

Reactions of Modern Broiler Chickens to Administration of Cinnamon Powder in the Diet

Research Article

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ABSTRACT

The objective of this paper was to study the responses on productive performance, carcass characteristics and plasma constituents of modern broiler chicks to administration of cinnamon powder (CP) in the diet. Commercial breeds (Ross 308) of broiler chicks examined from 1 to 42 days of age. This experiment was conducted as a completely randomized design with 5 treatments and four replicates (15 chickens per pen) involving: 1) control diet (basal diet); 2) basic diet plus CP 0.25%; 3) basic diet plus CP 0.50%; 4) basic diet plus CP 0.75% and 5) basic diet plus CP 1.0%. The addition of CP to the diets of broiler chicks had no significant effects ($P>0.05$) on cholesterol, triglyceride, low density lipoproteins (LDL), abdominal fat, gizzard and heart weights and on breast protein percentage. However, the administration of CP had significant effects ($P<0.05$) on final body weight, body weight gain, feed intake, feed conversion ratio (FCR), liver weight, glucose level, thiobarbituric acid (TBA) and breast fat percentage of broiler chicks. The highest ($P<0.05$) FCR and body weight gains were observed with diet 3 at the end of the experiment. In general, the addition of CP to the diet of broiler chicks improved body weight and decreased the TBA, glucose, LDL and weight of some inner organs. Taking into account the results mentioned before, the use of CP can be proposed as an ingredient for broiler diets.

KEY WORDS animal performance, broiler chickens, cinnamon, medicinal plants.

INTRODUCTION

Actually, dietary supplementation of medicinal plants as antibiotic replacement is a new approach in modern poultry farming systems. In the last few years, some of the side effects of antibiotics, such as microbial resistance and increase of blood cholesterol level in the domestic animals, have led to prohibit the use of these commercial products (Mansoub, 2010). In this context, medicinal plants could act as broiler growth promoters and antimicrobial declining global risks and animal perils. One of the medicinal plants that could be used is cinnamon. *Cinnamomum zeylanicum* is one of the oldest herbal medicines known, being mentioned in Chinese texts as long as 4000 years ago. It is often

used for medical purposes due to its unique properties. The essential oil from *C. zeylanicum* bark is rich in *trans-cinnamaldehyde* with antimicrobial effects against animal and plant pathogens, food poisoning and spoilage bacteria and fungi (Morris *et al.* 1979; Mastura *et al.* 1999). It has been established that the oils and extracts from cinnamon possess a distinctive antioxidant activity, which is especially attributed to the presence of phenolic and polyphenolic substances (Tomaino *et al.* 2005). Furthermore, cinnamon extract inhibits *Helicobacter pylori* at the concentration range of common antibiotics, its antimicrobial properties are mainly related to its *cinnamaldehyde* content, followed by eugenol and carvacrol contents (Taback *et al.* 1999). Cinnamon oil and its constituents (*cinnamaldehyde*

and *eugenol*) have antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermis*, *Salmonella sp.* and *Vibrio parahemolyticus* (Chang *et al.* 2001). Furthermore, there are several evidences that show that some herbs, spices and various plant extracts have not only antimicrobial effects, but also appetite and digestion stimulating properties (Kamel, 2001; Yu *et al.* 2007). Aromatic plants, such as cinnamon and thyme and essential oils acquired from these plants, were used as alternatives to antibiotics, due to their antimicrobial effects with the advantage of having stimulative effects on digestive system (Osman *et al.* 2005). Lee *et al.* (2004) found that adding cinnamon to broiler diets improved their growth performance. The improvement of body weight gain (BWG) and feed conversion ratio (FCR) are due to the active materials (*cinnamaldehyde* and *ugenol*) found in cinnamon, causing higher feed use efficiency and enhanced growth. The aim of the present study was to evaluate the effect of different levels of dried cinnamon powder (CP) on the performance of broiler chickens.

MATERIALS AND METHODS

This work was carried out from April to May 2013 at the animal science research center of Mazandaran, Iran. It is located at an altitude of 51.2 m above sea level. The average annual rainfall at this place is of 715 mm.

Experimental design and management

Three hundred 1-d-old chickens (Ross 308, males and females) were divided over 20 pens (15 chickens per pen) in a completely randomized design and were fed with 5 diets (treatments) involving: 1: control diet (basal diet); 2: basic diet plus CP 0.25%; 3: basic diet plus CP 0.50%; 4: basic diet plus CP 0.75% and 5: basic diet plus CP 1.00%. The experiment lasted for 42 d and it was divided in 2 phases (1-21 d and 22-42 d). The diets of each phase were prepared few days before being offered to the animals. For the feeding period, the diets were stored in a dark barrel in the stable for a maximum of 7 d. The diets were formulated with a different content of protein and energy (Table 1). In the vitamin-mineral premix, no synthetic antioxidants were added. Four different natural CP were selected and mixed to basic diets. Diets (Table 1) were formulated based on NRC (1994) tables of feedstuffs to meet nutrient requirements recommended for broilers. A mash starter, finisher and water were offered *ad libitum* from tube feeders and automatic drinkers with a twenty-four hours light program. Chicks were randomly distributed into the experimental groups.

The body weight (BW) was measured and registered weekly. At the end of the experimental period, blood sam-

ples were collected from each bird (1 bird per replicate) for quantifying blood parameters and immediately shipped to laboratory. Blood samples were then analysis for glucose, cholesterol (CHO), triglyceride (TG) and low-density lipoproteins (LDL) in the nutrition laboratory.

Concentrations of plasma total metabolites were determined using commercial kits, following the assumptions of Zhao *et al.* (2007).

On day 42, samples of thigh and breast from each bird were taken and immediately shipped to a laboratory for analysis of thiobarbituric acid (TBA) in carcass meat and to quantify the protein and fat content of breast muscle according to the indications.

Also, at the end of the experiment, one bird from each replicate was slaughtered for inner organs analysis according to the protocol described by Zhao *et al.* (2007).

Table 1 Composition of the experimental diets

Ingredients (%)	Starter 1-21 d	Grower 22-42 d
Corn	58.7	54.2
Wheat	0	15
Soybean meal	32.6	23.8
Fish powder	3	3
Plant oil	2.45	1.17
Clam shell	0.65	0.5
Bone powder	1.60	1.51
Salt	0.25	0.23
Min premix ¹	0.25	0.25
Vit premix ²	0.25	0.25
DL-methionine	0.15	0.07
Total	100	100
Analysis results		
ME (kcal/kg diet)	3012	3012
Crude protein (%)	21.6	18.6
Calcium (%)	0.94	0.84
Available phosphorus (%)	0.42	0.38
Sodium (%)	0.14	0.14
Linoleic acid (%)	1.43	1.29
Lysine (%)	1.25	1.02
Methionine + Cysteine (%)	0.87	0.68

¹ Premix provided: vitamin A: 1400 IU; vitamin D₃: 3000 IU; vitamin E: 50 mg; vitamin K: 4 mg; vitamin B₆: 3 mg; vitamin B₁₂: 7 mg; Niacin: 57 mg; Pantothenic acid: 20 mg; Folic acid: 0.2 mg; Choline: 150 mg.

² Mineral premix provides per kilogram of diet: Ca: 4.6 mg; P: 3.18 mg; Mn: 100 mg; Fe: 50 mg; Zn: 80 mg; Cu: 10 mg; Co: 0.25 mg and Iodine: 1.4 mg.

Statistical analysis

The data obtained from this study were analyzed by analysis of variance in a completely randomized design model using general linear models (GLM) of SAS (1996), following the model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} : the amount of each observation.

μ : the overall mean.

T_i : the effect of the treatments.
 e_{ij} : the experimental error.

Significant differences among means were tested using the Duncan's new multiple ranges test (Duncan, 1955). The differences were statistically assessed at $P < 0.05$.

RESULTS AND DISCUSSION

Performance

There were significant differences in BW BWG and FCR among treatments ($P < 0.05$) (Table 2) The highest BW and the lowest FCR were found in 0.50% CP. Furthermore, the lowest BW was found in the control group. Moreover, the highest and the lowest FI values were observed in the 1.00 and 0.25% CP groups, respectively. Improvements on BWG and FCR may due to the active materials (*cinnamaldehyde* and *ugenol*) found in cinnamon, causing greater efficiency in the utilization of feed, resulting in enhanced growth rate. There is an evidence to suggest that herbs, spices and various plant extracts have appetite and digestion stimulating properties and antimicrobial effects (Kamel, 2001). Aromatic plants, such as cinnamon and thyme and essential oils acquired from these plants, were used to have simulative effects on digestive system of poultry. In contrast to our results, Shirzadegan *et al.* (2012) showed that the addition of green tea to the diet of broilers induce a negative effect on BW. Similarly, Karunakaran and Kadirvel (2001) reported that the addition of Chestnut to the diet of broilers did not have any positive effects on performance of broilers. Moreover, Yalcin *et al.* (2007) showed that FCR and BW were not affected by garlic supplementation in the diet; these results were not agreed with our results.

In our study, broilers at 42 days old feeding supplemented diets showed higher BW and BWG compared to those feeding the control diet, but the FCR was not affected by treatments. It indicated that the cinnamon regulatory mechanisms of FI include the glucostatic theory, thermostatic theory, lipostatic theory and protein intake hypothesis (Koochacsaraie *et al.* 2011).

Furthermore, it implied that hypoglycemia stimulates a nervous center for feed consumption whereas hyperglycemia stimulates the center of satiety in animal brain. The FI reduction in 0.25% and 0.50% CP groups in comparison to the control group might be due to the glucostatic theory or the increase in glucagon levels. The reason for the lowest performance (FCR) of 0.75% and 1.00% CP groups compared with the oth may be due to negative effects of components such as coumarin, alkaloids, volatile oils and other anti nutritional factors contained in this herb (Shirzadegan *et al.* 2012).

Blood metabolites

The results indicated that there were found significant differences between treatments for glucose and TBA ($P < 0.05$), but there was no found any effect of the addition of CP on CHO, TG and LDL among treatments ($P > 0.05$) (Table 3). The highest and the lowest glucose levels were observed in the control and 0.5% CP treatments, respectively. Koochacsaraie *et al.* (2011) indicated that the addition of CP lead to a significantly decrease of plasma glucose level. Bolukbashi *et al.* (2007) reported that dietary thyme oil increases plasma levels of TG, LDL-cholesterol and HDL-cholesterol in broilers. Khosravi *et al.* (2008) reported that the addition of nettle extract to a broiler diet had no significant positive effect on total CHO.

Table 2 Effect of cinnamon powder on overall performance of broiler chicks

Parameters	0.00% ¹	0.25%	0.50%	0.75%	1.00%	SEM
BW (g)	2503 ^a	2621 ^b	2796 ^c	2676 ^d	2743 ^e	8.7
BWG (g)	2538 ^a	2576 ^a	2751 ^b	2631 ^{ac}	2698 ^{bc}	18.2
FI (g)	5612 ^a	5457 ^b	5527 ^{ab}	5839 ^c	5891 ^c	20.3
FCR	2.17 ^a	2.11 ^{ab}	2.01 ^b	2.21 ^a	2.18 ^a	0.020

¹Cinnamon powder levels of the diets (%).

BW: body weight; BWG: body weight gain; FI: feed intake and FCR: feed conversion ratio.

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

Table 3 Effect of cinnamon powder on blood metabolites of broilers

Parameters	Glucose (mg/dL)	CHO (mg/dL)	TG (mg/dL)	LDL (mg/dL)	TBA (mg/dL)
0.00 ¹	275.2 ^a	114.7	89.7	101.2	0.874 ^{ab}
0.25	264.7 ^a	112.1	92.5	81.2	0.855 ^{ab}
0.50	238.7 ^b	99.9	94.7	62.0	0.881 ^a
0.75	249.2 ^b	121.2	100.5	66.5	0.857 ^{ab}
1.00	240.5 ^b	107.2	106.0	88.7	0.843 ^b
SEM	2.30	81.00	6.50	7.70	0.0050

¹Cinnamon powder levels of the diet (%).

CHO: cholesterol; TG: triglyceride; LDL: low density lipoproteins and TBA: thiobarbituric acid.

SEM: standard error of the means.

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

Another study indicated that *C. zeylanicum* essential oil inhibits the hepatic 3-hydroxy-3-methylglutaryl CoA (HMG-CoA) reductase activity in rats, resulting in lower hepatic cholesterol content and suppresses lipid peroxidation via the enhancement of hepatic antioxidant enzyme activities (Lee *et al.* 2003).

However, in our study it was not observed a significant response in CHO and TG levels of chickens that received CP in their diets. It was thought that the antioxidant property of cinnamon blocked lipid peroxidation of tissue lipids, especially polyunsaturated fatty acids. For this reason, in our study the TG levels of serum were not found significantly high after addition of CP (particularly in treatments with high level of CP).

Likewise, addition of CP to the diet (except for the 0.50% treatment) decreased the TBA content in carcass meat compared to the control. According to this, the lowest and the highest TBA levels were found in the 1.00% CP and 0.50% groups, respectively. It indicated that the digestive tract itself is considered to be a major site of free-radical production in animals and some of them might be delivered via portal blood system into the liver. The present results agree with other studies carried out by Ei Deek and Al Harthi (2004) and Shirzadegan *et al.* (2012) on medicinal plants, which reported that the ingestion of green tea decreases the carcass meat TBA percentage. Likewise, lipid-lowering and a decrease on anti-oxidative activities of 3, 4-di (OH)-cinnamate and 3, 4-di (OH)-hydrocinnamate was also reported by Lee *et al.* (2001). In our study, TBA was significantly reduced in chickens fed diets supplemented with 0.25, 0.75 and 1.00% of CP, which could be due to phenolic component in cinnamon.

Carcass traits

Breast protein and fat

Table 4 shows that the breast fat percentage was significantly ($P<0.05$) influenced by the addition of CP to the diet of broiler chicks. The highest and the lowest breast fat percentage were observed in the 0.25 and 0.50% CP treatments, respectively. These results imply an enzyme relationship through cinnamon and fat metabolism in body. Shirzadegan *et al.* (2012) indicated that cinnamon and turmeric provoke a decrease in lipogenesis and (HMG-CoA) reductase activity in birds, resulting in lower TG and CHO content in muscles. Shut down in breast fat in our study might be due to this action. However, different levels of CP had not any significant effect on the breast protein percentage of broilers. Means in the same column with no common superscript differ significantly ($P<0.05$). Our study shows no significant effect ($P>0.05$) of CP on heart, gizzard and abdominal fat weights percentage and a significant effect on liver weight percentage ($P<0.05$) (Table 5).

Table 4 Effect of cinnamon powder on breast protein and fat percents of broilers

Parameters	Breast protein (%)	Breast fat (%)
0.00 ¹	22.5	0.704 ^a
0.25	24.1	0.798 ^b
0.50	23.2	0.545 ^c
0.75	23.5	0.566 ^c
1.00	21.8	0.699 ^a
SEM	0.90	0.0060

¹Cinnamon powder levels of the diet (%).

SEM: standard error of the means.

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

Table 5 Effect of cinnamon powder on inner organs weight of broilers

Parameters	Liver (%)	Heart (%)	Abdominal fat (%)	Gizzard (%)
0.00 ¹	3.01 ^a	0.60	3.67	3.2
0.25	2.95 ^{ab}	0.59	3.77	3.6
0.50	2.90 ^{ab}	0.61	3.81	3.1
0.75	2.70 ^{ab}	0.65	3.52	3.6
1.00	2.78 ^{ab}	0.67	3.70	3.3
SEM	0.100	0.009	0.008	0.15

¹Cinnamon powder levels of diet (%).

SEM: standard error of the means.

Means in the same column with no common superscript differ significantly ($P<0.05$).

According to this, the highest and the lowest liver weight percentage were found in the control and 0.75% CP treatments, respectively. It seems that glucagon is increased in the 0.75% CP treatment due to an increase on lipolysis and a reduction on abdominal fat and liver weight (because of reducing in liver fat).

Taking this into consideration, Alcicek *et al.* (2004) observed an improvement on carcass efficiency (spleen, gizzard, cecum and thigh) of broilers when in the diet of the animals is incorporated an essential oil mix. A possible reason for promoting an increase on carcass yield could be more intensive amino acids anabolism (Szewczyk *et al.* 2006).

Liver weight in our study after CP consumption is decreased due to a reduction in the secretion of some enzymes. The results published by Langhout (2000) showed that oil extracts could stimulate the digestion system in poultry, improve the function of liver and increase the pancreatic digestive enzymes. Enhancement of the metabolism of oils, carbohydrates and proteins in the major organs would increase growth rate of these organs (Mellor, 2000).

CONCLUSION

In conclusion, our study showed that supplementing different concentrations of cinnamon powder in the diet (especially at a level of 0.50%) increase the final body weight of broiler chickens. Moreover, broilers muscle TBA is also decreased after consumption of 0.50% cinnamon powder. On the basis of these findings, we suggest that cinnamon powder may play an important role in broilers' diets, but

more study is needed to determine all the effects of cinnamon powder on broiler chickens' performance.

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