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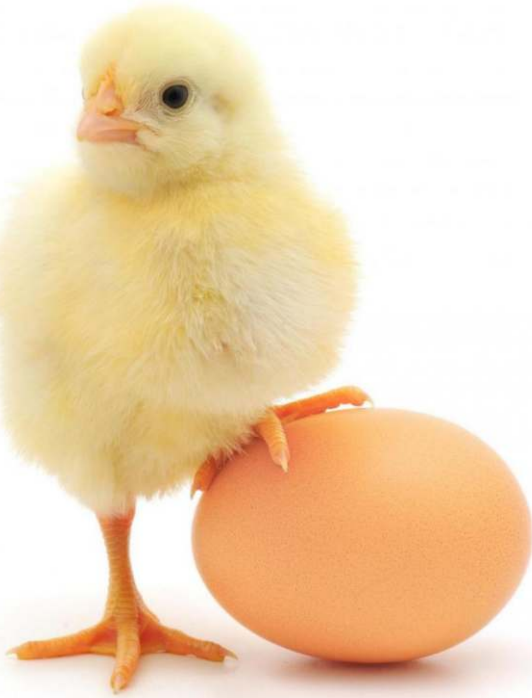

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Influence of Beta-glucanase Supplementation on Growth Performances and Digestive Organs Weights of Broiler Chickens Fed Corn, Wheat and Barley-based Diet

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Abstract: This study was performed with broiler chickens to evaluate the effects of adding beta-glucanase on bird performances and digestive organs weights. A total of 1600 1-day-old broilers (Arbor Acres) were divided into 2 groups and fed either a control diet (group C) based on corn, wheat and barley or a control diet supplemented with beta-glucanase preparation (Safizym GP 40, Lesaffre Feed Additives, France) at the dose of 40 mg per kg of diet (group G). Body weight, feed intake were recorded at 40 days of age. The same day, 8 chickens from each group were slaughtered for carcass yield and digestive organs weights. Experimental data were statistically analyzed by using the ANOVA procedure of Stat View programme. Throughout the whole trial period (1-40 days of age), body weight was significantly ($p \leq 0.05$) increased (+2.9%) in birds of group G (1723 g) compared to those of group C (1674 g). Moreover, there was no significant difference in feed intake between broilers consuming the control diet supplemented or not with beta-glucanase activity (4052 g). However, the feed conversion ratio was significantly reduced by 4% when the basal diet was supplemented with beta-glucanase ($p \leq 0.05$). The addition of beta-glucanase reduced ($p<0.05$) the small intestine weight related to the body weight compared to C group (5.40 vs.6.98%, respectively). Thus, it is possible to introduce in the broiler diet up to 35% of barley when beta-glucanase is used at the recommended dose of 40 mg per kg of diet.

Key words: Beta-glucanase, barley, wheat, corn, performances, broiler chickens

INTRODUCTION

Economically, it is interesting to substitute partially maize by barley and wheat. However, the water-soluble Non-Starch Polysaccharides (NSP) of the endosperm cell walls of barley and wheat have anti-nutritive properties in poultry. In fact, the presence of soluble beta-glucans in barley (Almirall *et al*., 1995) and soluble arabinoxylans in wheat (Choct and Annison, 1992) are the major cause of growth depression and poor feed conversion in poultry. These compounds exert their anti-nutritional effects by increasing viscosity of the aqueous fraction in the small intestine contents. The exaggerated intestinal viscosity affects the digestion and absorption of nutrients in chicks (Annison, 1993) by reducing glucose and sodium transport into the epithelial cells and reducing the release rate of pancreatic enzymes and bile acids (Moundras *et al*., 1997). The hydrolysis and digestion of nutrients are therefore decreased. Moreover, several studies have demonstrated that the intestinal microflora play an important role in the anti-nutritive properties of water soluble NSP (Langhout *et al*., 1999; Mathlouthi *et al*., 2002).

The additions of exogenous enzymes (xylanase and/or beta-) to wheat and barley-based diets can overcome the anti-nutritive effect of water soluble NSP. Numerous studies have reported the beneficial impact of exogenous enzymes on chick performance and nutrient digestibility (Almirall *et al*., 1995; Cowan *et al*., 1996). However, little information is available concerning the efficiency of beta-glucanase in broiler chickens fed diet containing corn, wheat and barley. The major studies tested either the efficiency of a mixture of xylanase and beta-glucanase in broilers fed wheat and barley-based diet or the efficiency of beta-glucanase in birds fed barley-based diet.

In the present study, we evaluate the effects of the addition of beta-glucanase to corn, wheat and barley-based diet on performances of broiler chickens and digestive organs weights.

MATERIALS AND METHODS

Animals and diets: One thousand and six hundred one-day-old male broiler chickens (Arbor Acres, SOTAVI, Tunisia) were weighed, placed in 16 floor pens (i.e. 100 birds per pen; size: 2.4 x 2.6 m) and randomly assigned among 2 dietary treatment groups (8 replicates per treatment). Used litter, top-dressed with 7 cm of wood shavings, was utilized as bedding. The room

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Table 1: Formulation and calculated composition of broiler chicken diets

Ingredients (g/kg)	Starter (1-21 d)	Grower (22-40 d)
Wheat	190.0	210.0
Barley	300.0	350.0
Corn	121.8	90.0
Soya oil	47.0	47.0
Soybean meal	304.1	266.7
Calcium carbonate	12.5	12.5
Dicalcium phosphate	13.0	13.0
NaCl	3.6	3.5
Mineral mixture[1]	1.0	1.0
Vitamin mixture[2]	5.0	5.0
DL Methionine	1.5	1.3
Lysine	0.5	0.0
Total	1000.0	1000.0
Nutrient composition (g/kg)		
ME[3] (kcal/kg)	2953.0	2959.0
CP[4] (N x 6.25%)	200.0	190.0
Lysine	11.3	10.0
Methionine	4.5	4.1
Methionine + cystine	8.3	7.7
Tryptophane	2.5	2.4
Calcium	9.6	9.5
Available phosphorus	3.9	4.0

[1]Mineral mixture supplied (mg.kg^{-1} of diet): Co, 0.33; Cu, 8.7; I, 1.2; Se, 0.2; Zn, 84; Fe, 44; Mn, 106;
[2]Vitamin mixture supplied per kg of diet: vitamin A, 10000 IU; cholecalciferol, 1500 IU; vitamin E, 15 mg; butylated hydroxytoluene, 125; menadione, 5 mg; thiamine, 0.5; riboflavin, 4 mg; calcium pantothenate, 8 mg; niacin, 25 mg; pyridoxine, 1 mg; vitamin B_{12}, 0.008; folic acid, 1 mg; biotin, 0.2 mg; choline chloride, 750 mg.
[3]ME: Metabolizable energy;
[4]CP: Crude protein

temperature was gradually decreased from 32°C at day 1 to 24°C at day 22. The light was continuous during the first three days then the lighting regimen was 23 h per day. Basal diets for starting and growing periods containing corn, wheat and barley were formulated (Table 1) according to the nutritional requirements for chickens (Larbier and Leclercq, 1992) and calculated using PORFAL software version 2.0 (ITP-INRA, France). The basal diets (C) were fed in mash form and contained no antibiotics or other growth factors. The exogenous enzyme used in this trial was the commercial powdered preparation Safizym GP 40 produced by Lesaffre Feed Additives (France) with beta-glucanase activities of 70 000 BGN per g of product. The enzyme preparation was added to basal diets at the rate of 40 mg (2800 BGN of beta-glucanase) per kg of diet (G). Thus, the two dietary treatments groups were C and G and they were purchased from a commercial company (Provital, Grombalia, Tunisia). The diets were given to broiler chickens from 1 to 40 days of age. Feed and water were supplied *ad libitum* throughout the entire experiment. Body weights were determined at 1, 22 and 40 days of age. Feed intake was recorded weekly and by a group of 100 chickens during the entire experiment.

Yield carcass and digestive organs weights: At the end of experiment (40 d of age) one bird from each replicate were randomly selected for eviscerated carcass yield as described by Mushtaq *et al.* (2005). Abdominal fat, heart, liver, gizzard, proventriculus and small intestine were removed and weighted.

Statistical analyses: The level of statistical significance was preset at $p \leq 0.05$. Data were statistically analyzed for treatment effect by the ANOVA procedure of the Statview software for Windows 4.5 (1992-1996). Mean differences were determined using the Fisher test of least significance.

RESULTS AND DISCUSSION

The results of the present study show that the addition of beta-glucanase to the corn, wheat and barley-based diet improved ($p \leq 0.05$) broiler chicken body weight (1.723 vs. 1.674 kg) during the whole experiment period (Table 2). Body weight of broiler chickens at 22 days of age was not affected by the beta-glucanase supplementation. Moreover, from 1 to 22 d of age there was no difference ($p > 0.05$) in weight gain of broiler chickens fed C or G diets. However, from 23 to 40 d of age, broilers fed the G diet grew faster ($p \leq 0.05$) than the birds fed the C diet (1.227 vs. 1.144 kg). Similar feed intakes were recorded for C and G groups during the entire experimental period (4.073 and 4.030 kg, respectively). The inclusion of beta-glucanase in the broiler chickens diet based on corn, wheat and barley improved ($p \leq 0.05$) the feed to gain ratio from 23 to 40 d of age (2.417 vs. 2.625) but not from 1 to 22 d of age. During the whole experimental period (1 - 40 d), the feed conversion ratio was decreased ($p \leq 0.05$) by the beta-glucanase supplementation. Moreover, the addition of beta-glucanase reduced ($p < 0.05$) the small intestine to body weight ratio compared to C group (5.40 vs. 6.98%, respectively). Yield carcass, abdominal fat, gizzard, proventriculus, heart and liver weights were not affected by the addition of beta-glucanase in broiler feed.

Thus, the improved feed conversion ratio in birds fed the corn, wheat and barley-based diet supplemented with beta-glucanase was due to an increase in the weight gain from 23 to 40 d of age. This beneficial effect of exogenous enzymes has previously been reported by numerous studies (Cowan *et al.*, 1996). It is likely that beta-glucanase markedly increase the nutritive value of wheat and barley (Choct *et al.*, 1995) in broiler chicken. This improved performance of birds fed corn, wheat and barley-based diet by beta-glucanase supplementation is not due to release of simple sugars but rather to the ability of the enzyme to prevent the formation of viscous digesta (Choct and Annison, 1992). Moreover, Danicke *et al.* (1999) reported that xylanase supplementation has depression effect on some harmful bacteria groups adhering to the intestine epithelium of broiler chickens fed rye based-diet. In addition, Mathlouthi *et al.* (2002)

Table 2: Body weight, weight gain, feed intake and feed to gain ratio in broiler chickens fed corn, wheat and barley-based diets supplemented or not with beta-glucanase from 1 to 40 days of age

Variables	Basal diet (C)	Basal diet + beta-glucanase (G)	Probability
Body weight (1 d) (kg)	0.037±0.001	0.038±0.001	NS (p = 0.8030)
Body weight (22 d) (kg)	0.531±0.017	0.519±0.032	NS (p = 0.3988)
Body weight (40 d) (kg)	1.674±0.038	1.723±0.046	S (p = 0.0391)
Weight gain (1-22 d) (kg)	0.494±0.017	0.481±0.031	NS (p = 0.3745)
Weight gain (23-40 d) (kg)	1.144±0.048	1.227±0.050	S (p = 0.0043)
Weight gain (1-40 d) (kg)	1.637±0.038	1.686±0.046	S (p = 0.0391)
Feed intake (1-22 d) (kg)	1.079±0.034	1.073±0.030	NS (p = 0.7719)
Feed intake (23-40 d) (kg)	2.994±0.101	2.962±0.026	NS (p = 0.3995)
Feed intake (1-40 d) (kg)	4.073±0.133	4.030±0.420	NS (p = 0.4036)
Feed/gain ratio (1-22 d)	2.186±0.062	2.237±0.172	NS (p = 0.4464)
Feed/gain ratio (23-40 d)	2.625±0.178	2.417±0.090	S (p = 0.0104)
Feed/gain ratio (1-40 d)	2.490±0.117	2.393±0.049	S (p = 0.0484)

NS: No Significant; S: Significant

Table 3: Effect of beta-glucanase on yield carcass, heart weight, abdominal fat and digestive organs weights of broiler chickens

Variables	Basal diet (C)	Basal diet + beta-glucanase (G)	Probability
Liver weight/body weight (%)	2.67±0.36	2.41±0.42	NS (p = 0.2028)
Abdominal fat weight/body weight (%)	1.24±0.41	1.01±0.27	NS (p = 0.2147)
Heart weight/body weight (%)	0.35±0.08	0.37±0.06	NS (p = 0.7144)
Gizzard and proventriculus/body weight (%)	2.08±0.207	2.14±0.18	NS (p = 0.5500)
Small intestine weight/body weight (%)	6.98±0.49	5.40±0.88	S (p = 0.0006)
Yield carcass (%)	58.99±1.42	59.45±2.45	NS (p = 0.6287)

NS: No Significant; S: Significant

showed that xylanase and beta-glucanase addition decreased the number of *E. coli* but not the number of *Lactobacilli* in the caeca of broilers fed wheat and barley based-diet. For all these reasons, the addition of beta-glucanase had beneficial effects on broiler chickens performances. According to the present study, the use of beta-glucanase alone is able to overcame the anti-nutritive effect of barley and wheat water soluble NSP.

In conclusion, it is possible to introduce in the broiler diet up to 35% of barley and 21% of wheat when Safizym GP40, containing beta-glucanase activity, is used at the recommended dose of 40 mg per kg of diet.

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