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Short communication

The effects of restricting enzyme supplementation in rye-based diets for broilers

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ABSTRACT

The purpose of the current study was to restrict enzyme addition in order to evaluate if supplementation throughout the broiler production cycle is required. Here we analyze the possibility of circumscribing xylanase supplementation in rye-based diets to the earliest periods of the life of the broiler. In the current experiment, 1-day-old chicks were divided into 5 treatments and fed a rye-based diet supplemented with a commercial enzyme mixture containing a microbial xylanase. The five treatments consisted of birds fed a non-supplemented diet and birds fed diets supplemented with the exogenous enzyme for the entire period of the experiment (28 days), the first 21 days, the first 14 days or the first 7 days of the trial. The data revealed that broilers fed diets supplemented with enzymes during 28 days had similar (P>0.05) growth performance, gastrointestinal enzyme activity and relative organ sizes to broilers fed supplemented diets only in the first 21 days of the experimental period. These results suggest that the action of exogenous enzymes, when used to supplement rye-based diets for broilers, may be restricted to the first 21 days of the broiler's production cycle without compromising animal performance.

1. Introduction

The use of rye in broiler diets may be limited due to the presence of soluble non-starch polysaccharides (NSP), particularly arabinoxylans, which create a viscous environment within the intestinal lumen (Smits and Annison, 1996; Józefiak et al., 2007). Increased viscosity impairs digestibility and absorption of dietary nutrients leading to a depression in growth rate and feed conversion ratio (FCR) (Antoniou and Marquardt, 1981; Bedford, 1993). Some commercial xylanases are able to reduce the degree of polymerization of the soluble anti-nutritive and recalcitrant carbohydrates that are abundant in cereal-based diets. Thus, enzyme supplementation in diets containing significant levels of soluble NSP leads to a reduction in digesta viscosity, resulting in more efficient nutrient digestion and absorption (Smits and Annison, 1996; Silva and Smithard, 2002; Józefiak et al., 2007). As a consequence, there is an improvement in broiler performance (Dusel et al., 1998; Bedford, 2000).

Ingredients such as barley and especially rye contain high levels of soluble carbohydrates that can hold water in the digesta producing a thick viscous solution and very wet excreta (Choct and Annison, 1990; Knudsen, 1997; Silva and

Abbreviations: BW, body weight; FCR, feed conversion ratio; GI, gastrointestinal; NSP, non-starch polysaccharide.

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Table 1
Composition and calculated analysis of the rye-based diet.[a]

Ingredient	g/kg of diet
Rye	580
Soybean meal, 470 g/kg CP	320
Soybean oil	40.0
Sodium chloride	3.0
Calcium carbonate	22.4
Dicalcium phosphate	10.6
DL-Methionine	2.0
Mineral and vitamin premix[b]	2.0
Filler[c]	20.0
Calculated nutrient content[d]	
Metabolizable energy (MJ/kg)	11.7
Crude protein	226
Lysine	11.2
Methionine	4.9
Calcium	9.1
Available phosphorus	4.0

[a] Treatments consisted of a rye-based diet supplemented with enzyme for the entire 28 days, the first 21 days, the first 14 days, the first 7 days or not supplemented.
[b] Mineral–vitamin premix provided the following per kilogram of diet: biotin 0.5 mg, calcium pantothenate 10 mg, cholecalciferol 0.05 mg, cyanocobalamin 0.12 mg, folic acid 0.5 mg, menadione 2 mg, nicotinic acid 30 mg, pyridoxine 1.7 mg, retinol 2.7 mg, thiamin 1 mg, α-tocopherol 20 mg, riboflavin, 4.2 mg, Co 0.2 mg, Cu 10 mg, Fe 80 mg, I 1 mg, Mn 100 mg, Se 0.3 mg, Zn 80 mg.
[c] The filler consisted of ground rye. When enzyme supplementation was provided, the filler was used to mix the enzyme onto the diet. When no enzyme supplementation was provided, the filler was added alone.
[d] Calculation of nutrient content based on Ingredient Analysis Table (Feedstuffs, 2009).

Smithard, 2002). It has been documented that broilers fed barley-based diets display an improved performance in response to β-glucanase supplementation, in particular at the early stages of their life (Newman and Newman, 1988; Rotter et al., 1989; Nahas and Lefrançois, 2001). However, information on age-related efficacy of xylanase supplementation to rye-based diets is scarce. Mourão and Pinheiro (2009) have found that the reduction of body weight (BW) and increase in FCR with diets based on rye in comparison to diets based on corn was attenuated with age. Therefore, these authors (Mourão and Pinheiro, 2009) found, in a 35 day trial, that xylanase supplementation to a rye-based diet had significant effects on FCR only until 21 days of age. Here, we hypothesize that broilers fed on rye-based diets should be more responsive to exogenous enzymes at the initial weeks of growth. In this study, the capacity of xylanases to affect the performance of broilers fed rye-based diets was explored by circumscribing enzyme supplementation to different phases up to 28 days of age.

2. Materials and methods

One hundred and sixty 1-day-old Ross 308 male broiler chicks birds were assigned to 40 cages of 4 birds each with each cage measuring 48 cm × 55 cm. Chicks were wing-banded for individual identification. The 40 cages were randomly assigned to 5 treatments consisting of a rye-based diet supplemented with the commercial enzyme mixture Avizyme 1100 containing a minimum of 2500 U/g of endo-1,4-β-xylanase, and 800 U/g of protease (Danisco Animal Nutrition DuPont Industrial Biosciences, Marlborough, UK) at a 0.05% (w/w) inclusion rate for the entire 28 days (treatment R1–28), the first 21 days (treatment R1–21), the first 14 days (treatment R1–14) or the first 7 days (treatment R1–7) of the trial, the fifth group was fed a non-supplemented basal diet (treatment R0). The basal diet (Table 1) contained 60% of rye and was formulated to meet the nutrient requirements defined by the NRC (1994). Chicks were given free access to water and pelleted feed that was then crumbled. Feed consumption and BW was determined weekly throughout the experiment, and mortality was recorded daily. At 28 days of age, one bird per pen was slaughtered by an intravenous injection of an aqueous isotonic solution of 125 mg Thiopental (Braun, Barcelona, Spain). The gastrointestinal (GI) organs were removed and emptied with running water. The weight of the crop, gizzard and liver, and the length of the duodenum, jejunum, ileum and caecum were measured. Digesta samples were collected at the various GI compartments to measure contents viscosity. To measure the viscosity of small intestine contents, samples were collected from the duodenum plus jejunum and ileum, centrifuged for 10 min at 10,867 × *g* and the viscosity of sample supernatant was measured at 6 rpm using a viscometer (Model LVDVCP-II, Brookfield Engineering Laboratories, Middleboro, MA) with a cup maintained at 24 °C. Due to the high viscosity of digesta samples from birds consuming a rye-based diet, 500 μl of sample was diluted with 500 μl of water before viscosity measurements were taken.

Data related to bird performance were subjected to ANOVA according to the general linear models procedure of SAS SAS Institute (2001). The Tukey's procedure was used to detect significant differences between treatment groups. In addition, polynomial contrasts were used to evaluate differences between periods of feed supplementation. Differences were considered significant when $P<0.05$.