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Full Length Research Paper

Influence of turmeric rhizome and black pepper on blood constituents and performance of broiler chickens

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The aim of this study was to evaluate the effects of turmeric rhizome powder (TRP) and black pepper (BP) on blood components and performance of male broiler chickens. A 2 × 3 factorial arrangement with two levels of TRP (0 and 0.5 g/kg) and three levels of BP (0, 0.5 and 1 g/kg) were used to provide six dietary treatments. Each diet was randomly fed to four groups of 12 chicks each, and performance and hematological criteria were measured. The results showed that weekly body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) of broilers were not influenced by TRP. The addition of 0.5 g TRP to diet significantly decreased alanine aminotransferase (ALT) activity, but did not affect aspartate aminotransferase (AST) and lactate dehydrogenase (LDH) activities, and concentration of low density lipoproteins (LDL), high density lipoproteins (HDL), cholesterol, and triglycerides in serum. Serum chloride and total electrolyte balance significantly decreased by TRP, whereas sodium and potassium concentrations were unchanged. Supplementation of diet with 1 g BP significantly reduced FCR in the first week; however, this pronounced effect was not observed in the later weeks. The BWG and FI were not influenced by BP. Even though, the serum metabolites such as LDL, HDL, cholesterol, electrolytes and activity of AST, ALT and LDH enzymes were not influenced by the addition of BP to diet, serum triglycerides significantly reduced in birds fed diet containing 1 g BP as compared to those fed control diet. There was no significant interaction between TRP and BP on blood metabolites and performance of male broiler chickens.

Key words: Turmeric rhizome, black pepper, hematological criteria, broiler chickens.

INTRODUCTION

Different spices have been used as food additive all over the globe along the history. These botanicals have received a high attention as nutraceuticals and multifunctional feed supplements for various purposes in poultry production during recent years. Turmeric rhizome (*Curcuma longa*) is an extensively used spice, food preservative and coloring material that has biological actions and medicinal applications (Burt, 2004). The main component of turmeric is curcumin that is a good antioxidant (Karami et al., 2011) and antibacterial (Negi et al., 1999) with hypo-cholesterolemic properties. Emadi and Kermanshahi (2007 a, b) indicated that turmeric rhizome powder (TRP) is an inducer of immune response and aspartate aminotransferase (AST) and lactate dehydrogenase (LDH) activities in the serum of broiler chickens. Supplemented diets with TRP significantly decreased alanine aminotransferase (ALT) and alkaline phos-phatase (ALP) activities. Kermanshahi and Riasi (2006) and Abbas (2009) demonstrated that dietary TRP significantly reduced triglycerides, total cholesterol and low density lipoproteins (LDL)-cholesterol of serum in layers and broilers. Curcumin reduced the activity of reactive oxygen species and elevates the antioxidant enzymes like superoxide dismutase, catalase and glutathione peroxidase levels in blood (Joe and Lokesh, 1994). Although curcumin is the main active component, it does not share all effects of turmeric

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Abbreviations: TRP, Turmeric rhizome powder; **BP,** black pepper; **BWG,** body weight gain; **FI,** feed intake; **FCR,** feed conversion ratio; **ALT,** alanine aminotransferase; **AST,** aspartate aminotransferase; **LDH,** lactate dehydrogenase; **LDL,** low density lipoproteins; **HDL,** high density lipoproteins.

(Gilani et al., 2005).

Black pepper (*Piper nigrum*) bioactive compounds such as piperine have different characteristics like anti-mutagenic properties (El Hamss et al., 2003). Piperine is an active alkaloid that modulates benzopyrene metabolism through cytochrome P450 enzyme (CYP), which is important for the metabolism and transport of xenobiotics and metabolites (Reen et al., 1996) and depresses aflatoxin B_1 toxicity by suppressing CYP mediated bioactivation of the mycotoxin (Singh et al., 1994; Reen et al., 1997).

Brenes and Roura (2010) indicated that botanicals interactions need to be investigated due to the complexity in terms of the number and the variability of bioactive compounds, and the interactions between essential oils, and feasible synergistic effects to maximize or minimize the concentrations required to achieve a particular impact of the botanicals. The objective of the current study was to evaluate the effect of supplementary TRP and BP and their interaction on serum components and performance of male broiler chickens.

MATERIALS AND METHODS

A total of 288 day-old Ross 308 male chicks were obtained from a commercial hatchery (Qouchan, Mashhad, Iran) and randomly distributed to 24 floor pens. Each pen (1 m^2) was equipped with a manual feeder and two nipple drinkers, and the floor was covered with clean wood shavings. Chicks were vaccinated for Infectious Bronchitis on the first day, Newcastle Disease and Avian Influenza on 7 and Inflammatory Bursal Disease on day 14 of age. The initial house temperature was set at 32°C and gradually decreased by about 2.5°C per week. A lighting schedule of 24 h light with approximately 20 lx was used for the entire period. The birds were given starter and grower diets from day 1 to 21. The basal diets were formulated (Table 1) to meet the nutrient requirements of the broiler chickens as recommended by Ross 308 broiler management guide (Aviagen, 2009). A 2 × 3 factorial experiment with two levels of dietary TRP (0 and 0.5 g/kg) and three levels of BP (0, 0.5 and 1 g/kg) was used in a completely randomized design. Each of the 6 assay mash diets was fed to 4 replicates of 12 chicks each for 21 days. Feed and water were offered *ad libitum* throughout the experiment. The experimental protocol was approved by the Animal Care Committee of Ferdowsi University of Mashhad, Iran.

Body weight gains (BWG), feed intake (FI) and feed conversion ratio (FCR) were measured weekly. The FI was determined from the difference between supplied and residual feed in each pen. The FCR was calculated from the ratio between FI and weight gain of chick, in each pen and was adjusted for mortality. Mortality was weighed and recorded daily.

Blood samples were collected from wing vein and analyzed by an automatic analyzer (Bio Systems S. A. – Costa Brava 30, 08030 Barcelona, Spain) at 21 days of age. Sera were separated and obtained by centrifugation of the coagulated blood (2500 rpm: 10 min) within 30 min after sampling to measure serum chemical components. The reported procedures were used to measure the activity of LDH (Young, 1995), AST, ALT (IFCC, 1986 a, b), and concentrations of low density lipoprotein (LDL) (Nauck et al., 2002), high density lipoprotein (HDL), triglycerides, sodium, potassium and chloride in the serum (Burtis and Ashwood, 1999). Data were analyzed using the General Linear Model procedure of the Statistical Analysis System (SAS, 2004). Tukey's Studentized Range (HSD) test was also used to compare the means ($P<0.05$).

RESULTS AND DISCUSSION

Mortality data were not subjected to statistical analysis because just three chicks died throughout the trial (Gutierrez et al., 2007). The effects of TRP, BP and their interaction on weight gain, FI, and FCR of male broilers during the first 21 day of age are shown in Table 2. Body weight gain and FI of male broiler chicks during different weeks were not influenced by TRP, BP or their interactions. The addition of BP at the rate of 1 g/kg significantly improved FCR in the first week, but this effect did not continue in the later weeks. The TRP and its interaction with BP did not have a significant effect on FCR. These findings concur with the results of Mehala and Moorthy (2008b) who revealed that even though the addition of turmeric to the diet at the levels of 1 or 2 g/kg did not have a significant effect on FI and FCR, chicks weight gain significantly declined when 2 g turmeric was added to the diet during the first week. They also found that the abdominal fat percentage, breast and thigh muscle cholesterol were not changed among treatment groups (Mehala and Moorthy, 2008a). Wenk (2006) reported that many herbs and botanicals can increase FI and improve growth rate; however, Windisch et al. (2008) reviewed the topic and found no clear evidence of the effects of herbs and spices on improvement and palatability in farm animals.

It has been observed that bile acid secretion increased in laboratory animals fed curcumin, but not in piperine fed animals (Platel and Srinivasan, 2000a, 2004). Piperine of black pepper is now recognized as a bioavailability enhancer of various structurally and therapeutically diverse drugs and phytochemicals (Suresh and Srinivasan, 2006). Moreover, it has been reported that some spices stimulate pancreatic digestive enzymes– lipase, amylase and proteases, which play a crucial role in digestion (Platel and Srinivasan, 2000b). A few of these spices were also found to enhance the activities of terminal digestive enzymes of small intestinal mucosa (Sharathchandra et al., 1995; Platel and Srinivasan, 1996, 2001a). Concomitant with such a stimulation of either bile secretion or activity of digestive enzymes by these spices, leading to an accelerated digestion, a reduction in feed transit time in the alimentary tract has also been observed (Platel and Srinivasan, 2001b). The improvement of broilers performance by these spices due to the above mentioned mechanisms was expected, whereas in the current research, any positive effect of these botanicals except the partial improvement of FCR by BP was not observed. It seems that these results are related to species of animal or inclusion rate of TRP or BP. Similarly, Mehala and Moorthy (2008b) revealed that dietary turmeric was not effective on overall BWG, FI and FCR of broiler chickens.

The effects of TRP, BP and their interaction on

Table 1. The composition of basal diets.

Item	Starter (1 to 10 day)	Grower (11 to 21 day)
Ingredients (g/kg)		
Corn	503.2	561.9
Soybean meal	413	360.7
Vegetable oil	42	40
Limestone	13.6	11.2
Dicalcium phosphate	16.5	14.7
Common salt	4.3	4.3
L-Lysine HCl	1	1
DL-Methionine	1.4	1.2
Vitamin and mineral premix [1]	5	5
Calculated contents (g/kg unless otherwise stated)		
ME (MJ/kg)	12.34	12.55
Crude protein	226	207
Calcium	10.2	8.6
Available phosphorus	4.9	4.3
Lysine	12.4	10.5
Methionine	4.6	4.0
Methionine + Cystine	9.2	8.0
DCAB (mEq/kg)	251	228

[1]Vitamin and mineral premix supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D3, 9800 IU; vitamin E, 121 IU; B12, 20 µg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 µg; thiamin, 4 mg; zinc sulfate, 60 mg; manganese oxide, 60 mg.

enzymes activity, lipids and electrolytes of male broiler chicks' serum at 21 days of age are shown in Table 3. Enzyme activity of ALT in serum of chicks fed diet containing TRP significantly decreased as compared to those fed control diet (9 vs. 12 IU/L); however, no significant difference was observed for AST and LDH activities. The BP and its interaction with TRP did not have a considerable effect on these enzyme activities. Emadi and Kermanshahi (2007b) indicated that dietary inclusion of TRP significantly increased the activity of LDH and AST, whereas significantly decreased ALT and ALP activities. Fernandez et al. (1994) induced liver damage by aflatoxin in layers and broilers and an increase in serum ALT activity was observed. The reduction of ALT activity by TRP in our study can be indicative of better function of liver.

The TRP, BP and their interaction did not have a significant effect on LDL, HDL and cholesterol in serum of chicks. In previous studies, dietary TRP significantly decreased triglycerides, total cholesterol and LDL-cholesterol of serum in layers (Kermanshahi and Riasi, 2006) and broilers (Abbas, 2009). Curcumin (Srinivasan and Satyanarayana, 1987; Soudamini, et al 1992; Babu and Srinivasan, 1997) and turmeric extract (Deshpande et al., 1997; Ramirez-Tortosa et al., 1997) exhibited hypocholesterolemic effects, particularly in cholesterol-fed animals. Emadi et al. (2007) reported that 2.5 g/kg turmeric supplementation in broilers diet significantly increased total cholesterol and HDL-cholesterol and significantly decreased LDL-cholesterol at 42 days of age. Babu and Srinivasan (1997) have suggested that such a cholesterol-lowering effect could be mediated by the stimulation of hepatic cholesterol-7- hydroxylase which converts cholesterol to bile acids, facilitating the biliary cholesterol excretion. Conversion of cholesterol to bile acids is a multiple-step process in which the initial step, 7α-hydroxylation, is the rate limiting reaction. It is possible that in spice principles-fed animals whose liver microsomal aryl hydroxlase activity is stimulated, cholesterol-7-α-hydroxlase is also similarly activated (Suresh and Srinivasan, 2006). Higher activity of hepatic cholesterol-7-α-hydroxlase has been evidenced in animals fed curcumin, but not in animals fed piperine (Srinivasan and Sambaiah, 1991). Suresh and Srinivasan (2006) by *in vitro* trial revealed that aryl hydroxylase activity was reduced by piperine. These findings coincide with hypocholesterolemic properties of curcumin and not of piperine (Srinivasan et al., 2004). In addition, Emadi et al. (2007) concluded that incorporation of TRP into the male broiler diets significantly increased total cholesterol, HDL-cholesterol and hemoglobin and decreased LDL-cholesterol, VLDL-cholesterol and red blood cells at 42 days of age ($P<0.05$). However, Mehala and Moorthy (2008a) reported that the serum glucose, total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides level was not significantly influenced by turmeric. Dietary 0.2 to

Table 2. Effect of turmeric rhizome powder (TRP), black pepper (BP) and their interaction on body weight gain (g/b), feed intake (g/b) and feed conversion ratio of male broilers during the first 21 days of age.

Effect	Body weight gain (g/b)				Feed intake (g/b)				Feed conversion ratio			
	1 to 7 day	8 to 14 day	15 to 21 day	1 to 21 day	1 to 7 day	8 to 14 day	15 to 21 day	1 to 21 day	1 to 7 day	8 to 14 day	15 to 21 day	1 to 21 day
TRP (g/kg)												
0	74.16	159.04	336.70	569.90	103.09	208.71	527.87	839.68	0.89	1.20	1.58	1.38
0.5	76.83	152.60	315.15	544.55	106.11	197.13	548.95	582.18	0.90	1.30	1.75	1.45
SEM	1.879	5.343	10.008	11.957	2.823	15.267	18.519	20.380	0.022	0.044	0.075	0.034
BP (g/kg)												
0	75.27	162.28	323.37	560.93	105.88	187.48	519.86	813.21	0.91[ab]	1.15	1.62	1.35
0.5	73.57	159.28	329.22	562.27	107.85	202.36	571.95	882.15	0.94[a]	1.26	1.74	1.46
1	77.65	145.67	325.18	548.49	100.07	218.92	523.42	842.43	0.84[b]	1.34	1.63	1.43
SEM	2.301	6.544	6.544	12.257	3.457	18.698	22.682	24.960	0.022	0.053	0.092	0.047
S.O.V.	------------------------------------ P-value ------------------------------------											
TRP	0.328	0.405	0.145	0.151	0.458	0.598	0.431	0.669	0.797	0.162	0.117	0.137
BP	0.468	0.186	0.942	0.766	0.280	0.506	0.220	0.175	0.043	0.091	0.604	0.222
TRP × BP	0.693	0.917	0.077	0.141	0.436	0.647	0.308	0.505	0.693	0.084	0.931	0.875

[a,b] Means within each column for every effect with uncommon superscript are significantly different ($P<0.05$).

Table 3. Effect of turmeric rhizome powder (TRP), black pepper (BP) and their interaction on some enzymes activity, concentration of some lipids and electrolytes of male broilers serum at 21 day of age.

Effect	AST (IU/L)	ALT (IU/L)	LDH (IU/L)	LDL (mg/dL)	HDL (mg/dL)	Triglyceride (mg/dL)	Cholesterol (mg/dL)	Na^+ (mEq/L)	K^+ (mEq/L)	Cl^- (mEq/L)	Electrolyte* (mEq/L)
TRP (g/kg)											
0	192.88	12.11[a]	4010.55	23.55	86.77	79.33	135.22	132.55	4.16	36.11[b]	100.61[a]
0.5	207.11	9.00[b]	4286.66	22.44	88.00	69.88	123.22	132.11	3.70	59.33[a]	76.47[b]
SEM	8.298	0.711	231.351	2.566	4.046	5.674	5.350	3.015	0.168	6.381	7.832
BP (g/kg)											
0	193.00	11.66	4021.66	24.16	80.33	87.00[a]	133.83	134.50	3.91	50.66	87.75
0.5	197.00	10.33	4181.66	22.50	91.66	76.50[ab]	128.00	129.66	3.78	45.16	88.25
1	210.00	9.66	4242.50	22.33	90.16	60.33[b]	125.83	132.83	4.10	47.33	89.60
SEM	10.163	0.871	283.346	3.143	4.955	6.783	6.552	3.693	0.206	7.816	9.953
S.O.V.	------------------------------------ P-value ------------------------------------										
TRP	0.248	0.009	0.415	0.764	0.834	0.262	0.138	0.918	0.074	0.024	0.035
BP	0.486	0.292	0.852	0.902	0.253	0.044	0.679	0.652	0.568	0.883	0.988
TRP × BP	0.533	0.259	0.862	0.788	0.129	0.530	0.719	0.622	0.851	0.738	0.854

[a,b] Means within each column for every effect with uncommon superscript are significantly different ($P<0.05$). *AST: Aspartate aminotransferase; ALT: alanine aminotransferase; LDH: lactate dehydrogenase; LDL: low density lipoprotein; HDL: high density lipoprotein; electrolytes = $N^+ + K^+ - Cl^-$.

5 g black pepper or 0.5 g piperine did not affect blood and liver cholesterol of rats (Srinivasan and Satyanarayana, 1981). Samarasinghe et al. (2003) indicated that turmeric at the rate of 3 g/kg in chicks diet significantly reduced fat deposition.

In this study without cholesterol supplementation, the blood lipoproteins concentration were not affected by dietary TRP which may be due to conventional balanced diet or low inclusion level of TRP. Serum triglycerides were significantly reduced in birds fed diet containing 1 g BP as compared to those fed control diet (63.33 vs. 87 mg/dL), but this significant effect was not observed for TRP or its interaction with BP. Chloride concentration and total electrolytes balance of serum were significantly decreased by TRP ($P<0.05$), but were not influenced by BP and its interaction with TRP. Sodium and potassium concentrations of serum were not influenced by TRP, BP or their interaction. There are some fluctuations in the influence of spices on blood constituents of chicks. Steiner (2009) indicated that dietary phytogenics may not always show an expected response in poultry.

Conclusion

Under the conditions of this study, there was no significant interaction between TRP and BP on blood metabolites and performance of male broiler chicks during 1 to 21 days of age. Based on our findings, due to large variation of composition and other feasible effective factors, it is concluded that the inclusion of herbs such as TRP and BP in the diet may not always exhibit an expected influence on bird performance.

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