with solubles inclusion level (g/kg)		
	200	400	600
Ingredients (g/kg)			
Maize starch[a]	516	293.5	77
Wheat-DDGS	200	400	600
Soybean oil	18	36	48
Dextrose	100	100	100
Sucrose	130	130	130
Vitamin–mineral premix[b]	2.5	2.5	2.5
Limestone	4.5	9	13.5
Common salt	4	4	4
Marker premix[c]	15	15	15
Phytase premix	10	10	10
Analysed composition[d]			
Dry matter (g/kg)	880	890	885
Phosphorus (g/kg)	2.0	2.9	4.2
Calcium (g/kg)	3.5	4.7	6.9
Phytase activity (FTU/kg)	962	810	933

[a] Phytase premix replaced maize–starch at 10 g/kg.
[b] Vitamin and mineral premix supplied per kg of diet: Vitamin A, 16,000 IU; vitamin D3, 3000 IU; vitamin E, 25 IU; vitamin B1, 3 mg; vitamin B2, 10 mg; vitamin B6, 3 mg; vitamin B12, 15 μg; nicotinic acid, 60 mg; pantothenic acid, 14.7 mg; folic acid, 1.5 mg; biotin, 125 μg; choline chloride, 25 mg; iron, 20 mg; copper, 10 mg; manganese, 100 mg; cobalt, 1.0 mg; zinc, 82.2 mg; iodine, 1 mg; selenium, 0.2 mg; and molybdenum, 0.5 mg.
[c] Contained 1 g of titanium dioxide added to 4 g of maize–starch.
[d] Values are means of duplicate analyses.

digestibility in wheat-DDGS for broilers and turkeys using exogenous phytase but only few studies have determined the value of exogenous phytase in diets containing maize-DDGS for broilers (Martinez-Amezcua et al., 2006; Olukosi et al., 2010).

Broiler and turkey diets are formulated to contain optimal levels of P that best supports maintenance and performance. It is essential to provide information about the digestible P content of wheat-DDGS, because digestible P values of feed ingredients are a more accurate measure of bird requirement compared with total P values. WPSA (2013) developed a standard protocol for determining digestible P in feed ingredients for broilers and encourages use of digestible P as a measure of bird P requirements.

The objective of the current study was to determine the true ileal P digestibility (TPD) and true total tract P retention (TPR) of wheat-DDGS without or with phytase supplementation in broilers and turkeys.

2. Materials and methods

2.1. Animals and management

The Scotland's Rural College Animal Experiment Committee approved all bird handling and sample collection procedures.

One hundred and twenty-six Ross 308 male broiler chicks (Experiment 1) or 126 BUT 10 male turkey poults (Experiment 2) were used for the determination of TPD and TPR of wheat-DDGS. Birds had *ad libitum* access to the diets and water in the entire pre- and experimental periods. The birds were reared in a house with facilities to control temperature, light and humidity. In the two experiments, the birds were offered a pre-experimental diet that offers energy and nutrients comparable with specific breed requirements. In each experiment, birds were allocated to one of 6 experimental diets in a randomised complete block design using d 14 bodyweight as blocking criterion and transferred to metabolism cages on d 14. Each treatment had seven replicate cages and three birds per replicate cage.

2.2. Diets and sample collection

The pre-experimental diet offered from d 1 to d 14 in experiments 1 and 2 contained (as-is) 12.7 MJ/kg of ME, 230 g/kg of CP and 6.8 g/kg of total P. The 6 experimental diets used in each experiment consisted of three levels of wheat-DDGS in a maize starch–dextrose based diet (200, 400 or 600 g/kg) and two levels of phytase (without or with) in a 3×2 factorial arrangement. The phytase was added at a rate of 1000 FTU/kg. The phytase was derived from *Escherichia coli* and expressed in *Schizosaccharomyces pombe*. One phytase unit was defined as the quantity of enzyme required to liberate 1 μmol of inorganic P per min, at pH 5.5 from an excess of 15 μM sodium phytate at 37 °C.

Titanium dioxide was added to the experimental diets (3 g/kg of diet) to enable determination of ileal P digestibility or total tract P retention by the index method. Experimental diets were offered between d 14 and d 21. The ingredient and chemical compositions of the experimental diets used in both experiments are shown in Table 1. Excreta were collected daily from each cage for 3 d (d 18–d 20), dried and pooled within a cage. Birds were euthanized by cervical dislocation