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Effects of Garlic and Green Tea as Alternative Feed Additives in Broiler Diet

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ABSTRACT

The objective of this study was to evaluate the use of garlic and green tea as alternative for safe broiler production. The experiment was done for a period of 35 days with 300 day-old Cobb-500 straight run broiler chicks. Birds were divided into five dietary treatment groups with four replications and each having 15 birds per replication. Treatments consisted as corn-soybean meal based basal diet and basal diet supplemented with 0% feed additives, 0.20% antibiotic, 0.25% garlic powder, 0.25% green tea powder and combination of garlic and green tea powder (0.125% garlic powder and 0.125% green tea powder). Body weight, feed intake of the bird were recorded every week, whereas dressing parameters, meat and bone development, serum biochemical parameters and hematological parameter were measured at the end of the experiment. Body weight, body weight gain increased ($P<0.05$) in the garlic and antibiotic groups compared to the control group. Higher ($P<0.05$) feed intake was observed in garlic group compared with the green tea, combined and control group. Improved ($P<0.05$) feed conversion ratio was found in garlic and green tea group alone or in a combination as well as antibiotic group compared to the control group. Abdominal fat, serum cholesterol and serum LDL were lower ($P<0.05$) and serum HDL was higher ($P<0.05$) in the supplemented groups compared to the control and antibiotic groups. Serum triglyceride was significantly ($P<0.05$) lower in the antibiotic, garlic, green tea and combined groups compared to the control group. Combined group showed lower ($P<0.05$) serum GPT and creatinine value compared to the control group; whereas lower serum GOT value was found in the antibiotic group. The results indicated that there was no significant difference ($P>0.05$) in hematological parameters (RBC, Hb and PCV) among the treatment groups. Taken together, addition of garlic and green tea to broiler diet had positive effect on growth performances, lipid profile and serum biochemical parameters. There was no negative effect on meat yield, bone development, carcass parameters, hematological parameters, serum GOT, GPT and creatinine value. It may be suggested that the garlic and green tea could be potential feed additives for the production of antibiotic free safe broiler.

Introduction

In the past few decades poultry industries have developed in several areas including nutrition, genetics, management for maximum efficiency in growth performance and meat yield. Antibiotics played an important role in improving the feed efficiency and disease prevention when they are used as feed supplement at subtherapeutic level (Castanon, 2007). However, intense use of antibiotics in animal and poultry farming leads to development of antibiotic resistant bacteria which is a potential threat to human health. Some scientific research suggested that the use of antibiotics could lead to problem of antibiotic resistance organism (Diarra *et al*., 2007) and presence of antibiotics residues in poultry product (Gonzalez and Angeles, 2017). These concerns exist worldwide in the areas where antibiotics are used for growth promoting purposes; however EU banned the use of antibiotics at sub-therapeutic levels in 2006. In 2013, Food and Drug Administration called for major manufacturers of medically important animal drugs to voluntarily stop labeling them for animal growth promotion. For maximum production without antibiotic growth promoter, we need alternatives to antibiotics. Lots of researchers are searching for alternatives to antibiotics to promote growth and enhance gut health, and reduce the use of antibiotics in animal production. Some antibiotic alternatives that are available to increase animal productivity and help poultry and livestock perform to their genetic potential under existing commercial conditions include probiotics, organic acids, phytogenics, prebiotics, synbiotics, enzymes, antimicrobial peptides, hyperimmune egg antibodies, bacteriophages, clay and metals (Gadde *et al*., 2017). Among them, medicinal plants are drawn attention to

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the researchers (Hossain *et al.* 2012a; Hossain *et al.* 2012b; Abd El-Latif *et al*., 2013; Islam *et al*., 2019) due to their vast source of bioactive components.

Tea (*Camellia sinensis*) is a common beverage for human and it has attracted much attention in recent years for lots of health benefits. The polyphenolic compounds of green tea have been shown to improve body weight gain and feed efficiency in broilers (Biswas and Wakita, 2001). The bioactive compounds maintain microflora balance and exhibit antimicrobial effects against pathogenic bacteria (Guray *et al*., 2011). The polyphenolic compounds of green tea show some beneficial effect like improving body weight gain and feed efficiency in poultry (Erener *et al*., 2011) and pigs (Hossain *et al*., 2012b). Green tea and its derivatives such as green tea extract, green tea leaves, green tea by-products, green tea polyphenols and green tea flowers are used in poultry diets for improving performance (Khan, 2014). Huang *et al*. (2013) studied lipid metabolism and the genomics of lipid metabolism regulation in green tea-supplemented broiler chickens, reporting that green tea supplementation reduced body fat, serum triglycerides, serum low density lipoprotein bound cholesterol, and total cholesterol along with an increase in high density lipoprotein bound cholesterol.

Garlic (*Allium sativum*) is used as food additives throughout the world for its vast range of medicinal properties like antibacterial, antiviral, antifungal, anti protozoal, hepato protective and various other properties without any adverse effects. So, garlic supplemented broiler chicken diets have been recognized for their strong stimulating effect on the body weight gain (Rehman and Munir, 2015). It has a great impact on haematological parameters, which affect the physiological, pathological and nutritional status of poultry (Oleforuh-okoleh *et al*., 2015). Considering the above discussion, the aim of the study is to evaluate the effect of garlic and green tea in broiler diet in terms of growth performance, carcass quality, hematological and serum biochemical parameter for the production of safe broiler.

Materials and Methods

Experimental birds, diets and management

The experiment was carried out in the Bangladesh Agricultural University Poultry Farm. A total of 300 Cobb-500 day-old straight run broiler chickens with an average initial body weight 40.15 ± 0.11g were used in the feeding trial of five weeks. All the birds were allocated into five dietary treatment groups. Each dietary group consists of 60 chicks distributed into 4 replicated pens having 15 chicks in each replication. The room was partitioned into 20 pens (7 feet x 3 feet) of equal size by using wire net. A corn-soya based diet was formulated to meet the nutrient requirements of Cobb 500 commercial broiler (Cobb Breeder Management Guide, 2012). Starter diet was provided from day 1 to 21 day and then grower diet was provided up to 35 days. The ingredient and nutrient composition of the control diet are shown in Table 1 and Table 2. The garlic was bought from local market and then cleaned, peeled, cut into small pieces and then sun-dried on a polyethylene sheet and grounded. Green tea was bought from local market. Trade name of the green tea was “Finlays”. Trade name of the antibiotics used in the experiment was “Renamycin”. Here, first group was considered as control group with no additives. In second group 0.02% antibiotic was mixed with basal diet. In the third, fourth and fifth group 0.25% garlic powder, 0.25% green tea powder, combination of 0.125% garlic powder and 0.125% green tea powder were mixed respectively with basal diet. In all cases, *ad libitum* feeds were offered to the broilers. Feed was supplied in such a way that feeder was not kept empty.

Data collection and record keeping

Each pan was considered as experimental unit in the experiment. The broilers were weighed by pen at the end of every week. After measuring the remaining feed at the end of the week, feed intake and feed conversion ratio were calculated.

Processing of broiler and blood collection

At the end of the experiment, one bird per replication (close to average weight of each replication) was selected for the determination of carcass characteristics. After fastened for 12 hour the bird were slaughtered to complete bleeding. Three ml of blood sample from each replicate bird was taken from the jugular vein during bleeding. Tubes containing blood were placed in a slanting position (45º angles) at room temperature for clotting for two hours. Feathers were removed by hand pinning. Dressed broilers were cut into different parts. Then head, shank, viscera, giblet (heart, liver and gizzard) and abdominal fat were removed for determination of meat yield parameters. After 2 hours separated blood serum was transferred to an eppendorf tube and centrifuged at 3000 rpm for 10 minutes. The serum was then transferred into another eppendorf tube and preserved at -20ºC until analysis.

Blood hematological and biochemical analysis

Total erythrocyte count (RBC), hemoglobin (Hb) contents and packed cell volume (PCV) were determined as per technique described by Lamberg and Rothstein (1977). The total serum cholesterol, triglyceride, low density lipoprotein (LDL) and high density lipoproteins (HDL) concentrations were measured according to previous methods described by Allain *et al.* (1974), Bucolo and David (1973), Friedewald *et al.* (1972) and Alen *et al.*

(1979). Serum glutamic-puruvic transaminase (GPT), glutamic oxaloacetic transaminase (GOT), creatinine were determined using methods described by Bahman *et al.* (2011).

Statistical analysis

Data of body weight, body weight gain, feed consumption, feed conversion ratio (FCR), meat yield and internal organ and blood biochemical parameters of broilers were subjected to analysis of variance (ANOVA) in a completely randomized design (CRD) employing SAS (2009) statistical package program. Differences among all treatments were separated by Duncan's multiple range tests. In the result, $P<0.05$ was considered statistically significant.

Results and Discussion

Body weight and body weight gain

Body weight and body weight gain of broiler in different dietary treatment groups are presented in the Table 3. Addition of garlic and green tea to experimental diets positively influenced body weight and body weight gain as same as antibiotic group. Garlic group showed significantly higher ($P<0.05$) body weight compared to the control, green tea and combined group at 4th week; control and green tea group at 5th week of age. This is in general agreement with previous studies with garlic (Onyimonyi *et al*., 2012; Elagib *et al*., 2013) and green tea (Erener *et al*., 2011). The bioactive components present in garlic and green tea help the absorption of nutrient in the gastrointestinal tract of bird by preventing pathogenic organism. That is why these plant materials help body growth, though effectiveness of garlic and green tea as additives to diet depends on its daily intake or doses in feed and animal species. Hossain and Yang (2014) also found higher body weight and better FCR in broiler through feeding a fermented medicinal plant that rich in bioactive components. The results of the present study contrasted some of the previous observations that indicated garlic (Karim *et al*., 2017) and green tea (Ko and Yang, 2008) did not affect the body weight and body weight gain in broiler.

Feed intake and feed conversion ratio

Garlic group showed highest ($P<0.05$) total feed intake over the other dietary groups (Table 3). Abd El-Latif *et al*. (2013) and Elagib *et al*. (2013) also supported this result and stated that garlic treated group could improve the palatability of diets and had the positive effect on broilers feed intake. But contrasted with the result of Raeesi *et al*. (2010) who indicated garlic have no effect on feed intake. Karim *et al*. (2017) reported a lower feed intake of garlic supplemental group than control group. This can be explained by the odor of garlic that may reduce the feed intake of birds. Supplementation of garlic and green tea along or combination improved FCR ($P<0.05$) compared to the control group (Table 3). Raeesi *et al*. (2010) showed that birds received 3% garlic powder in their diets had better FCR than control group. However, Shomali *et al*. (2012) and Karim *et al*. (2017) found no significant differences in FCR in broilers. In addition, green tea by-product and green tea plus probiotics fed groups showed no significant differences compared to the antibiotic group in finishing pigs (Hossain *et al*., 2012c). Bhatt (2015) stated that herbs enhance and add flavors in animal feed and can therefore influence eating patterns, secretion of digestive fluids and total feed intake. The primary site of activity is the digestive tract. Due to the wide variety of active components, different herbs and spices affect digestion processes differently.

Meat yield and dressing parameters of broiler

The present study showed that there was no significant difference in breast meat, thigh meat, drumstick meat and wing weight among different treatment groups. Garlic and green tea alone or in combination showed significantly ($P<0.05$) low abdominal fat weight than the control and antibiotic group. Sarker *et al*. (2010) stated that addition of 1% green tea in broiler diet reduced the abdominal fat than the control group. Reduction of abdominal fat upon the supplementation of garlic and green tea was probably due to the presence of sulfur compounds mainly alliin, allicin in garlic and polyphenols particularly different types of catechins in green tea.

Serum lipid profile

Addition of garlic powder as well as green tea separately or as a mixture caused reduction ($P>0.05$) in the levels of serum total cholesterol, triglyceride, LDL and increased HDL (Fig.1). These results agreed with previous reports (Onyimonyi *et al*., 2012; Karim *et al*., 2017) where dietary supplementation of garlic powder in broilers was found to cause a significant decrease in the mean values of serum total cholesterol as compared to the control birds. Niel *et al*. (1996) and Chowdhury *et al*. (2002) indicates the sulphur containing bioactive compounds mainly allicin in garlic homogenates help to show cholesterol lowering effect. Allicin also inhibits the action of hydroxymethlygutaryl-CoA reductase, which is the most important enzyme that participates in the synthesis of cholesterol and lipids (Lawson and Bauer, 1998). Several reports (Yang *et al*., 2003; Ariana *et al*., 2011) indicated that dietary supplementation of green tea in broiler cause a significant decrease in the mean values of total cholesterol, triglyceride and LDL. This may be due to the effect of green tea bioactive component on hepatic 3-hydroxy-3-methylglutaryl coenzyme which is required for cholesterol synthesis in the liver (Ariana *et al*., 2011). Some researchers (Sayama *et al*., 2000; Weisburger *et al*., 2001) stated that the catechin contents of green tea,

mainly EGCG could inhibit a digestive lipase activity and affected on the lipid metabolism of animals.

Blood hematological and biochemical parameters

The results from Table 5 indicate that there was no significant difference in hematological parameters (RBC, Hb and PCV) among different treatment groups and these results are supported by some researchers (Onyimonyi *et al*., 2012; Elagib *et al*., 2013) who found non-significant effects on hematological parameter supplying garlic and green tea in broiler feed. Garlic and green tea group showed higher (P<0.05) GOT value while antibiotic group had lower GOT value (Figure 2). Garlic and green tea did not induce significant effects in the activities of serum GOT and GPT or in blood creatinine level (Zeinab *et al*., 2010). However, previous reports (Abd El-Latif *et al*., 2013) implemented that feeding garlic significantly decreases the serum activity of GPT in broiler. In case of creatinine, there was no significant difference among control, antibiotic, garlic and green tea group while combine group showed the significantly (P<0.05) lower creatinine value (Figure 3).

Table 1. Ingredients and chemical composition of broiler starter diet

Ingredient	Control	Antibiotic	Garlic-0.25%	GT-0.25%	Garlic-0.125% + GT-0.125%
Maize	54.99	54.97	54.74	54.74	54.74
Soya meal	31	31	31	31	31
Protein concentrate	7	7	7	7	7
Di calcium phosphate	1.35	1.35	1.35	1.35	1.35
Limestone	0.8	0.8	0.8	0.8	0.8
Soybean oil	4	4	4	4	4
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.03	0.03	0.03	0.03	0.03
Common salt	0.36	0.36	0.36	0.36	0.36
Antibiotic	-	0.02	-	-	-
Garlic	-	-	0.25	-	0.125
Green tea	-	-	-	0.25	0.125
Total	100	100	100	100	100
Chemical composition (Calculated)					
ME (kcal/kg)	3050	3050	3049	3049	3049
CP %	23.66	23.66	23.66	23.66	23.66
Lys %	1.24	1.24	1.24	1.24	1.24
Met %	0.50	0.50	0.50	0.50	0.50
Met + Cys %	1.00	1.00	1.00	1.00	1.00
Ca%	1.21	1.21	1.21	1.21	1.21
Available P %	0.45	0.45	0.45	0.45	0.45

ME= Metabolizable Energy, CP= Crude Protein, Ca= Calcium, Available P= Available Phosphorus, Met= Methionine, Lys= Lysine, Cys= Cystine

Table 2. Ingredients and chemical composition of broiler grower diet

Ingredient	Control	Antibiotic	Garlic-0.25%	GT-0.25%	Garlic-0.125% +GT-0.125%
Maize	60	59.98	59.75	59.75	59.75
Soya meal	24.09	24.09	24.09	24.09	24.09
Protein concentrate	8	8	8	8	8
Di calcium phosphate	1.35	1.35	1.35	1.35	1.35
Limestone	0.7	0.7	0.7	0.7	0.7
Soybean oil	5	5	5	5	5
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.03	0.03	0.03	0.03	0.03
Common salt	0.36	0.36	0.36	0.36	0.36
Antibiotic	-	0.02	-	-	-
Garlic	-	-	0.25	-	0.125
Green tea	-	-	-	0.25	0.125
Total	100	100	100	100	100
Chemical composition (Calculated)					
ME (kcal/kg)	3150	3150	3149	3149	3149
CP %	20.59	20.59	20.59	20.59	20.59
Lys %	1.06	1.06	1.06	1.06	1.06
Met %	0.63	0.63	0.63	0.63	0.63
Met+Cys %	0.92	0.92	0.92	0.92	0.92
Ca%	1.05	1.05	1.05	1.05	1.05
Available P %	0.42	0.42	0.42	0.42	0.42

ME= Metabolizable Energy, CP= Crude Protein, Ca= Calcium, Available P= Available Phosphorus, Met= Methionine, Lys= Lysine, Cys= Cystine

Table 3. Growth performances of broiler in different dietary treatments

Parameters	Treatments					PSE
	Control	Antibiotic	Garlic-0.25%	GT-0.25%	Garlic-0.125% +GT-0.125%	
Body weight (g/bird)						
Initial weight	40.25	40.00	40.25	40.08	40.17	0.15
1st week	110.67	112.9	111.24	109.97	115.6	5.78
2nd week	310.8	321.95	328.5	326.59	312.33	22.98
3rd week	554.67	588.00	600.83	584.33	565.34	34.55
4th week	956^{c}	1033.94^{ab}	1051.58^{a}	986.83^{bc}	987.33^{bc}	37.64
5th week	1391.98^{c}	1491.63^{ab}	1499.37^{a}	1429.25^{bc}	1441.75^{abc}	40.12
Body weight gain (g/bird)						
1st week	70.41	72.9	70.98	69.88	75.43	5.80
2nd week	200.13	209.05	217.27	216.62	196.73	21.78
3rd week	243.87	266.05	272.33	257.75	253	32.98
4th week	401.34	445.94	450.75	402.5	422	30.47
5th week	435.98	457.68	447.79	442.42	454.42	52.49
Total	1351.73^{c}	1451.63^{ab}	1459.13^{a}	1389.17^{bc}	1401.59^{abc}	40.16
Feed Intake (g/bird)						
1st week	132.5	139.17	135	129.17	135.83	11.86
2nd week	297.5	313.34	315.83	308.34	286.67	23.42
3rd week	486.67	500.17	512	512.84	498.67	63.93
4th week	738.34	774.34	789.33	742.83	771.67	44.24
5th week	791.00	782.58	802	782.58	767.5	75.68
Total	2446^{b}	2509.58^{ab}	2563.17^{a}	2475.75^{b}	2460.33^{b}	42.55
Feed conversion ratio (feed/gain)						
1st week	1.89	1.92	1.9	1.85	1.81	0.17
2nd week	1.49	1.5	1.47	1.43	1.47	0.14
3rd week	1.99	1.89	1.89	1.99	1.98	0.14
4th week	1.85	1.77	1.77	1.86	1.83	0.12
5th week	1.82^{a}	1.74^{ab}	1.79^{a}	1.77^{ab}	1.69^{b}	0.06
Total	1.81^{a}	1.75^{b}	1.76^{b}	1.77^{ab}	1.76^{b}	0.03

a,b,c values with different superscripts in the same row differ significantly (P<0.05). PSE= Pooled Standard Error

Table 4. Dressing parameters of broiler in different dietary treatments

Parameters (% relation to BW)	Treatments					PSE
	Control	Antibiotic	Garlic-0.25%	GT-0.25%	Garlic-0.125% + GT-0.125%	
Skin	4.97	5.5	5.57	5.37	6.36	0.84
Head	2.74	2.71	2.58	2.83	2.87	0.25
Shank	3.98	3.76	4.07	4.52	4.09	0.59
Liver	3.06	3.04	2.42	2.54	2.47	0.46
Spleen	0.18	0.17	0.16	0.16	0.14	0.03
Kidney	0.58	0.52	0.51	0.56	0.56	0.05
Heart	0.53	0.56	0.49	0.45	0.56	0.07
Abdominal fat	2.04^{a}	1.73^{b}	1.38^{c}	1.54^{c}	1.41^{c}	0.11
Gizzard	1.96	2.04	1.76	2.28	1.92	0.34
Ceaca	0.77	0.72	0.62	0.81	0.73	0.22

a,b,c values with different superscripts in the same row differ significantly (P<0.05). PSE= Pooled Standard Error.

Table 5. Hematological parameter of broiler in different dietary treatments

Parameter	Treatments					PSE
	Control	Antibiotic	Garlic-0.25%	GT-0.25%	Garlic-0.125%+GT-0.125%	
RBC (million/mcL)	2.86	2.84	2.86	2.74	2.95	1.30
Hb (g/dl)	7.38	7.48	7.35	7.30	7.67	0.32
PCV (%)	25.75	26.75	26.13	26.00	26.88	0.29

RBC= Red Blood Cell, Hb= Hemoglobin, PCV= Packed Cell Volume, PSE= Pooled Standard Error.

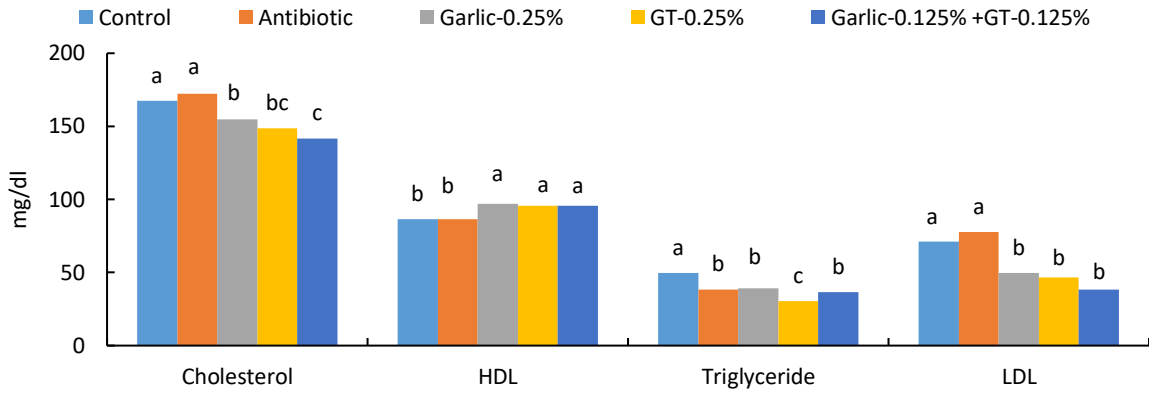

Figure 1. Serum lipid profile of broiler in different dietary treatments. The values are expressed as milligram/deciliter. Bars within a parameter not sharing a common letter are significantly different (P<0.05).

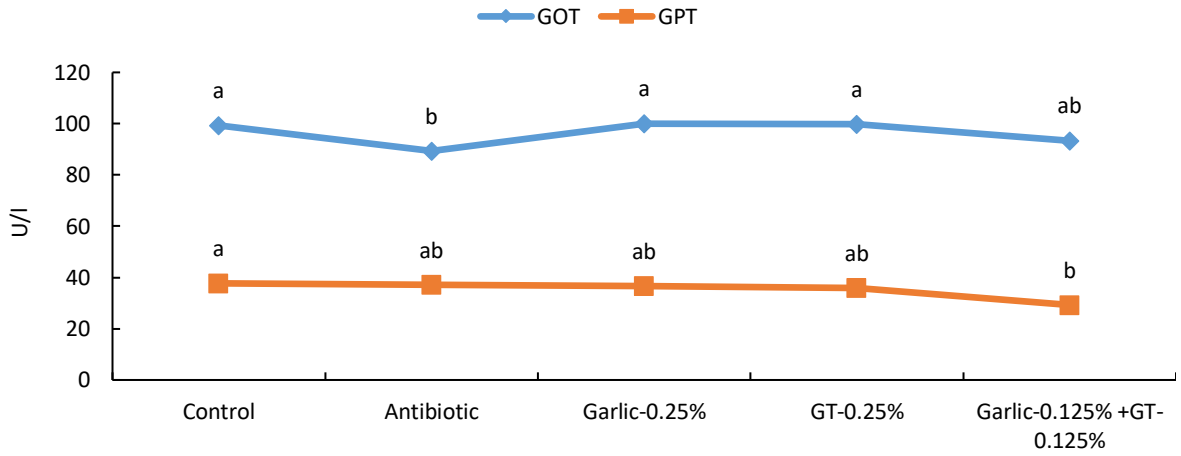

Figure 2. Serum GOT and GPT value of broiler in different dietary treatments. The values are expressed as U/l. a,b values in the same parameter indicate significant differences (P<0.05).

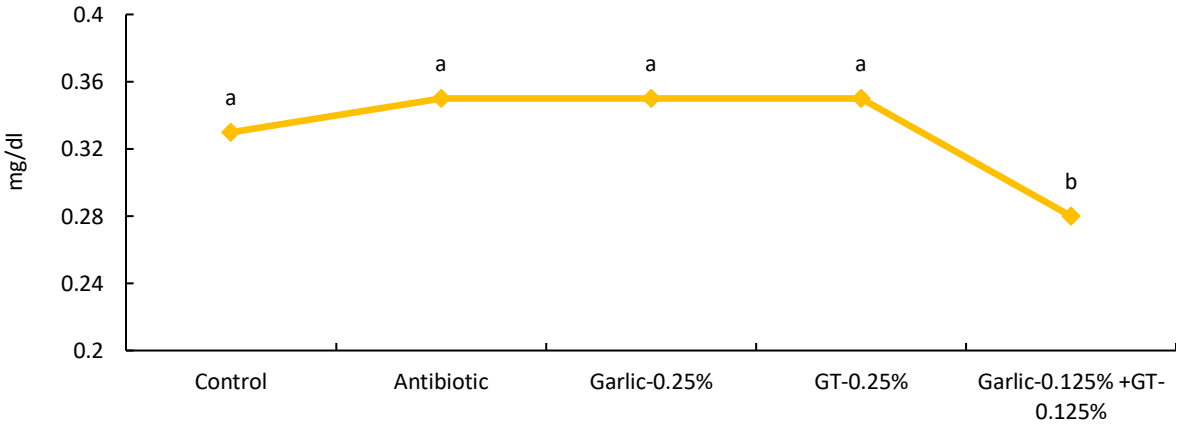

Figure 3. Serum creatinine value of broiler in different dietary treatments. The values are expressed as milligram/deciliter. a,b values in the same parameter indicate significant differences (P<0.05).

Conclusion

It may be concluded that supplementation of garlic and green tea to broiler diet have positive effect on growth performances, lipid profile and serum biochemical parameters, and no negative effect on meat yield, bone development, carcass parameters, hematological parameters, serum GOT, GPT and creatinine value. Based on the results of the study, it may be suggested that the garlic and green tea could be potential feed additives in broiler diet and can be used as alternatives to antibiotics growth promoter for the production of safe broiler.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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