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Effect of dietary tannic acid supplementation in corn- or barley-based diets on growth performance, intestinal viscosity, litter quality, and incidence and severity of footpad dermatitis in broiler chickens

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ABSTRACT

A study was conducted to evaluate the effect of dietary tannic acid and barley supplementation on growth performance, intestinal viscosity, litter quality, and footpad dermatitis (FPD) in broiler chickens. Five hundred forty-four 1-d-old male broiler chicks were randomly assigned to dietary treatments with 8 replicated pens per treatment and 17 broiler chickens pen as a 2 × 2 factorial arrangement of 2 diets (a corn-soybean meal diet or a diet with 30% barley) and tannic acid (0 and 2 g/kg) in a completely randomized design. Growth performance, intestinal viscosity, litter quality, and FPD incidence and severity were recorded. The results showed that there was no interaction between diets and tannic acid levels. Barley-based diets reduced ($P < 0.05$) the body weight (BW) gain at 0–42 d, and feed intake at 21–42 d and 0–42 d. At 28 d of experiment, the viscosity of intestinal contents of anterior and posterior segments was greater ($P < 0.05$) in broiler chickens fed diets with barley. Similarly, the viscosity of intestinal contents of posterior segment was greater ($P < 0.05$) at 42 d, in broiler chickens fed barley-based diets. Litter pH, moisture, and NH_3 volatilization were increased ($P < 0.05$) in response to barley-based diets. Barley-based diets increased ($P < 0.05$) the incidence and severity of FPD lesions in broiler chickens at 14, 28, and 42 d of experiment. Although dietary tannic acid had no effect on performance, intestinal viscosity, and litter quality compared to those fed diets without tannic acid ($P > 0.05$), it tended to reduce body weight gain ($P = 0.05$) and increase feed conversion ratio (FCR; $P = 0.09$) at 0–21 d and NH_3 volatilization on 28 ($P = 0.08$) and 42 d ($P = 0.07$). Dietary tannic acid supplementation prevented the FPD lesion development and reduced ($P < 0.05$) the total FPD lesions at d 42. Moreover, the severe lesions decreased ($P = 0.08$) on d 42 in broiler chickens fed tannic acid. In conclusion, barley-based diets may worsen the growth performance and litter quality, and increase the intestinal viscosity that increases the incidence and severity of FPD in broiler chickens. Dietary tannic acid supplementation may not affect the growth performance, intestinal viscosity, and litter quality. However, it may reduce the incidence and severity of FPD in broiler chickens.

1. Introduction

Footpad dermatitis (FPD) is a disease characterized by necrotic lesions on the plantar surface of feet in growing turkeys and broiler chickens. The FPD can impair the health and productivity of broiler chickens, and reduce the quality of chicken feet as human food, resulting in economic losses (Cengiz et al., 2012a, b; Mayne et al., 2007a). It is well documented that the major cause of FPD is the quality of litter, mostly the moist/wet litter (Mayne et al., 2007a). The composition of diet is one of the diverse risk factors associated with FPD, including sex, breed, diet, body weight, litter moisture, environmental temperature, stocking density, and litter type (Mayne, 2005). Among the nutritional causes of FPD, soybean meal has been investigated as a major contributor to FPD because of its non-starch polysaccharides (NSP) content. Hess et al. (2004) reported that indigestible carbohydrates also known as NSP in plant based protein sources may contribute to the development of FPD in broiler chickens. However, several other factors also account for the development of FPD. The concentration of soluble NSP is high in grains such as wheat, barley, and others in comparison with soybean meal. High dietary NSP levels tend to increase the viscosity of intestinal contents, resulting in stickier fecal droppings. The prolonged adhesion of fecal material is

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more likely to irritate and result in the deterioration of the epidermis and keratin layers over time (Shepherd and Fairchild, 2010). The soluble NSP of barley may induce the FPD development in broiler chickens, however, exact dietary inclusion levels of barley to initiate the FPD development are not known. Cengiz et al. (2012b) reported that hulled barley at 25% of diet was unable to develop FPD in broiler chickens. Therefore, in the present study, hulled barley was used at 30% of diet, that was expected to deteriorate litter quality and increase FPD incidence and severity.

To date, various approaches have been employed for the prevention and treatment of FPD in broiler and turkey chickens. These include the dietary supplementation with enzymes (Cengiz et al., 2012b), as well as alterations in the levels of sodium (Cengiz et al., 2012c), biotin (Cengiz et al., 2012d; Mayne et al., 2007b), zinc (Cengiz et al., 2014), and methionine (Chavez and Kratzer, 1972). However, the inability of these strategies to fully prevent or ameliorate FPD has required alternative solutions to this problem. Tannins have been defined as anti-nutritional substances, and a handsome body of literature is available on their anti-nutritive effects in poultry (Garcia et al., 2004; King et al., 2000). Studies have shown that high amounts of tannins in diets are responsible for reduced digestibility of feed ingredients and poor growth performance (Kubena et al., 2001; Mansoori and Acamovic, 2007). Also, there is still an ambiguity in the safe levels of tannic acid for broiler chickens. Conversely, tannic acid is considered as a potential antimicrobial growth promoter being used as a feed additive for the control of diseases and to improve growth performance, fecal consistency, and litter quality (Redondo et al., 2014). Keeping in view these properties, we hypothesized that low levels of dietary tannic acid may actually improve the litter quality to reduce the incidence and severity of FPD by lowering the viscosity of digesta and optimizing the intestinal environment in broiler chickens fed barley-based diets. To the best of our knowledge, no work has been reported on this subject. Therefore, objective of the present study was to evaluate the preventive effect of tannic acid against FPD in broiler chickens fed diets based on barley.

2. Materials and methods

The present study was carried out at the Poultry Research Unit (Adnan Menderes University, Aydın, Turkey). All procedures involved in this study were approved by the Animal Care and Use Committee of Adnan Menderes University.

2.1. Experimental design and treatments

Five hundred forty-four 1-d-old male broiler chickens were randomly assigned to dietary treatments with 8 replicated pens per treatment and 17 broiler chickens per pen as a 2 × 2 factorial arrangement of 2 diets (a corn-soybean meal diet or a diet with 30% barley) and tannic acid (0 and 2 g/kg) in a completely randomized design. Corn-soybean meal-based and barley-based diets were formulated (Table 1) for the starter 0–10 d), grower 10–24 d), and finisher 24–42 d) to meet or exceed the nutrient requirements of broiler chickens (NRC, 1994). To include 30% barley, the ingredients of the corn-based rations were adjusted to closely match the nutrient matrix of both diets. Tannic acid extracted from chestnut wood (Silva Feed ENC; SilvaTeam S.P.A., Cuneo, Piedmont, Italy) was used in this study. The inclusion rate (2 g/kg) was based on a small preliminary study (Cengiz, Ö., unpublished data).

2.2. General management of broiler chickens

1-d-old male Ross 308 broiler chicks were purchased from a local commercial hatchery (Egetav Tavukçuluk San. ve Tic. A.Ş., İzmir, Turkey). A floor space of 0.06 m^2 was provided to each chick. The floor space occupied by feeders and drinkers was exclusive of the floor space provided to chicks. The trial lasted for 42 d. A 5–6 cm deep layer of pine wood shavings was used as a bedding in each pen. Feed and water was provided ad libitum throughout the experiment. Floor feeders were used for feeding chicks from 0 to 10 d and tube feeders from 10 to 42 d. Nipple drinkers were used for drinking water. Fluorescence lights were used at night only. A temperature of 33 °C was maintained during the first week that was reduced gradually 0.5 °C per day until a constant temperature of 24 °C was attained.

Table 1
Composition and analysis of the diets (as fed basis).

Item	Experimental Diets					
	Starter 0–10 d)		Grower 10–24 d)		Finisher 24–42 d)	
	Corn	Barley	Corn	Barley	Corn	Barley
Ingredient (g/kg)						
Corn	556.3	250.0	561.5	250.0	590.0	270.0
Soybean meal	375.0	375.0	360.0	336.0	335.0	315.0
Barley	–	300.0	–	300.0	–	300.0
Vegetable oil	25.0	32.0	41.5	75.2	42.5	79.0
Limestone	8.9	10.0	8.5	12.0	8.0	12.5
Dicalcium phosphate	23.0	21.2	20.0	17.0	17.3	16.0
Salt	3.5	3.5	3.5	3.5	3.5	3.5
DL-Met	3.7	3.7	2.5	3.0	1.2	1.5
L-Lys	2.1	2.1	–	–	–	–
Vitamin-mineral premix[a]	2.5	2.5	2.5	2.5	2.5	2.5
Calculated nutrient composition						
Metabolizable energy (MJ/kg)	12.69	12.64	13.18	13.20	13.35	13.40
Crude protein (g/kg)	230	230	220	220	210	210
Ca (g/kg)	10.0	10.0	9.1	9.0	8.0	8.8
Available P (g/kg)	5.0	4.9	4.5	4.5	4.0	4.3
Analyzed nutrient composition (g/kg)						
Dry matter	884	879	883	877	887	880
Crude protein	227.8	230.4	218.0	217.6	208.5	208.3
Ether extract	61.9	68.7	78.0	83.2	80.8	86.5
Nitrogen free extract	511.1	502.4	507.6	499.8	524.2	509.5
Neutral detergent fiber	84.6	114.2	79.7	109.5	75.4	104.3
Ca	11.8	11.4	10.9	11.0	9.9	10.8
Total P	8.6	8.7	7.9	7.5	7.3	7.2
Total NSP	130.5	157.8	127.5	148.9	124.1	145.8

[a] Supplied per kilogram of diet: Vitamin A, 12,000 IU; Vitamin D_3, 1500 IU; Vitamin E, 30 mg; Vitamin K_3, 5 mg; Vitamin B_1, 3 mg, Vitamin B_2, 6 mg; Vitamin B_6, 5 mg; Vitamin B_{12}, 0.03 mg; Niacin, 40 mg; Calcium D-pantothenate, 10 mg; Folic acid, 0.75 mg; D-Biotin, 0.075 mg; Choline chloride, 375 mg; Mn, 80 mg; Fe, 40 mg; Zn, 60 mg; Cu, 5 mg; I, 0.4 mg; Co, 0.1 mg; Se, 0.15 mg; and Antioxidant, 10 mg.

2.3. Chemical analysis of feeds

The dry matter content of experimental diets was determined by drying the feed sample at 105 °C for 8 h. Crude protein (CP) values of diets were estimated following the analysis of nitrogen (N) content using Kjeldahl method. Ether extract (EE) were determined using soxhlet extraction technique. Neutral detergent fiber (NDF) values of the feeds were determined according to Van Soest procedure (Van Soest et al., 1991). Crude ash was determined using the muffle furnace. Nitrogen free extract (NFE) was calculated as difference between the dry matter and CP, EE, NDF, and crude ash. Calcium concentrations in the diets were determined according to wet ash digestion method using nitric and perchloric acids (Method 935.13; AOAC, 2000). Alkalimetric ammonium molybdophosphate method was used to measure the phosphorus (P) concentration in the diets (Method 964.06; AOAC,