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Research Article

Effect of Dietary Supplementation of Turmeric (*Curcuma longa*), Ginger (*Zingiber officinale*) and their Combination as Feed Additives on Feed Intake, Growth Performance and Economics of Broiler

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Abstract

Objective: The present study was carried out to assess the consequence of supplementation of turmeric, ginger and their combination in the diets of broiler chickens and assessment in terms of feed intake, growth performance and economics of feeding. **Materials and Methods:** A total of 360 day old Cobb-500 chicks were randomly allocated to six dietary treatments each with three replicates of 20 chicks/replicate (n = 60). Six experimental diets were formulated in such a way that control diet (T₀) contained neither turmeric nor ginger. Birds in group T₁ and T₂ were fed diets containing 0.50 and 0.75% turmeric, whereas birds in group T₃ and T₄ fed diet contained 0.50 and 0.75% ginger, respectively. Birds in group T₅ fed diets containing a combination of 0.50% ginger and 0.50% turmeric with commercial feed. The feeding experiment was carried out for 32 days and different parameters measured included: feed intake, weight gain, feed conversion ratio, dressing percentage and blood parameters. **Results:** Feed intake of experimental birds in T₄ group was higher compared to other groups, i.e., (T₀, T₁, T₂, T₃ and T₅) without a significant level. A body weight gain (g/bird) was found to be significantly (p<0.05) higher in ginger (T₃ group) and turmeric (T₂ group) supplemented group as compare to T₄, T₁, T₅ and T₀ group. Feed Conversion Ratio (FCR) was significantly (p<0.05) lower in the T₃ group as compare to other groups. The dressing percentage, thigh weight, back, neck, wing percentages and blood parameters (Hb, PCV and ESR) were not statistically different among control and other treatment groups. However, the relative weight of breast, wing, gizzard and proventriculus were significantly increased (p<0.05). The cost of production and return of birds was highly economical in treatment T₂ as compared to other treatment groups. **Conclusion:** On the basis of the results of the study, it is concluded that supplementation of turmeric (*Curcuma longa*) improves the growth performance of broilers when added at the rate of 0.75% level as feed additives in broiler ration.

Key words: Body weight, broiler chickens, feed intake, turmeric, ginger

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry industry can produce very high-quality proteins for human nutrition as well as a source of income for the community in many countries, hence poultry production has very important role in economic development of any country¹. In Bangladesh, the demand for broiler meat is increased rapidly, driven by increased income and population growth and urbanization. Thus, broiler farming seems to be a considerable part of meat production and consumption in the country. Broiler production has grown dramatically in the past two decades; these improvements are largely due to numerous researches and breeding programs which further enhanced feed utilization, growth rate and low levels of activity. Feed is the key constituent of overall costs of poultry farming responsible for about 80% of the total expenses is on the procurement of feed². The awareness in feed additives flourished over the last decade of the past century. The feed additives are a cluster of nutrient and non-nutrient composites which help in improving the efficiency of feed utilization and consequently dropping the high cost of feed. These additives have established a great consideration as feed supplements for numerous purposes in poultry production throughout the recent years³. In the past, antibiotics were the utmost regularly used as feed additives. Though, currently use of antibiotics is not only restricted but also their practice in livestock and poultry industry have been prohibited in many countries due to modification of natural gut microbiota and drug resistance in microorganisms and humans. Natural growth promoters such as prebiotics, probiotics, synbiotics, enzymes, plant extracts, etc., can be used to feed the broilers without any adverse effect on the performance of birds⁴. Beneficial properties of bioactive plant constituents in animal nutrition may comprise the stimulation of appetite and feed intake, the enhancement of endogenous digestive enzyme secretion, stimulation of immune responses and antibacterial, antiviral and antioxidant action⁵⁻⁷. Turmeric and ginger as natural growth promoters can be used as an alternative of common artificial growth promoters like antibiotics⁸.

Turmeric rhizome (*Curcuma longa*) (Zingiberaceae), commonly known as turmeric, is a widely used spice, food preservative and coloring agent that has biological activities and medicinal applications^{9,10} and grown in Southern and Southeastern tropical Asia. The active ingredients found in Turmeric (*Curcuma longa*) are curcumin, demethoxycurcumin, bisdemethoxycurcumin¹¹ and tetrahydrocurcuminoids¹². Curcumin is the crucial indispensable bioactive component liable for the biological action of *Curcuma longa*¹³. Traditionally, it has been used to treat various

diseases/disorders e.g., liver obstruction, jaundice, ulcers, inflammation, dysentery, diabetes, stomach disorders, fresh wounds, insect stings and viral infections including chickenpox and smallpox. Curcumin has also anti-inflammatory¹⁴ and antioxidant^{7,15} properties. It is also used in gastrointestinal and respiratory disorders¹⁶. A number of experiments have been conducted to assess curcumin effect on the performance of broiler chickens and laying hens^{7,13,17-21}.

Ginger is the rhizome of the plant *Zingiber officinale*, grown primarily in Central Asia, China, India and Pakistan and exported worldwide, consumed as a delicacy, medicine or spice. Primary research designates that nine composites found in ginger may bind to serotonin receptors which may affect gastrointestinal function. The main important compounds in ginger are gingerol, ginger diol and ginger dione which have the ability to stimulate digestive enzymes, affect the microbial activity and having anti-oxidative activity²². Research accompanied *in vitro* spectacles that ginger extract might regulate the quantity of free radicals and the peroxidation of lipids²³ and have anti-diabetic properties²⁴. Ginger have been reported to possess useful pharmacological potent chemical substances for use in poultry²⁵, this is due to its antioxidants, antibacterial, anti-inflammatory, antiseptic, anti-parasitic and immunomodulatory properties. The positive effect of ginger on blood circulation, gastric secretion and enterokinesia was reported by Ali *et al.*²⁶. Therefore, the purpose of this research was to investigate the effect of adding a different level of turmeric and ginger powder alone and in combination on growth performance, carcass traits and relative weight of different organs, hematological parameters and feed conversion ratio of broiler Chickens.

MATERIALS AND METHODS

Ethical approval: This research was carried out as a part of MS in Animal Science Research after the approval of competent authority of the Director of Research and Dean P.G. Studies, Sylhet Agricultural University, Sylhet, Bangladesh.

Location of study: The experiment was carried out at the at Nadim poultry farm located at Baghmara village, city of Sylhet district which lies approximately on latitude 24° 53' 56" N and longitude 91° 52' 19" E with an average elevation of 26 m (85 ft) above sea level. This region is the North eastern region of Bangladesh of Eastern Surma-Kushiyara floodplain agro climatic zone of Bangladesh, which includes Sylhet, Moulvibazar, Sunamganj and Habigonj districts. A climate is tropical monsoon bordering on a humid subtropical climate with an average temperature of 28.1 °C; August is the hottest

month of the year. January is the coldest month, with temperatures averaging 18.5°C. The average annual rainfall is 3876 mm.

Source and processing of turmeric and ginger: Groundnut turmeric and ginger used in this study was bought from a local spice market in raw form. Then, it was cleaned and cut into smaller pieces and dried sufficiently in the sunlight to remove moisture content. After drying, required amount of turmeric and ginger was prepared by fine grinding and passing through 1 mm sieve to make powder form.

Experimental birds and diets: About 1 day old 240 broiler chicks of Cobb-500 strain with average body weight 40.00-40.28 g were wing banded and distributed randomly into six groups having three replicates of 20 birds each by randomized block design and allocated to six dietary treatments as T₀, T₁, T₂, T₃, T₄ and T₅. All experimental birds were fed commercial broiler starter (1-15 days) and grower feed (16-30 days). Experimental birds in control group (T₀) were fed only commercial broiler ration while, birds in T₁, T₂, T₃, T₄ and T₅ groups were fed on commercial broiler ration supplemented with 0.50% turmeric, 0.75% turmeric, 0.50% ginger, 0.75% ginger and combination of 0.50% turmeric and 0.50% ginger, respectively. Ingredient compositions of these starter and grower rations are presented in Table 1.

Feeding and management procedures: All the experimental birds were reared in well ventilated shed in deep litter pens and kept under uniform management conditions. Each pen was 5×4 ft which was for 20 birds. The commercial feed mixtures and clean drinking water were supplied to the birds *ad libitum* throughout the study period to meet the nutrient requirement. Feed was supplied 3 times daily for the first 7 days and gradually increased to 4 times. All the birds of each experimental group were weighed weekly in the morning, before feeding and watering. Feed intake was calculated by measuring the amount of feed offered and residue leftover after 24 h. Feed conversion ratio was calculated by dividing the feed intake by weight gain. Vaccination and other biosecurity routine poultry management practices were carried out carefully.

Carcass quality evaluation: At the end of the experiment, 2 birds of each replicate were randomly selected and weighed to obtain final live weight and finally slaughtered by using sharp knife for complete bleeding, blood collected by using anticoagulant in test tube, feather of birds were plucked.

Table 1: Nutrient Composition of supplied ration

Ingredients	Starter (01-14 days)	Grower (15-35 days)
Moisture (%)	11	11
Energy (Kcal.)	3150	3175
Protein (%)	22.5	22.1
Fat (%)	5	5
Ash (%)	4	4
Lysine (%)	1.4	1.4
Methionine (%)	0.65	0.60
Phosphorus (%)	0.75	0.75
Calcium (%)	1.2	1.2

Head, viscera and shanks were removed. Dressing percentage was calculated free from giblets (Heart, gizzard, liver) and the weight of each organ was calculated as percentage of the carcass weight.

Economic study: Cost benefit analysis was calculated by comparing the total cost (Purchase cost of day old chicks, feeds, labor, electricity, Spicy etc.) and the return from selling of broilers and the gross return was calculated by the differences between sale price (Tk./live bird) and total cost (Tk./live bird).

Data collection and statistical analysis: Data regarding feed intake were recorded on daily basis. Weight gain was calculated on weekly basis by subtracting weight of the respective week from the last week weight. The FCR was calculated by dividing the feed intake by weight gain. The data collected on various parameters were subjected to one-way ANOVA using the General Linear Models (GLM) procedure of SPSS software. Treatment means were tested using the Duncan's multiple range test²⁷ and statistical differences declared at p<0.05.

RESULTS AND DISCUSSION

Effect of turmeric and ginger on body weight, feed intake and FCR: Efficient nutritional management is required for improvement of production and also good health of broiler birds. Turmeric and ginger were used in this experiment to observe the improvement of broilers growth performance. The highest feed intake was observed in T₄ (0.75% ginger) and lowest in T₅ group of birds (0.5% turmeric+0.5% ginger (Table 2). Feed intake was decreased in T₁, T₃ and T₅ group whereas increased in T₂ and T₄ group compare with T₀ group but the level was not significant (p<0.05). However broiler fed diet supplemented with 0.50% turmeric in T₁, 0.50% ginger in T₃ and combined use of turmeric and ginger (turmeric 0.50%+ginger 0.50% ginger) in T₅ decreased feed intake compare with control group. But feed intake was increased

Table 2: Effect of dietary ginger and Turmeric Powder (TP) on body weight, feed intake and FCR of broiler in (0-32) days

Treatments	Traits		
	Feed Intake (g)	Weight gain (g)	FCR
Mean ± SE			
T ₀	2839.20±12.23	1690.80±3.19 ^f	1.67±0.005 ^a
T ₁	2773.49±5.82	1780.07±2.50 ^d	1.55±0.002 ^{bc}
T ₂	2843.08±6.56	1866.48±2.16 ^b	1.52±0.004 ^d
T ₃	2821.57±7.90	1907.90±2.76 ^a	1.47±0.005 ^e
T ₄	2887.96±6.82	1858.53±2.21 ^c	1.55±0.003 ^c
T ₅	2763.42±7.96	1763.70±2.44 ^e	1.56±0.003 ^b
Level of significance	NS	*	*

^{a,b,c,d,e,f}Means in the same raw with different superscripts are significantly different, T₀: Control diet (Commercial feed), T₁: Commercial feed+0.5% turmeric, T₂: Commercial feed+0.75% turmeric, T₃: Commercial feed+0.5% ginger, T₄: Commercial feed+0.75% ginger, T₅: Commercial feed+0.5% turmeric+0.5% ginger, NS: Non significant, *Means significant at 5% level

Table 3: Effect of dietary ginger and Turmeric Powder (TP) on carcass characteristics of broiler in (0-32) days

Treatments	Traits (%)					
	Dressing	Breast	Wing	Thigh	Back	Neck
Mean ± SE						
T ₀	72.70±0.30	34.75±0.35	10.01±0.08	27.90±0.20	15.10±0.20	6.18±0.17
T ₁	73.95±0.15	34.85±0.65	10.41±0.36	25.60±0.59	13.70±0.20	5.44±0.39
T ₂	73.85±0.65	35.05±0.85	10.77±0.33	27.96±0.16	13.49±0.46	5.60±0.37
T ₃	72.60±0.70	34.85±0.10	12.53±0.24	27.10±0.13	14.70±0.30	6.21±0.24
T ₄	72.15±0.25	35.05±0.44	11.00±0.06	28.75±0.15	15.45±0.54	5.83±0.13
T ₅	72.15±0.25	35.34±0.44	11.00±0.06	28.75±0.15	15.45±0.54	5.83±0.13
Level of significance	NS	*	*	NS	NS	NS

T₀: Control diet (Commercial feed), T₁: Commercial feed+0.5% turmeric, T₂: Commercial feed+0.75% turmeric, T₃: Commercial feed+0.5% ginger, T₄: Commercial feed+0.75% ginger, T₅: Commercial feed+0.5% turmeric+0.5% ginger, NS: Non significant, *Significant at 5% level

when turmeric and ginger ratio were supplemented with 0.75% turmeric (T₂) and 0.75% ginger (T₄). Zhang *et al.*³ and Herawati²⁸ attributed that the supply of ginger with commercial broiler feed improve the palatability and digestibility of supplied feed resulting better growth performance of broiler. They further postulated that due to the effect of this natural product, the digestive tract would have been emptied earlier and feed consumption will have been promoted. Ginger (1 and 2 g kg⁻¹ at diet) has been found to increase secretion of gastrointestinal enzymes including lipase, disaccharides and maltase³. The improved performance may be attributed to the two types of digestive enzymes in ginger; protease and lipase, which are present as part of the plants natural protective mechanisms^{3,28}. Ginger enhances bird's nutrient digestion and absorption because of its positive effect on gastric secretion, enterokinesia and digestive enzyme activities⁸. Supplementation of turmeric powder in the drinking water with turmeric at the rate of 5.0 g L⁻¹ did not influence body weight gain, daily feed intake and feed conversion ratio of 21 days old Ross 308 broiler chickens²⁹.

The diet supplied with turmeric and ginger reveal the non-significant effect on feed intake of broilers compared to diet supplied without ginger and turmeric (Table 3).

The results are almost similar with the findings of Al-Sultan³⁰, Durrani *et al.*¹⁹ and Gowda *et al.*³¹. Significantly lower feed intake with turmeric supplementation in broiler diet was observed by Durrani *et al.*¹⁹ Whereas, increased feed consumption in broilers was observed by supplementation of diet with turmeric^{30,31}.

The highest weight gain was attained in T₃ (0.5% ginger) group of birds (Table 2). It was observed from the results that average live weights of broilers were increased gradually by using higher ratio of turmeric. Diet supplied with 0.5% turmeric shows slightly higher weight gain than the diet supplied without turmeric whereas diet supplied with 0.75% turmeric shows the highest weight gain than the diet supplied with 0.5% turmeric. On the other hand, weight gain was higher in all treatments when birds fed diet supplemented with 0.5% (T₃) ginger and decrease weight gain when ginger ratio increased. However in combined use of turmeric and ginger, weight gain was slightly higher than control but lower than single use of turmeric and ginger in T₀, T₁, T₂, T₃ and T₄. The live body weight among different treated groups were significantly different (p<0.05) compare with control group. The improvement in body weight gain in different levels of ginger powder could be attributed to the fact that herbal plant may provide some compounds that enhance digestion

and absorption of some nutrients in these diets which leading to improve the growth of birds^{8,32}. They also reported that ginger has characteristics as stimulant for feed digestion and conversion which increase body weight gain. Improvement in the growth performance due to supplementation of turmeric was attributed to the beneficial properties of phytochemicals in turmeric that possess antimicrobial, antifungal and antioxidant activities in broiler chickens that may improve the utilization of dietary nutrients³³. On the other hand, there were some reports which show that turmeric had the ability to stimulate the digestive system, such as stimulate the intestinal lipase, sucrose and maltase activities³⁴ as well as the secretion of pancreatic lipase, amylase, trypsin and chymotrypsin enzymes³⁵. Recently dietary supplementation of turmeric in diets increased villus length and width in the duodenum, jejunum and caeca of broiler chickens³⁶. Therefore, there is a possibility to improve the growth performance due to dietary turmeric meal in broiler chickens which is attributed to improve digestive system.

The average Feed Conversion Ratio (FCR) in different treatment groups (T_0 , T_1 , T_2 , T_3 , T_4 and T_5) were 1.67 ± 0.005 , 1.55 ± 0.002 , 1.52 ± 0.017 , 1.47 ± 0.005 , 1.55 ± 0.003 and 1.56 ± 0.003 , respectively. Lower feed conversion ratio was observed in T_3 and the highest in T_5 compare with control group. The result showed that the use of turmeric and ginger in broiler feed had significant ($p < 0.05$) and positive effect on FCR and the most efficient FCR was found in T_3 group (0.50% turmeric). The findings of the present study agree with the result of Durrani *et al.*¹⁹, Kumari *et al.*³⁷ and Ademola *et al.*³⁸. Dietary turmeric had positive effect on broiler performances^{19,37}. Dietary ginger used in diet also had positive effect on broiler performances³⁸. However the addition of turmeric as feed additives showed better results in the growth, feed intake and FCR in broilers affected by turmeric administration³⁷. Weight gain increased by addition of ginger to the basal diet so FCR decreased automatically.

Effect of turmeric and ginger on carcass characteristics of broiler: The supplied commercial broiler diet with 0.5% turmeric (T_1) revealed the highest dressing percent (Table 3). The dressing % value was not significantly different ($p < 0.05$) under different treatment groups. The similar results obtained by some researcher and they didn't find any significant differences in dressing percentages after using ginger and turmeric at 1.0 and 2.0 g kg⁻¹ in broiler ration as feed additives³⁹⁻⁴². Back, thigh and neck percentage of broilers in different treatment groups (T_0 , T_1 , T_2 , T_3 , T_4 and T_5) also shown in the Table 3. Slight variation was observed among all values of carcass characteristics but thigh, back and neck

percentages were not significantly different ($p < 0.05$) when compare with control group. The finding of this experiment was similar with the results of Durrani *et al.*¹⁹, Abd El-Hakim *et al.*⁴⁰ and Rahmatnejad *et al.*⁴². They reported higher relative weight for breast and thigh meat in broiler fed turmeric powder at 5.0 g kg⁻¹ in diet. On the other hand, Rahmatnejad *et al.*⁴² stated that dietary turmeric at the rate of 1.0 g kg⁻¹ in diet had no positive effect on broiler growth performances or Abd El-Hakim *et al.*⁴⁰ stated that dietary turmeric at the rate of 2.0 g kg⁻¹ in diet had no effect on carcass production. Dressing percentage, breast weight and leg weights increased significantly in response to an aqueous extract of a plant mixture containing ginger at 5 g L⁻¹ water⁴³. Onu⁴⁴ affirmed that the addition of ginger (0.25%) in the basal diet of broiler chicks did not result in significant differences in carcass characteristics.

The percentages of wing and breast showed significant ($p < 0.05$) improvement with the inclusion of ginger powder in the broiler diets. It was observed that carcass characteristics improved in broilers fed different levels of ginger from 1-42 days of age⁴⁵. Breast, back and neck percentage were more or less showed same values and there were not significant differences ($p < 0.05$). On the other hand, there was no significant effect on carcass characteristics of broilers fed with 0.25% levels of ginger powder and extract of ginger up to 6 weeks of age^{41,44}. Dietary turmeric meal supplementation reduce fat content, increase carcass quality and dressing percentage, as well as increase the breast, thigh and gible weight of broiler chickens¹⁹.

Effect of turmeric and ginger on internal edible and non-edible parts of broiler: The gizzard and the proventriculus weight were slightly increased with the uses of turmeric and ginger powder in ration of broilers (Table 5). Slight variation was observed in relative weight of heart, spleen and liver percentages among different treatment groups (Table 4). This variation may be due to different size of birds with their body weight for different treatments. The statistical analysis showed that there were no significant ($p < 0.05$) differences in the weight of liver, spleen and heart. However, proventriculus and gizzard weight were significantly different ($p < 0.05$). The results are similar with the findings of several scientists⁴⁶⁻⁴⁷. Al-Mashhadani⁴⁷ reported that internal edible and non-edible organs weight was not statistically ($p > 0.05$) influenced by the dietary treatment of turmeric at 0.4 and 0.6% in broiler ration. However, inclusion of turmeric and ginger powder cause a significant effect ($p < 0.05$) on gizzard and proventriculus relative weight as compared with control group. On contrary, no significant differences found in

Table 4: Effect of dietary ginger and Turmeric Powder (TP) on carcass traits of broiler in (0-32) days

Treatments	Traits (%)				
	Liver	Gizzard	Heart	Spleen	Proventriculus
Mean ± SE					
T ₀	4.06±0.035	2.52±0.070	0.58±0.015	0.12±0.010	0.46±0.015
T ₁	4.34±0.025	2.52±0.035	0.59±0.010	0.10±0.054	0.43±0.005
T ₂	4.12±0.035	2.58±0.030	0.63±0.015	0.11±0.054	0.49±0.010
T ₃	3.95±0.030	2.63±0.020	0.60±0.015	0.12±0.054	0.49±0.010
T ₄	4.47±0.020	2.65±0.005	0.58±0.010	0.13±0.001	0.56±0.010
T ₅	4.02±0.040	2.72±0.045	0.59±0.010	0.12±0.001	0.50±0.005
Level of significance	NS	*	NS	NS	*

T₀: Control diet (Commercial feed), T₁: Commercial feed+0.5% turmeric, T₂: Commercial feed+0.75% turmeric, T₃: Commercial feed+0.5% ginger, T₄: Commercial feed+0.75% ginger, T₅: Commercial feed+0.5% turmeric+0.5% ginger, NS: Non significant, *Significant at 5% level

Table 5: Effect of dietary ginger and Turmeric Powder (TP) on haematology of broiler in (0-32) days

Treatments	Traits		
	Hb (g dL ⁻¹)	PCV (%)	ESR (mm h ⁻¹)
Mean ± SE			
T ₀	7.92±0.050	31.50±0.50	1.83±0.035
T ₁	7.38±0.065	32.00±0.00	1.70±0.080
T ₂	7.66±0.110	32.50±0.50	1.78±0.030
T ₃	7.72±0.150	32.50±0.50	1.68±0.095
T ₄	7.24±0.055	31.50±0.50	1.84±0.035
T ₅	7.74±0.025	31.50±0.50	1.72±0.050
Level of significance	NS	NS	NS

T₀: Control diet (Commercial feed), T₁: Commercial feed+0.5% turmeric, T₂: Commercial feed+0.75% turmeric, T₃: Commercial feed+0.5% ginger, T₄: Commercial feed+0.75% ginger, T₅: Commercial feed+0.5% turmeric+0.5% ginger, NS: Non significant, *Significant at 5% level

Table 6: Total cost of production and profit per bird fed from different diets at 32 days

Parameters	Treatments					
	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅
Feed cost (TK/live bird)	120.65	118.68	121.68	120.73	123.56	118.25
Chick cost (TK/live bird)	54.00	54.00	54.00	54.00	54.00	54.00
Management (TK/live bird)	32.50	32.50	32.50	32.50	32.50	32.50
Spicy cost (TK/live bird)	0.00	2.89	4.23	14.43	21.26	15.78
Medicine (TK/live bird)	5.00	5.00	5.00	5.00	5.00	5.00
Total cost (TK/live bird)	212.15	213.02	217.41	226.66	236.32	225.53
Market price (TK/kg live bird)	133.00	133.00	133.00	133.00	133.00	133.00
Sale price (TK/live bird)	224.77	236.76	247.38	252.7	246.05	234.06
Net Profit (TK/live bird)	12.62	23.74	29.97	26.04	9.73	8.53

T₀: Control diet (Commercial feed), T₁: Commercial feed+0.5% turmeric, T₂: Commercial feed+0.75% turmeric, T₃: Commercial feed+0.5% ginger, T₄: Commercial feed+0.75% ginger, T₅: Commercial feed+0.5% turmeric+0.5% ginger

internal edible and non-edible organ by using turmeric at 0.4 and 0.6% in broiler ration⁴⁶. The addition of ginger (0.25%) in the basal diet of broiler chicks did not effect significantly on liver, heart, spleen and gizzard weight⁴⁴.

Effect of turmeric and ginger on haematology of broiler: The hemoglobin (Hb) value of different treatment groups were varied from control group (T₀) in Table 5. The highest hemoglobin value was obtained in T₀ and the lowest value in T₄ group. Though, hemoglobin value varies among different groups but this variation was not significant (p>0.05). Similarly the Erythrocyte Sedimentation Rate (ESR) and Packed Cell Volume (PCV) of broilers in different treatment groups (Table 5) were not significantly different (p>0.05). The results

of the present study are in agreement with the findings of some scientists^{7,48,49}. They reported that there were no significant differences in Hb, ESR and PCV values by using turmeric and ginger. Barazesh *et al.*⁵⁰ reported that supplementation of ginger root powder in diet of broilers did not affect the blood haematology. Supplementation of ginger did not exhibit any significant effect on haemoglobin, PCV and ESR value of broilers⁵¹. The slight increase in the blood constituents of chicks with increased concentration of ginger may be associated with the effects of ginger bioactive compounds on improving antioxidant status of the bird⁵².

Cost benefit analysis: The data of Table 6 show that the broiler was sold in live weight basis in the respective group.

Here it was seen that all groups make a profit. The highest profit was gained from T₂ (0.75% turmeric) and the lowest from T₅ (0.5% ginger+0.5% turmeric).

CONCLUSION

It is concluded that ginger supplementation was superior in comparison to turmeric and mixture of turmeric and ginger supplementation of turmeric (*Curcuma longa*) improves the performance of broilers when added at the rate of 0.75% level as feed additives in broiler ration.

SIGNIFICANCE STATEMENT

This study discovers the possible application of ginger and turmeric as a source of phytobiotic feed additive to replace the chemical antibiotic and other growth promoter to enhance the growth performance of broiler and make broiler farming profitable. This study will help the researcher to uncover the critical level of spices like feed additive application in broiler diet that many researchers were not able to explore. Thus, a new theory on these phytobiotic feed additive may be arrived at.

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