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Effects of Black Pepper (*Piper Nigrum*), Turmeric Powder (*Curcuma Longa*) and Coriander Seeds (*Coriandrum Sativum*) and Their Combinations as Feed Additives on Growth Performance, Carcass Traits, Some Blood Parameters and Humoral Immune Response of Broiler Chickens

R. Abou-Elkhair[1], H. A. Ahmed[2], and S. Selim[1,3,]*
[1] Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine,
Sadat City University, Sadat 32897, Egypt

ABSTRACT: Different herbs and spices have been used as feed additives for various purposes in poultry production. This study was conducted to assess the effect of feed supplemented with black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*), coriander seeds (*Coriandrum sativum*) and their combinations on the performance of broilers. A total of 210 (Cobb) one-d-old chicks were divided into seven groups of 30 birds each. The treatments were: a control group received no supplement, 0.5% black pepper (T1), 0.5% turmeric powder (T2), 2% coriander seeds (T3), a mixture of 0.5% black pepper and 0.5% turmeric powder (T4), a mixture of 0.5% black pepper and 2% coriander seed (T5), and a mixture of 0.5% black pepper, 0.5% turmeric powder and 2% coriander seeds (T6). Higher significant values of body weight gain during the whole period of 5 weeks ($p<0.001$) were observed in broilers on T1, T3, T5, and T6 compared to control. Dietary supplements with T1, T2, T3, and T6 improved the cumulative G:F of broilers during the whole period of 5 weeks ($p<0.001$) compared with control. The dressing percentage and edible giblets were not influenced by dietary supplements, while higher values of relative weight of the liver ($p<0.05$) were obtained in T5 and T6 compared to control. The addition of feed supplements in T5 and T6 significantly increased serum total protein and decreased serum glucose, triglycerides and alkaline phosphatase concentrations compared with the control group ($p<0.05$). Broilers on T6 showed significant decrease in the serum glutamate pyruvate transaminase concentration ($p<0.05$) compared to control. The broilers having T5 and T6 supplemented feed had relatively greater antibody titre ($p<0.001$) at 35 d of age than control. It is concluded that dietary supplements with black pepper or coriander seeds or their combinations enhanced the performance and health status of broiler chickens. (**Key Words:** Antibody Titre, Blood Biochemistry, Carcass, Chicken, Herbs, Performance)

INTRODUCTION

Dietary antibiotic growth promoters have played a key role in animal and poultry production. However, most of these antibiotics have been banned in many countries, particularly the European Union, because of public health concern regarding their residues in the animal products and the development of antibiotic resistance in bacteria (Schwarz et al., 2001; Lee et al., 2004). Presently, there is an increasing of interest to find non-synthetic alternatives for antibiotics between the scientists. Phytogenic feed additives such as herbs and spices are commonly incorporated into the diets of agricultural livestock, particularly swine and poultry, to improve flavor and palatability, therefore enhancing productive performance (Windisch et al., 2008). Herbs and spices are well identified

* Corresponding Author: Shaimaa Selim. Tel: +358-045-3062009, Fax: +358-9-191-58379, E-mail: shaimaa.selim@helsinki.fi
[2] Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Damanhur University, Damanhur 22111, Egypt.
[3] Department of Agricultural Sciences, Faculty of Agriculture and Forestry, Helsinki University, Helsinki 00014, Finland.
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to exert potent antimicrobial properties *in vitro* against various pathogens, and as alternative feeding strategy to replace antibiotic growth promoters (Smith-Palmer et al., 1998; Burt, 2004; Si et al., 2006; Lee et al., 2013). However, our knowledge regarding their modes of action and aspects of their application is still limited.

Black pepper (*Piper nigrum*) is a flowering vine extracted from the core of a pepper plant, and belongs to the family Piperaceae, genus Piper and species Piper nigrum. Black pepper has been shown to be rich in glutathione peroxidase and glucose-6-phosphate dehydrogenase (Karthikeyan and Rani, 2003). The antioxidant and radical scavenging properties of black pepper seeds have been well documented (Gülcin, 2005). Khalaf et al. (2008) showed that piperine can increase the absorption of selenium, vitamin B complex, beta-carotene and curcumin as well as other nutrients. Furthermore, it is an active alkaloid modulate benzopyrene metabolism through cytochrome P450 which is essential for metabolism and transport of xenobiotics and metabolites (Reen et al., 1996), enhances thermogenesis of lipid (Malini et al., 1999), and increases the flow of digestive juice (Moorthy et al., 2009).

Turmeric (*Curcuma longa*) is an extensively used spice, food preservative and coloring material which has biological actions and medicinal applications (Burt, 2004). The active and main ingredient found in turmeric is curcumin, which was found to have antioxidant (Karami et al., 2011) and antibacterial activities (Negi et al., 1999). Additionally, Soni et al. (1997) proved the protective effect of turmeric as feed additives on aflatoxin induced mutagenecity and hepatocarcinogenicity. Another herbal plant, coriander (*Coriandrum sativum*) is mainly used for its seeds which used primarily as a flavoring agent in the food industry or as a spice in bread, curry, fish, meat and confections. Coriander seeds contain an essential oil up to 1%, the main component is linalool, which has potential antibacterial (Burt, 2004; Cantore et al., 2004; Kubo et al., 2004), antioxidant (Wangensteen et al., 2004), antidiabetic (Gallagher et al., 2003), and hypolipidemic properities (Chithra and Leelamma, 2000). It has also appetizing and stimulatory effects in the digestion process (Çabuk et al., 2003).

Specific collaborative effects of herbal mixture on chicken performance have not received much attention (Moran, 1982). Brenes and Roura (2010) suggested that certain interactions of botanicals need to be examined because of the complexity regarding the number and variability of bioactive compounds. Therefore, the aim of the current study was to evaluate the effects of supplementary black pepper, turmeric powder and coriander seeds, and their combinations on growth performance, blood biochemistry, carcass traits, and humoral immune response of broiler chickens. The research hypothesis tested was that dietary supplements with black pepper, coriander seeds, and turmeric powder and their combinations would improve growth performance and health status of broiler chickens.

MATERIAL AND METHODS

Birds and experimental design

The experiment was carried out under the protocol approved by the Faculty of Veterinary Medicine, Damanhur University, Egypt. Two hundred-ten 1-d-old Cobb 500 broiler chicks were randomly assigned to 7 treatments, each treatment comprised 3 replicates with 10 birds each. The groups were allocated as follows:

Control = basal diet with no supplement
T1 = basal diet plus 0.5% black pepper (BP)
T2 = basal diet plus 0.5% turmeric powder (TUR)
T3 = basal diet plus 2% coriander seeds (COR)
T4 = basal diet plus a mixture of BP and TUR
T5 = basal diet plus a mixture of BP and COR
T6 = basal diet plus a mixture of BP, TUR, and COR

Birds diet and husbandry

Maize and soybean based starter (0 to 21 d of age) and grower-finisher (22 to 35 d of age) diets were formulated to meet NRC recommendations (NRC, 1994). Table 1 presents the ingredients and the composition of the basal diets. Proximate analysis, which was conducted according to AOAC International (1995), showed no major deviation from calculated values. Black pepper, TUR and COR were mixed with the bird diets according to the experimental design. Ten birds were housed in each isolator with a density 10 birds/m^2. All birds were reared in the floor pens using wood shavings as litter. Temperature was adjusted at 32°C±2 in the first wk then lowered 2°C each successive week then maintained at 28°C±2. Relative humidity was about 60% to 80%. The chicks were vaccinated against Newcastle disease (ND). Access to feed and water was provided on an *ad libitum* basis.

Chicken performance measurements

Body weight and feed intake (FI) were monitored on a pen basis weekly, while body weight gain (BWG) and gain-to-feed ratio (G:F) values were consequently calculated. Mortality was also recorded on a daily basis in each pen. Chickens were killed by cervical dislocation at the end of the trial. Six birds per treatment group (2 birds from each replicate) were randomly selected for tissue sampling and for determining carcass yield. They were defeathered, eviscerated and dressed. Tissues of liver, gizzard, heart, proventriculus, thymus gland, spleen and bursa of Fabricius

Table 1. Ingredients and nutrient composition (% DM) of broiler starter and finisher rations

	Broiler starter	Broiler finisher
Ingredient (%)		
Yellow corn	57.93	59.62
Soybean meal (48%)	35.00	32.45
Corn oil	3.00	4.00
Sodium chloride	0.35	0.35
Dicalcium phosphate[1]	1.70	1.50
Premix[2]	0.30	0.30
Limestone	1.30	1.40
DL-methionine[3]	0.22	0.17
L- lysine-HCL[4]	0.20	0.20
Chemical analysis[5]		
DM	89.20	89.00
CP	21.89	20.79
Ether extract	6.70	8.00
Crude fibre	4.70	4.80
Calculated analysis		
ME (kcal/kg)	3,101.40	3,198.20
Ca	0.11	0.10
Available P	0.12	0.12
Methionine	0.55	0.49
Lysine	1.34	1.11

DM, dry matter; CP, crude protein.

[1] Dicalcium phosphate, 18% granular phosphate and 23 % calcium.

[2] Supplied per kg of diet: vitamin A 12,000 IU, vitamin D_3 3,000 IU, vitamin E 40 mg, vitamin K_3 3 mg, vitamin B_1 2 mg, vitamin B_2 6 mg, vitamin B_6 5 mg, vitamin B_{12} 0.02 mg, niacin 45 mg, biotin 0.075 mg, folic acid 2 mg, pantothenic acid 12 mg, manganese 100 mg, zinc 600 mg, iron 30 mg, copper 10 mg, iodine 1 mg, selenium 0.2 mg, cobalt 0.1 mg.

[3] DL-Methionine, Met AMINO (DL-2-amino-4-(methyl-thio)-butane acid, DL-methionine, α-amino-Y-methyl-oily acid) by Feed Grade 99% (EU).

[4] L-lysine HCL 99% (Feed Grade) L-lysine: 78.0% Min (Indonesia).

[5] According to AOAC International (1995).

were collected by removing skin, fat and connective tissue.

Sampling

At 12, 24, and 35 d of age, 6 birds from each treatment (2 birds from each replicate) were randomly selected for blood analysis. Blood samples were obtained from wing vein and directly aliquoted into 2-mL sterile vials, and allowed to clot for 4 h. After centrifugation (20 min, 1,200 ×g), the serum was aliquoted into 1-mL vials and stored at −20°C for serum antibody measurements using haemagglutination inhibition test (Alexander, 1988). The serum samples at 35 d of age were also used for determination of glucose, total protein, albumin, cholesterol, triglycerides, glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) and alkaline phosphatase (ALKP) using commercially available kits (Biosystem S.A, Costa Brava, 30, Barcelona, Spain) according to manufacturer's instructions.

Statistical analysis

Experimental data were analyzed as a randomized block design. All data were subjected to one-way ANOVA by the GLM procedure using the SPSS 18.00 statistical package (SPSS Ltd., Surrey, UK). Duncan's test was carried out to assess any significant differences for all measured parameters at the probability level of $p<0.05$ among the experimental groups.

RESULTS AND DISCUSSION

Body weight, BWG, FI, and G:F are presented in Table 2. There were no significant differences in BW of birds in the beginning of the experiment. Higher values of final BWG ($p<0.001$) during the whole period of 5 weeks were observed in broilers on T1, T3, T5, and T6 compared with chickens in the control group. Dietary inclusion of BP, COR, and TUR, and their combinations improved the cumulative G:F during the whole period of 5 weeks ($p<0.001$) compared to the control group. Broiler chicks on T5 and T6 had higher BW in the experimental weeks 1 ($p<0.05$) and 5 ($p<0.001$) than the control. These results indicate that BP and COR and its combinations were effective in improving growth performance of broiler chickens. These findings are supported by the results of Saeid and AL-Nasry (2010) who observed that COR supplementation improved BW, BWG, and feed conversion ratio (FCR) in broiler chickens. Similar results were shown by Güler et al. (2005) who stated that COR supplementation at a level of 2% improved BW and FCR in Japanese quails. Improvement of broilers BW as a result of BP supplementation was similar to the findings reported by Ghazalah et al. (2007), Tollba et al. (2007) and Mansoub (2011). Furthermore, Akbarian et al. (2012) observed that BWG of male broilers during different weeks was not influenced by BP, TUR, or their combinations.

Feed intake of broiler chicks during different weeks was not influenced by BP, COR, TUR, or their combinations. This was in agreement with the findings of Al-Kassie et al. (2011) and Akbarian et al. (2012) who observed no difference in FI in broiler chickens fed BP. On the contrary, Güler et al. (2005) reported an improvement in FI of Japanese quails fed diet contained COR. In the current study, supplementation of TUR alone or combined with BP showed no significant differences compared to the control group, which is in agreement with Mehala and Moorthy (2008) and Akbarian et al. (2012) who reported that dietary TUR was not effective in the overall productive performance of broiler chickens.

It has been reported that curcumin supplementation, but not piperine increased bile acid secretion in laboratory animals (Platel and Srinivasan, 2000b; 2004). Black pepper contains piperine which is known as a bioavailability enhancer of a variety of structural and therapeutically

Table 2. Body weight, body weight gain (BWG), feed intake (FI) and G:F values of broiler chickens in response to diet and age[1]

Age	Dietary treatments[2]							SEM	p-value
	CON	T1	T2	T3	T4	T5	T6		
D 0									
BW (g)	41.1	41.2	41.1	41.1	41.1	41.1	41.1	0.64	1.00
D 0 to 7									
BW (g)	180.4[c]	187.4[abc]	180.8[c]	187.4[abc]	182.2[bc]	188.8[ab]	190.8[a]	3.42	0.01
FI (g)	222.2	225.9	211.1	214.8	222.2	214.8	211.5	15.18	0.45
G:F	0.63[b]	0.65[ab]	0.66[ab]	0.68[ab]	0.64[b]	0.69[ab]	0.71[a]	0.03	0.08
D 8 to 14									
BW (g)	460.4	479.4	465.4	475.2	465.2	483.0	481.3	9.04	0.07
FI (g)	290.5	285.2	288.9	284.6	303.7	299.6	299.5	19.57	0.32
G:F	0.96	1.02	0.99	1.01	0.93	0.98	0.97	0.05	0.56
D 15 to 21									
BW (g)	831.7	844.2	843.2	847.9	846.8	861.8	860.6	16.52	0.58
FI (g)	566.4	581.5	584.6	573.1	585.2	574.1	576.9	18.16	0.28
G:F	0.66	0.63	0.65	0.65	0.65	0.66	0.66	0.01	0.42
D 22 to 28									
BW (g)	1,046	1,092	1,081	1,077	1,073	1,107	1,081	40.71	0.86
FI (g)	656.0	657.6	653.8	650.0	659.2	655.5	653.8	28.60	0.94
G:F	0.33	0.38	0.36	0.35	0.34	0.37	0.34	0.06	0.96
D 29 to 35									
BW (g)	1,739[cd]	1,880[abc]	1,809[cd]	1,851[abc]	1,819[bcd]	1,910[a]	1,901[ab]	39.76	<0.001
FI (g)	860.0	838.5	833.3	842.4	846.7	833.3	846.1	30.50	0.07
G:F	0.81[b]	0.93[a]	0.87[ab]	0.92[ab]	0.88[ab]	0.96[a]	0.97[a]	0.05	0.09
D 0 to 35									
BWG (g)	1,698[d]	1,839[abc]	1,768[cd]	1,810[abc]	1,778[bcd]	1,869[a]	1,860[ab]	39.82	<0.001
FI (g)	2,595	2,589	2,572	2,565	2,611	2,577	2,588	42.03	0.94
G:F	0.65[d]	0.71[a]	0.69[bc]	0.70[ab]	0.68[c]	0.73[a]	0.72[a]	0.01	<0.001

G:F, gain-to-feed ratio; SEM, standard error of the mean.

[1] Values represent the means of 30 birds per each treatment (10 birds/pen).

[2] CON = control, T1 = 0.5% black pepper, T2 = 0.5% turmeric, T3 = 2% coriander, T4 = 0.5% black pepper and 0.5% turmeric, T5 = 0.5% black pepper and 2% coriander seeds, T6 = 0.5% black pepper, 0.5% turmeric, and 2% coriander seeds.

[abcd] Values in the same row with a different superscript differ significantly at p<0.05.

diverse drugs and phytochemicals through a number of mechanisms (Suresh and Srinivasan, 2006). The essential oil extracted from COR particularly linalool was responsible for stimulation of the digestive process in animals (Çabuk et al. 2003). Platel and Srinivasan (2000a) observed that curcumin and piperine promote pancreatic digestive enzymes such as lipase, amylase and proteases, which play important roles in the digestion process. Additionally, COR has a significant stimulating influence on intestinal disaccharidases and alkaline phosphatases, and also significantly improve terminal digestive enzyme activities (Platel and Srinivasan, 2001a). Moreover, Platel and Srinivasan, (2001b) observed an enhanced digestion and a reduction in feed passage time in the digestive tract as a result of curcumin and piperine supplementation. Therefore, the improvement of broiler performance by dietary supplementation of BP, COR, or their combinations may be due to the above mentioned mechanisms.

Carcass traits and relative weight of lymphoid organs of broiler chickens are presented in Table 3. No differences were noted in comparison for carcass yield across the groups. Higher values of liver (% BW) were obtained from birds fed on T5 and T6 (p<0.05) compared to the control group. In addition, the broilers in the groups having T2, T4, and T6 supplemented feed had a relatively higher relative weight of proventriculus compared with chickens in the control group (p<0.05). There were no significant differences in the gizzard, heart, spleen, thymus gland, and bursa of Fabricius relative weight (% BW) across the groups; suggesting that the dietary inclusion of BP, TUR, COR, or their combinations had no significant effects on these carcass traits. This result was in agreement with Al-Kassie and Witwit (2010) and Al-Kassie et al. (2012) who reported that the use of herbal plants had no effect on the dressing percentage, gizzard and heart. Additionally, Mansoub (2011) observed an increase in the percentage of liver weight in broilers on diet supplemented with 1% BP. Saeid and AL-Nasry (2010) observed that dietary inclusion

Table 3. Effects of experimental diets on the carcass traits and relative weights of lymphoid organs (% body weight) of broilers at 35 d age[1]

Parameters	Dietary treatments[2]							SEM	p-value
	CON	T1	T2	T3	T4	T5	T6		
Dressing	76.10	77.56	76.34	77.00	77.13	77.97	77.91	0.78	0.17
Liver	1.83[bc]	1.82[b]	1.85[abc]	1.85[abc]	1.93[ab]	1.95[a]	1.95[a]	0.05	0.03
Gizzard	2.12	2.12	2.09	2.04	2.11	2.15	2.13	0.05	0.45
Proventriculus	0.30[c]	0.38[abc]	0.43[ab]	0.37[bc]	0.48[a]	0.34[bc]	0.42[ab]	0.04	0.01
Heart	0.51	0.56	0.60	0.58	0.62	0.64	0.59	0.04	0.06
Spleen	0.10	0.11	0.11	0.11	0.12	0.13	0.12	0.01	0.38
Thymus	0.30	0.37	0.41	0.32	0.40	0.38	0.39	0.05	0.22
Bursa of Fabricius	0.06	0.09	0.06	0.07	0.07	0.08	0.07	0.01	0.27

[1] Values represent the means of 6 birds per treatment group (2 birds/pen).
[2] CON = control, T1 = 0.5% black pepper, T2 = 0.5% turmeric, T3 = 2% coriander, T4 = 0.5% black pepper and 0.5% turmeric, T5 = 0.5% black pepper and 2% coriander seeds, T6 = 0.5% black pepper, 0.5% turmeric, and 2% coriander seeds.
[abcd] Values in the same row with a different superscript differ significantly at p<0.05.

of COR at a level of 0.3% increased relative liver weight compared to other treatment groups and control. The supplementations of aromatic plants in poultry have stimulatory effects on the digestive system through increasing the production of digestive enzymes and improving utilization of digestive products via an enhanced liver function (Hernandez et al., 2004).

The effect of BP, COR, and TUR and their combinations on blood biochemistry of broiler chickens are presented in Table 4. Broilers on T4 ($p<0.05$), T5 ($p = 0.001$) and T6 ($p<0.001$) showed higher concentrations of serum total protein compared to the control group. The concentration of serum albumin, cholesterol and GOT were not significantly different compared to those of the control group. Data illustrated that the serum globulin concentration was significantly higher ($p<0.01$) in T6 than the control and other treatment groups, suggesting that dietary inclusion of a mixture of BP, TUR, and COR improved health status of broilers. The serum glucose concentrations were significantly lower in T4, T5, and T6 than other treatment groups and control ($p<0.05$). There were no significant differences in the serum cholesterol concentrations among treatments and the control group. Lower serum total triglyceride concentration was observed in broilers on T5 ($p<0.05$) and T6 ($p<0.001$) compared with the control broilers, indicating that the studied supplement combinations were effective in decreasing serum total triglycerides. Our results were in line with Mehala and Moorthy (2008) who observed that TUR supplementation alone was not significantly affect serum glucose, total cholesterol, HDL-cholesterol, LDL-cholesterol, or triglycerides.

Our results were in contrast to Al-Kassie et al. (2011) who observed an increase in the serum glucose level of broilers on 0.5, 0.75, and 1% BP, and Saeid and AL-Nasry (2010) who reported that dietary supplementation of COR increased serum total protein, and decreased serum total triglycerides and cholesterol compared to control. Regarding GPT and ALKP enzyme activities, there was a significant decrease ($p<0.01$) in their serum concentrations

Table 4. Effects of experimental diets on some serum parameters of broiler chickens at 35 d of age[1]

Parameters	Dietary treatments[2]							SEM	p-value
	CON	T1	T2	T3	T4	T5	T6		
Total protein (g/dL)	3.9[c]	3.9[c]	3.9[c]	4.1[bc]	4.2[b]	4.5[b]	5.1[a]	0.15	<0.001
Albumin (g/dL)	2.9	3.0	2.9	3.1	3.2	3.2	3.5	0.23	0.23
Globulin (g/dL)	1.0[b]	1.0[b]	1.0[b]	1.1[b]	1.0[b]	1.3[ab]	1.6[a]	0.17	0.006
Glucose (g/dL)	189.6[a]	186.4[a]	181.8[b]	177.2[c]	177.2[c]	179.0[bc]	177.2[c]	1.77	<0.001
Cholesterol (mg/dL)	211.0	209.4	211.0	206.6	207.6	207.0	205.8	2.47	0.22
Triglyceride (mg/dL)	203.6[ab]	205.0[ab]	207.0[a]	202.6[abc]	201.8[bc]	198.4[dc]	195.0[d]	2.17	<0.001
GOT (U/100 mL)	77.2	78.2	78.0	77.0	76.2	76.4	76.5	0.90	0.19
GPT (U/100 mL)	69.0[a]	69.6[a]	69.2[a]	68.4[a]	69.0[a]	67.8[a]	65.8[b]	0.90	0.005
ALKP (mg/dL)	12.3[a]	12.9[a]	12.8[a]	12.4[a]	12.3[a]	11.2[b]	11.1[b]	0.33	<0.001

GOT, glutamate oxaloacetate transaminase; GPT, glutamate pyruvate transaminase; ALKP, alkaline phosphatase.
[1] Values represent the means of 6 birds per treatment group (2 birds/pen).
[2] CON = control, T1 = 0.5% black pepper, T2 = 0.5% turmeric, T3 = 2% coriander, T4 = 0.5% black pepper and 0.5% turmeric, T5 = 0.5% black pepper and 2% coriander seeds, T6 = 0.5% black pepper, 0.5% turmeric, and 2% coriander seeds.
[abcd] Values in the same row with a different superscript differ significantly at p<0.05.

in T6 compared to control. This reduction may provide evidence for the hepatoprotective effect of BP, TUR, and COR mixture, indicating better liver function, which was in agreement with Akbarian et al. (2012) and Al-Jaff (2011).

Haemagglutination inhibition titre (log 2) of broilers at 12, 24, and 35 d of age are presented in Figure 1. Higher antibody titre was observed in broilers on T5 at 35 d of age ($p<0.001$) and T6 at 24 d ($p<0.05$) and 35 d of age ($p<0.001$) compared with chickens in the control group. The significant rise in the antibody titre value against ND was observed only when BP, TUR, and COR were included together but not separately, which might be due to the collaborative effect of active components in BP, TUR, and COR. Recent study by Kim et al. (2013) showed that the chickens fed TUR supplemented diets had enhanced systemic humoral and cellular immune responses compared with controls. In support of this, Lee et al. (2011) observed that the chickens immunized with an Eimeria profilin protein and fed diets supplemented with carvacrol, cinamaldehyde and capsicum oleoresin or turmeric oleoresin and capsicum oleoresin had increased body weights and antibody levels compared with immunized and infected chickens fed a non-supplemented diet. Additionally, lee et al. (2010) observed that *in vitro* exposure of spleen cells to an extract of TUR increased lymphocyte proliferation compared with the control group.

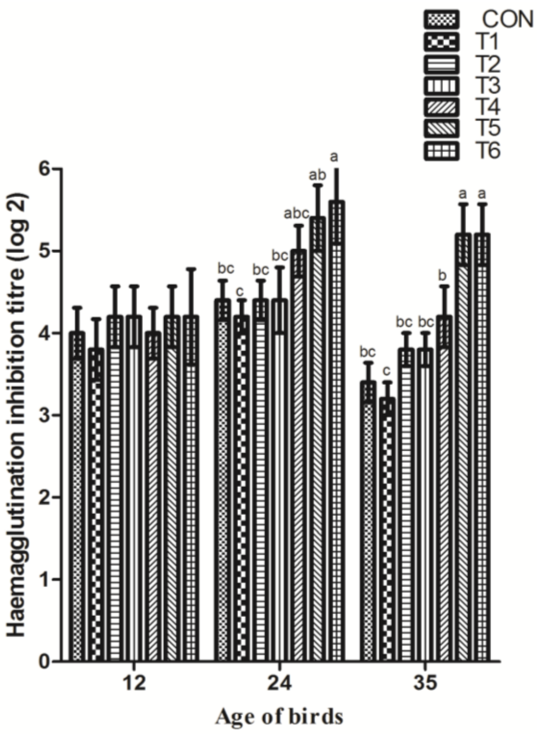

Figure 1. Haemagglutination inhibition titre (log 2) of broilers against Newcastle disease at 12 d, 24 d, and 35 d of age fed different experimental diets. Blood samples were collected from two birds selected randomly from each pen (30 birds/3 pens per group). The same birds were used on the other occasions. Values are expressed as mean±SE. [a,b,c] Treatments with different letters are different at $p<0.05$. CON = control, T1 = 0.5% black pepper, T2 = 0.5% turmeric powder, T3 = 2% coriander seeds, T4 = 0.5% black pepper and 0.5% turmeric powder, T5 = 0.5% black pepper and 2% coriander seeds, T6 = 0.5% black pepper, 0.5% turmeric powder, and 2% coriander seeds.

IMPLICATIONS

Under the conditions of this study, it could be concluded that dietary supplementation with BP, COR, or their combinations enhanced the performance and health status of broiler chickens. As a result, dietary supplements with BP, COR and its combinations may be used as natural growth promoters.

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