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Effect of Garlic Powder (*Allium sativum*) and Black Seed (*Nigella sativa*) on Broiler Growth Performance and Intestinal Morphology

Research Article

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ABSTRACT

This study was conducted to investigate the effects of garlic powder (GP) black seed (BS) and plant premix (GP and BS) in the diet on broiler growth performance and intestinal morphology. included 480 Hubbard broiler chicks(day-old). There were 4 treatment groups each consisting of 3 replicates. The four dietary treatments consisted of a control (basal diet), basal diet +0.5% GP, basal diet +0.5% BS and basal diet +0.5% (GP and BS), to the starter and finisher diet. The experiment lasted 42 days. Body weight , body weight gain, feed intake and feed conversion ratio were determined weekly and intestinal morphology was determined at the end of the study (42 day). The addition of GP and BS plant premix (GP and BS) to the diet resulted in significantly higher body weight, body weight gain and feed intake than control group. However, feed conversion ratio was not influenced by dietary treatment (P>0.05). The villus height,crypt depth and crypt depth to villus height ratio was significantly higher in Black seed and plant premix (GP and BS) than other groups. While villus height, crypt depth and crypt depth to villus height ratio were lower in the control group compared to the other groups (P-value). It was found that the goblet cells were not affected by any treatment. Based on the results of this study it could be suggested to supplement broiler feed with 0.5% GP.

KEY WORDS black seed, feed, garlic, intestinal morphology, performance.

INTRODUCTION

It has been reported that the usage of antibiotics has undesirable effects on animal health and production such as residua in the tissues long withdrawal period, and development of resistance in micro organisms allergies and genotoxicity, that is serious threat to human health. Therefore the use of antibiotic growth promoters has been banned in many countries especially in the European Union (Castanon, 2007). Aromatic plants and essential oil extracted from these plants have been used as alternatives to antibiotics. Therefore, these plants are becoming important for their antimicrobial effects and the stimulating effect on animal digestive system to increase production of digestive enzymes through enhance liver functions (Hemandez, 2004). Garlic (*Allium sativum*) and black seed (*Nigalla sativa*) are widely distributed and grown in various parts of the world and is commonly used in the food industry because of special aroma and natural safety (Khan *et al*. 2003). In addition, the essential oil from these plants also exhibited strong antibacterial antifungal, antioxidant properties were reported by (Ertas *et al*. 2005). Black seed and Garlic also stimulate immune system and digestive enzymes (Durrani *et al*. 2007). Onsequently there is a considerable research interest in the possible use of natural products such as essential oil from these plants to change gastro-

intestinal tract conditions such as altered diet or altered composition of the intestinal microflora (Hall *et al*. 1994). The intestine can change its surface by growing to length and by increasing or decreasing the height of its villi. Shortening and fusion of villi will result in loss of surface for digestion and absorption of food (Vidanaravhvhi *et al*. 2006). Santin *et al*. (2001) reported that development of the morphology of gastrointestinal tract is greatly influenced by the diet of animal. Therefore, the aim of the present study was to determine the effect of GP, BS and premix (GP and BS) on the performance and the changes within the intestinal wall structure in broiler chickens.

MATERIALS AND METHODS

A total of 480 day-old chicks of the commercial strain (Hubbard) were randomly allocated into one of four treatments (three replicate each). Each replicate consisted of 40 broilers. From days 1 and 21 the broilers were fed a starter diet followed by a grower, diet between days 22 and 42 (Table 1).

Table 1 Composition of the broiler diets

Ingredients	Starter (0-21 days) %	Finisher (22-42 days) %
Corn	48.2	58.7
Wheat	8	7.5
Soybean meal (40%)	28.5	20.5
Protein Concentration (50%)	10	10
Vegetable oil	4	2.5
Salt	1	0.5
Vitamin / Minerale mix*	0.3	0.3
Total	**100**	**100**
Calculated composition**		
ME (kcal/kg)	3079	3106
Crude protein (%)	22.06	19.37
Crude fiber (%)	3.54	3.2
Lysine	1.21	1.03
Methionine + Cystine	0.82	0.75
Ca (%)	1.2	0.95
P (%)	0.44	0.42

* Ingredients / kilogram of diet: vitamin A (as all-trans-retiiol acetate): 12000 IU; vitamin E: 10 IU; K_3: 3 mg; vitamin D3: 2200 IU; riboflavin: 10 mg; Ca pantothenate: 10 mg; niacin: 20 mg; choline chloride: 500 mg; vitamin B12: 10 Ug; vitamin B_6: 105 mg; thiamine (as thiamine mononitrate): 2.2 mg; Folic acid: 1 mg; D-biotin: 50 ug. Trace minerals (mg/kg diet), Mn: 55; Zn: 50; Fe: 30; Cu: 10; Se: 1 and Ethoxyquin: 3 mg.
** Calculated composition was according to NRC (1994).

The four dietary treatments consisted of a control (basal diet), basal diet +0.5% garlic powder, basal diet +0.5% black seed and basal diet +0.5% plant premix (GP and BS).

Body weight (BW) and body weight gain (BWG) of the birds were measured individually and the feed intake (FI) per pen were also measured after 42 days of age. Feed intake and body weight per pen were used to calculate the feed conversion ratio. After 42 days of age, 6 chickens per replicate (3 male and 3 female) were randomly sampled for morphometric analysis. The chickens were killed and the intestinal tract was removed immediately and severed from the gizzard. The pancreas was also removed. Three 1-centimeter tissue segments were taken from the proximal, middle and distal parts of duodenum, jejunum and ileum sections.

All samples from each of the birds were taken from the same area of each section of the tract. Samples were stored in 10% buffered neutral formalin for fixation,–under shaking to remove any adhering intestinal contents. Cross sections (5 µm thick) of each intestinal segment were processed in low-melt paraffin and stained with Hematoxylin and Eosin. This procedure causes a longitudinal section of villi. Using a Zeiss light microscope, 13 measurements per intestinal section were made for each parameter and averaged into one value per bird. Each histological data obtained from the mean of 40 records (2 sections and 20 villi per section). Data on villus height, epithelial thickness, goblet cell number, crypt depth and ratio of crypt depth to villus height, were analyzed with the general linear model procedure and differences among treatments means were classified by Duncan's multiple range test (SAS, 1997).

RESULTS AND DISCUSSION

The effect of the dietary supplementation with either GP or BS or plant premix (GP and BS) on body weight, body weight gain, feed consumption and feed conversion ratio of broiler in 42 days are given in Table 2. Dietary supplementation with plant premix (GP and BS) and BS increased the BW, the BWG and the FC when compared to the control. However, there are no differences ($P>0.05$) in the FCR between dietary treatments.

The birds fed on the diet containing 0.5% plant premix (GP and BS) showed an increase ($P<0.05$) in BW, BWG and an improved feed efficiency as compared to the control ($P<0.05$). Results of the present study support the findings of Al-Homidan *et al*. (2002) who reported a growth rate improvement in broilers when their diets were supplemented with 2% black seeds.

Table 2 Effects of garlic powder, black seed and plant mixed on performance of broilers (42 day)

Groups	Body weight (g/bird)	Feed intake (g/bird)	Body weight gain (g)	Feed conversion (kg/kg)
Control	2001.3±21.56^{c}	4357.0±2.1^{b}	1964.3±16.7^{b}	2.17±0.22^{a}
Garlic powder (0.5%)	2156.8±14.87^{b}	4363.5±2.3^{b}	2119.7±10.5^{a}	2.04±0.44^{ab}
Black seed (0.5%)	2196.8±25.27^{a}	4393.8±2.3^{a}	2159.3±8.1^{a}	2.01±0.08^{ab}
Plant mixed (0.5%)	2240.6±24.39^{a}	4435.0±2.6^{a}	2203.1±12.2^{a}	1.98±0.03^{a}

The means within the same column with at least one common letter, do not have significant difference ($P>0.05$).

Similar results have been obtained by Durrani *et al.* (2007) who observed that the addition of black seed at the rate of 40 g/kg^{-1} feed resulted in a maximum weight gain. Osman and Barody (1999) also found an increased feed consumption in broilers by feeding black seed. However in contrast to results reported by Durrani *et al.* (2007) in which the higher feed consumption was recorded in the control group as compared to other groups. Birds,receiving a fed containing BS, GP and plant premix (GP and BS) exhibited advantages in feed consumption throughout the study compared to the control. Feed conversion was also improved for birds consuming plant premix (GP and BS) as compared to the control. Similar results have been obtained by Al-Homidan *et al.* (2002) and Osman and Barody (1999). Other factors which could have contributed to the beneficial effects of the plant premix (GP and BS) on the growth performance of birds, were their probable antibacterial , antioxidant and antifungal (Ertas *et al.* 2005).

Black seed and garlic also stimulates the immune system and digestive enzymes (Durrani *et al.* 2007). Tollba and Hassan (2003) found that garlic as a natural feed additive, improved broilers growth, feed conversion ratio (FCR), and decreased mortality rate. Measures of the histological examination of the intestinal are given in table 3 and figure 1. The addition of either GP, BS or plant premix to the basal diet increased villus length, crypt depth and crypt depth to villus length ratio.

However, goblet cells number (per 100 µ villus height) was not affected. There is evidence to suggest that plant premix (GP and BS), GP and BS effect may be due to a greater efficiency in the utilization of feed , resulting in an enhanced development of intestinal morphology of poultry (Apajalahti *et al.* 2004).

Our finding are in agreement with those of Montagne (2003) who stated that villus: crypt ratio is an indicator of the digestive capacity of small intestine.

Table 3 Effects of garlic powder, black seed and mixed on intestinal morphology of 42 day-old broiler

Groups	Duodenum	Jejunum	Ileum
	Villus height (µm)		
Control	911.38±1.90^{c}	762.78±0.18^{b}	660.22±0.16^{c}
Garlic powder (0.5%)	988.13±1.72^{b}	778.30±0.13^{ab}	670.09±0.19^{b}
Black seed (0.5%)	1020.31±1.88^{a}	851.22±0.20^{a}	677.00±0.20^{b}
Plant premix (0.5%)	1081.19±0.89^{a}	885.56±0.22^{a}	692.35±0.11^{a}
	Crypt depth (µm)		
Control	140.30±0.36^{c}	111.83±0.22^{b}	110.33±0.02^{c}
Garlic powder (0.5%)	150.44±0.34^{b}	121.18±0.24^{ab}	113.85±0.01^{b}
Black seed (0.5%)	168.50±0.39^{a}	127.90±0.19^{a}	117.23±0.04^{a}
Plant premix (0.5%)	169.71±0.29^{a}	130.74±0.17^{a}	120.90±0.04^{a}
	Crypt depth to Villus height (c/v)		
Control	0.153±0.005^{b}	0.146±0.08^{b}	0.167±0.03^{b}
Garlic powder (0.5%)	0.152±0.003^{b}	0.155±0.08^{a}	0.169±0.02^{ab}
Black seed (0.5%)	0.165±0.003^{a}	0.150±0.07^{a}	0.173±0.03^{a}
Plant premix (0.5%)	0.159±0.001^{a}	0.147±0.06^{b}	0.174±0.01^{a}
	Goblet cell number (per 100 µm villus height)		
Control	7.39±0.25	10.01±0.15	11.28±0.21
Garlic powder (0.5%)	7.10±0.20	10.00±0.18	10.30±0.17
Black seed (0.5%)	7.81±0.22	9.95±0.20	9.90±0.16
Plant premix (0.5%)	7.92±0.21	8.90±0.11	10.23±0.18

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

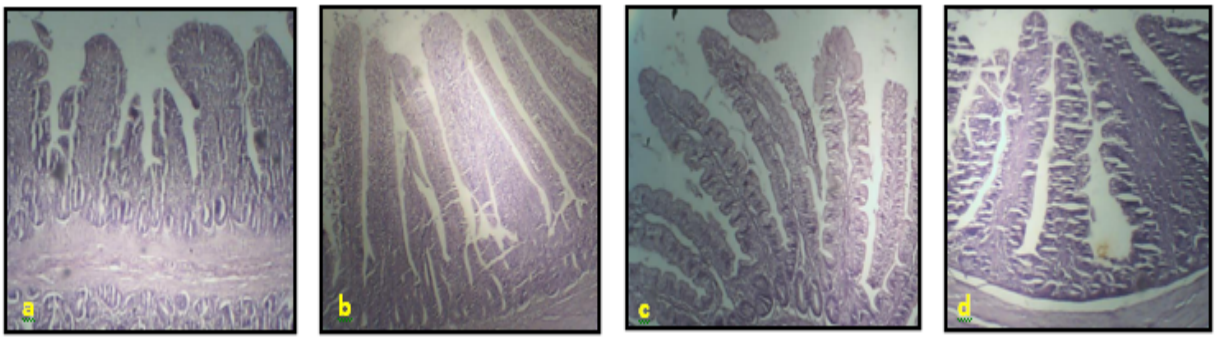

Figure 1 Effect of Garlic Powder (*Allium sativum*) and Black seed (*Nigella sativa*) in Intestinal morphology: a: Control; b: 0.5% GP; c: 0.5% BS d: 0.5% Plant mixed (100x , Mallory trichromical coloration) (stained with Hematoxylin and Eosin)

However, several researchers have studied intestinal morphology in poultry during the last decade but predominantly from the standpoint of normal development and not with regard to effects of antibiotics and other growth promoters (Uni *et al*. 1999; Geyra *et al*. 2001). It has been hypothesized that gut microflora decrease nutrient absorption by increasing GIT thickness, the rate of digesta passage, and also increase nutrient requirements of the host by increasing the turnover of the gut mucosa and by competing with the host for a portion of the dietary energy and (Ravindran *et al*. 1984; Apajalahti *et al*. 2004).

Krinke and Jamroz (1996) reported a reduced cell proliferation and a thinner epithelial in chicks fed on diet containing antibiotic. This is in agreement with the observed effect of garlic meal in present thinner intestinal epitheliums which enhance the absorption and reduce the metabolic demands of the gastrointestinal system (Visek, 1978). A shortening of the villi decreases the surface area for nutrient absorption.

The crypt can be regarded as the villus factory, and a large crypt indicates a fast tissue turnover and a high demand for new tissue (Yason *et al*. 1987). A decrease in either villus height or crypt may lead to a reduction in nutrient absorption.

It could be concluded that the improved intestinal morphology characteristics of birds receiving garlic powder, black seed and plant premix may explain the improved performances of the broiler chickens. Longer villi increase the surface area for nutrient absorption, while small crypt indicates a lower tissue turnover and a lower demand for new tissue. Changes in intestinal morphology, can lead to better nutrient absorption, decreased secretion in the gut and better overall performance.

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