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Effects of using garlic (*Allium sativum*) and turmeric (*Curcuma longa*) powder on production performance and biochemical parameters of broiler chicken

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Abstract
The goal of this study was to determine the effects of dietary supplementation of garlic **(***Allium sativum***)** powder (GP) and turmeric **(***Curcuma longa*) powder (TP) as an alternative to antibiotic on production performance, biochemical parameters and economic utility of broiler chicken rearing. A total of 300 Commercial broiler chicks of Cobb-500 strain randomly divided into 5 treatment groups *viz.* T_0 (Control), T_1 (antibiotic), T_2 (GP 0.5%), T_3 (TP 0.5%) and T_4 (GP 0.25% & TP 0.25%) having three replications consisting of 20 chicks in each. In this study, feed consumption (FC), live weight (LW) and FCR showed insignificant ($P>0.05$) difference among the treatments. Abdominal fat (%) significantly ($P<0.05$) lower in T_3 group compared to control group. Significantly ($P<0.05$) higher dressing percentage found in T_3 group compared to T_0, T_1 and T_2 groups. Significantly ($P<0.05$) lower concentration of serum glucose found in T_3 group compared to T_0 and T_1 group. Significantly ($P<0.05$) lower concentration of cholesterol found in all treated groups compared to control group. Total cost of production per broiler in T_1 (antibiotic group) was significantly ($P<0.05$) highest as compared to other treated groups. Total income, net profit and BCR per bird was comparatively ($P>0.05$) highest in T_3 group. Analyzing the above factor, the performance of T_3 group was better as a replacement of antibiotic. Birds fed 0.5% turmeric powder supplemented diet achieved superior result due to turmeric has ability to increase dressing percentage, reduce abdominal fat (%), glucose, cholesterol and reduce total cost of production.

Keywords: dressing percentage, abdominal fat, biochemical parameter, garlic, turmeric

Introduction
Over the past few decades, the use of antibiotic as growth promoters in poultry nutrition has been associated with fast growing nature of broiler chickens. Due to global threat of antimicrobial resistance (AMR) and increasing treatment failures, the non-therapeutic use of antibiotics in animal production has been banned in some countries (Cogliani *et al*., 2011) [8]. For this reason, Phytogenic or natural feed additives derived from herbs, spices, other plants and their extracts used in poultry nutrition. In present study garlic and turmeric was used as a replacement of antibiotic. Garlic (*Allium sativum*) have been widely used as herbal supplement in broiler chicken diet because of its strong stimulating effect on the immune system and the very rich aromatic oils which enhance feed digestion (Gardzielewska *et al*., 2003) [14]. It contained abundant bioactive components like sulfur containing compounds (alliin, diallylsulfides and allicin, ajoene) which act as antimicrobial (Gebreyohannes and Gebreyohannes, 2013; Jabar and Al-Mossawi, 2007) [15, 17]. Turmeric (*Curcuma longa*) can be a useful natural growth promoter and safe alternative to antibiotics (Khan *et al*., 2012) [21]. Active component name of turmeric is curcumin (Al-Mashhadani, 2015) [24] and it range from 2 to 5% of the turmeric (Bagchi, 2012) [5].Curcumin also possesses anti-inflammatory immunomodulatory and hepatoprotective properties (Daneshyar *et al*., 2011 and Rajput *et al*., 2013) [9, 28] .Considering the above factor, present study was designed to find the effect of garlic and turmeric powder on growth performance, carcass characteristics, biochemical properties of broiler chicken and also investigated the economic impact as a replacement of antibiotic.

2. Materials and Methods

2.1 Statement of the experiment

The research was conducted in the experimental trial shed at Sher-e-Bangla Agricultural University Poultry Farm, Dhaka, with 300-day-old (Cobb 500) straight run commercial broiler chicks for a period of 28 days.

2.2 Collection of experimental birds and diets

300-day-old Cobb 500 straight run commercial broiler chicks were collected from a renowned hatchery. They were kept in electric brooders equally and randomly distributed into five groups with three replicates of 20 birds in each. Garlic cloves & fresh turmeric rhizome were cleaned and dried sufficiently. Then turmeric and garlic powder was prepared by fine grinding and passing through 1 mm sieve. These powder were incorporated into the experimental diets to assess the feasibility of using garlic powder (GP), turmeric powder (TP) & their combination.

2.3 Treatment plan

T_0 = Basal diets (Control)
T_1 = Basal diets + Antibiotics (Doxivet ® - 1g/2 litre of drinking water)
T_2 = Basal diets + 0.5% Garlic Powder
T_3 = Basal diets + 0.5% Turmeric powder
T_4 = Basal diets + 0.25% Garlic Powder & 0.25% Turmeric powder

2.4 Management

Birds were raised in a well-ventilated broiler shed. Rice husk was used as litter at a depth of 6cm. clean tap water was offered *ad libitum* and feed were measured and offered twice a day. Feed ingredients and nutrient composition of the basal diet are presented in Table 1. Vaccination of birds were done routinely against infectious Bronchitis, Newcastle and Gambaro diseases.

Table 1: Feed ingredients and nutrient composition of starter and grower ration.

Ingredients	Starter Phase Day 1 to 14	Grower Phase Day 15 to 28
Corn,7.4% CP	53.8	56.76
Soybean meal, 44.5% CP	38.79	35.12
Soybean oil (%)	2.3	3.28
Oyster shell (%)	1.58	1.5
Sodium bicarbonate (%)	0.19	0.17
Dicalcium phosphate (%)	2.02	1.9
Salt (NaCl) (%)	0.2	0.23
Vitamin premix*	0.25	0.25
Mineral premix**	0.25	0.25
DL-Methionine (%)	0.35	0.33
L-Lysine HCl (%)	0.2	0.16
L- Threonine (%)	0.07	0.05
Chemical Composition		
ME (Kcal/Kg)	2900	3000
CP (%)	22.1	20.69
Methionine (%)	0.65	0.9
Lysine (%)	1.26	1.23
Methionine + Cysteine (%)	0.9	0.82
Calcium (%)	0.92	0.84
Available phosphorus (%)	0.41	0.38

*Supplied per kilogram of diet: Vitamin A 10,000 IU, Vitamin D_3 2,000 IU, Vitamin E 10mg, Vitamin K 20mg, Vitamin B_1 2mg, Vitamin B_2 10mg, Vitamin B_3 15mg, Vitamin B_6 300mg, Vitamin B_5 10mg, Vitamin B_8 5mg, Vitamin B_9 2500mg.
**Supplied per kilogram of diet: Manganese 500mg, Iron 250mg, Iodine 10mg, Zinc 600mg, Copper 100mg, Selenium 1mg and Cobalt 1mg

2.5 Data collection

Weekly live weight and weekly feed consumption was recorded and final live weight and feed consumption was calculated. FCR was calculated from final live weight and total feed consumption per bird in each replication. Mortality was recorded every day to find out the final livability rate. At end of the experiment after 28 days three birds were sacrificed from each replication. After slaughtering gizzard, liver, heart weight were measured from each broiler chicken and calculated their percentage according to live weight of bird. Dressing yield was calculated to find out dressing percentage.

2.6 Serum biochemical parameters

At end of the experiment 28 days, 2 mL of blood was collected via the wing vein from 2 birds in each replication of the treatment group. For the collection of serum blood samples were centrifuged. After separation of serum these were transferred into sterilized 0.5 ml serum cups. For measuring biochemical parameters (glucose and total cholesterol) using commercial kits.

2.7 Economic analysis

To find out the economic feasibility of different dietary groups calculating total cost and total income. The total cost was calculated by considering individual cost included feed cost and cost of dietary supplementation and common cost included sum price of DOC, litter, vaccine, medicine and others. The selling price of per kg bird was considered to calculate the total return and net profit of bird. Benefit cost ratio (BCR) was calculated through dividing the total income by the total cost of production. All expenses and income were calculated on the basis of market value (BDT) at the time of experimental period.

2.8 Statistical analysis

One-way ANOVA procedure of SPSS (version-16) software was used to analyze the data collected on various parameters. Duncan's multiple range test was used to analyze Differences between means and statistical differences declared at $P<0.05$.

3. Results and Discussion

3.1 Total feed consumption

Data presented in Table 2 showed that the effect of treatments on total feed consumption (g/bird) were not significantly ($P>0.05$) differ among the dietary groups. The birds of T_2, T_3 and T_4 groups consumed higher feed than T_1 group. However, highest feed intake found in 0.5% TP treated T_3 (2321.67g) group compared to other groups. Concomitant to the results Kyaw *et al.* (2017) [23] and Karangiya *et al.* (2016) [19] they reported that feed intake in control and 1% garlic powder group was similar and did not differ significantly. Ahmed *et al.* (2018) [11], Mondal *et al.* (2015) [25] found that the average feed consumption of broiler chick non-significantly ($P>0.05$) improved due to turmeric supplementation in the diets.

3.2 Final live weight

Data presented in Table 2 showed that the effect of treatments on final live weight (g/bird) were not significantly ($P>0.05$) differ among the dietary groups. However, highest ($P>0.05$) live weight was attained in T_3 (1625.67g) group among the treatment groups, whereas lowest in T_0 (1550.27g) group. Concomitant to the present findings Kyaw *et al.* (2017) [23] (1%), Issa and Abo Omar (2012) [16] (0.2% and 0.4%) they observed that supplementation of garlic did not significantly ($P>0.05$) affect the body weight. Sharma *et al.* (2015) [31] and Al-Mashhadani (2015) [24] who reported that supplementation

of turmeric powder in the basal diet of broiler chicken improved (P>0.05) final body weight of broiler chicken.

Table 2: Effect of dietary supplementation of garlic & turmeric powder on Production performance of broiler chicken

Parameters	Total Feed Consumption (g)/bird	Final Live Weight (g)/bird	FCR	Livability (%)
T_0	2297.80±24.74	1550.27±16.28	1.48 ± 0.02	100 ± 0.00
T_1	2283.43±19.48	1590.10±26.03	1.44 ± 0.03	100 ± 0.00
T_2	2299.67±12.78	1574.63±43.25	1.46 ± 0.04	100 ± 0.00
T_3	2321.67±20.63	1625.67±12.57	1.43 ± 0.02	100 ± 0.00
T_4	2292.67±31.29	1580.73±34.49	1.45 ± 0.02	100 ± 0.00
Mean ± SE	2299.25±9.17	1584.28±12.72	1.45 ± 0.01	100 ± 0.00

Here, T_0 = (Control), T_1 = (Antibiotic), T_2 = (0.5% Garlic Powder), T_3 = (0.5% Turmeric powder) and T_4 = (0.25% Garlic Powder & 0.25% Turmeric powder).

3.3 Feed conversion ratio

The effect of treatments on FCR of broiler chicken was not significant (P>0.05) presented in table 2. However, numerically improved FCR was found in 0.5%TP treated T_3 (1.43) group followed by other groups. These findings were well corroborated with the observation of Karim *et al*. (2017) [20] and Fadlalla *et al*. (2010) [12] they reported that garlic had no significant effect on the feed conversion ratio of birds. Present findings showed that at the end of 28 days of experiment best FCR found in 0.5% TP treated group than control and other groups. In harmony with the present results Fallah and Mirzaei (2016) [13] and Kafi *et al*. (2017) [18] who had reported that positive effects of turmeric powder supplementation on feed conversion efficiency in broiler chicken birds.

3.4 Livability

The livability rate showed on Table 2, different groups were not significantly (P>0.05) different and all the groups were showed livability 100% and the reason might be proper biosecurity management. These findings were well corroborated with the observation of Borgohain *et al*. (2019) [6] and Choudhury *et al*. (2018) [7].

3.5 Carcass characteristics

Table 3 revealed that, the percentage of liver, heart and gizzard were not significantly (P>0.05) differ among the treatment groups. These findings were in line with Karim *et al*. (2017) [20] and Sangilimadan *et al*. (2019) [30] they noted that garlic had non-significant effect on (Liver, Gizzard, and Heart weight). In harmony with the present results Shohe *et al*. (2019) [3] and Mondal *et al*. (2015) [25] explained that the values for the organ (Liver, Gizzard, and Heart) weight (g) did not vary between control and turmeric treated groups.

Different treatment groups (Table 3) showed significant (P<0.05) effect on percentage of abdominal fat of broiler chicken. Abdominal fat (%) significantly (P<0.05) lower in 0.5% TP (1.24 %) treated group compared to control (1.62 %) group. These present findings were in agreement with Adjei *et al*. (2015) [1] and Rahimi *et al*. (2011) [27] they observed that relative weights of the abdominal fat were not affected by garlic treatments. Present findings indicated that turmeric supplementation of broiler diets has the potential to reduce this type of waste by reducing abdominal fat content. Similar result observed by Yesuf *et al*. (2017) [33], Rajput *et al*. (2013) [28] and Wang *et al*. (2015) [32].

Table 3 also revealed that, significantly (P<0.05) higher dressing percentage found in T_3 (71.82 %**)** group compared to T_0, T_1 and T_2 groups. But, T_0, T_1 and T_2 had insignificant (P>0.05) different among them. Borgohain *et al*. (2019) [6] and El-katcha *et al*. (2016) [10] they reported that dressing percentage did not differ significantly due to inclusion of garlic powder. Mondal *et al*. (2015) [25] and Arslan *et al*. (2017) [4] found that supplementation of TP significantly (P<0.05) improved dressing percentage.

Table 3: Effect of dietary supplementation of garlic & turmeric powder to broiler diets on carcass characteristics

Parameters	Liver %	Heart %	Gizzard %	Abdominal Fat Percentage (%)	Dressing Percentage (%)
T_0	2.44 ± 0.01	0.43 ± 0.06	1.70 ± 0.20	1.62 ± 0.01^{a}	68.35 ± 1.08^{c}
T_1	2.43 ± 0.05	0.42 ± 0.02	1.64 ± 0.14	1.38 ± 0.06^{ab}	68.63 ± 1.21^{bc}
T_2	2.47 ± 0.07	0.50 ± 0.03	1.65 ± 0.02	1.38 ± 0.03^{ab}	69.13 ± 0.51^{bc}
T_3	2.51 ± 0.02	0.53 ± 0.03	1.66 ± 0.05	1.24 ± 0.01^{b}	71.82 ± 0.15^{a}
T_4	2.48 ± 0.02	0.49 ± 0.05	1.67 ± 0.03	1.35 ± 0.01^{ab}	71.00 ± 0.26^{ab}
Mean ± SE	2.47 ± 0.02	0.48 ± 0.02	1.66 ± 0.04	1.39 ± 0.04	69.79 ± 0.47

^{a,b,c}, values with different superscripts in the same column differ significantly (P<0.05). Here, T_0 = (Control), T_1 = (Antibiotic), T_2 = (0.5% Garlic Powder), T_3 = (0.5% Turmeric powder) and T_4 = (0.25% Garlic Powder & 0.25% Turmeric powder).

3.6 Serum biochemical parameters

The data on table 4 showed that, different dietary group had significant (P< 0.05) effect on serum glucose and cholesterol level (mg/dl) of broiler chicken. Significantly (P<0.05) lower concentration of serum glucose found in T_3 (201.12 mg/dl) group compared to T_0 and T_1 group. Significantly (P<0.05) lower concentration of cholesterol found in all treated groups compared to control (171.67 mg/dl) group. Concomitant to the results Kim (2010) [22] who reported that serum glucose levels has not any significant changes due to garlic supplementation. The present result were in line with Qasem *et al*. (2016) [26] and Ahmadi (2010) [2] they indicated that serum glucose levels were significantly lower in broiler chickens fed turmeric powder as a dietary supplement due to better utilization of glucose. Present findings were supported Ratika *et al*. (2018) [29], Karim *et al*. (2017) [20] and Borgohain *et al*. (2019) [6] they noted that total cholesterol was significantly (P<0.05) lower in the garlic supplemented group. The present study was well corroborated with the observation of Arslan *et al*. (2017) [4] and Choudhury *et al*. (2018) [7] they found that Serum total cholesterol was reduced due to turmeric supplementation compared to control group.

Table 4: Effects of dietary supplementation of garlic & turmeric powder on serum biochemical parameters of broiler chicken

Parameters	Glucose (mg/dl)	Cholesterol (mg/dl)
T_0	247.34 ± 12.84^{a}	171.67 ± 6.18^{a}
T_1	238.84 ± 4.23^{a}	152.56 ± 3.83^{b}
T_2	229.06 ± 9.91^{ab}	152.00 ± 5.63^{b}
T_3	201.12 ± 10.16^{b}	152.33 ± 4.49^{b}
T_4	224.06 ± 9.07^{ab}	151.89 ± 3.54^{b}
Mean ± SE	228.08 ± 4.75	156.09 ± 2.38

^{a,b}, values with different superscripts in the same column differ significantly (P<0.05). Here, T_0 = (Control), T_1 = (Antibiotic), T_2 = (0.5% Garlic Powder), T_3 = (0.5% Turmeric powder) and T_4 = (0.25% Garlic Powder & 0.25% Turmeric powder).

Economics of production

Table 5 showed that total cost of production per broiler in T_1 (antibiotic group) was significantly ($P<0.05$) highest as compared to other treated groups. Total income (BDT) and Net profit (BDT) per broiler was found to be numerically ($P>0.05$) highest in T_3 group (0.5% TP) followed by other groups. Net profit (Tk.) per broiler was found to be comparatively ($P>0.05$) lowest in T_1 (Antibiotic) group compared to other groups. BCR was comparatively ($P>0.05$) highest in T_3 (1.32) group and lowest in T_1 (1.27) groups. Among the treatment groups T_3 (0.5% TP) performed better than others. Present result showed that BCR was lowest in antibiotic group because of higher cost of production of using antibiotic. Concomitant to the results Shohe *et al.* (2019) [3], Mondal *et al.* (2015) [25] and Kafi *et al.* (2017) [18] who found the return of birds was high in turmeric treated groups as compared to control group.

Table 5: Effects of supplementation of garlic & turmeric powder in economic impact on broiler rearing.

Treatment groups	Total cost (BDT/bird)	Total income (BDT/bird)	Net profit (BDT/bird)	Benefit cost ratio (BCR)
T_0	161.43 ± 1.09^c	210.96 ± 1.95	49.53 ± 1.88	1.31 ± 0.01
T_1	170.26 ± 0.86^a	215.74 ± 3.13	45.48 ± 3.15	1.27 ± 0.02
T_2	165.54 ± 0.59^b	213.88 ± 5.19	48.35 ± 5.01	1.29 ± 0.03
T_3	166.20 ± 0.94^b	220.01 ± 1.51	53.81 ± 2.40	1.32 ± 0.02
T_4	165.05 ± 1.43^b	214.62 ± 4.14	49.57 ± 2.95	1.30 ± 0.02
Mean ± SE	165.70 ± 0.85	215.04 ± 1.53	49.35 ± 1.42	1.30 ± 0.01

^{a,b,c}, values with different superscripts in the same column differ significantly ($P<0.05$). Here, T_0 = (Control), T_1 = (Antibiotic), T_2 = (0.5% Garlic Powder), T_3 = (0.5% Turmeric powder) and T_4 = (0.25% Garlic Powder & 0.25% Turmeric powder).

4. Conclusion

It can be concluded that 0.5% turmeric powder supplementation had very effective impact on production performance, serum biochemical parameters and economic utility of broiler chicken rearing as a replacement of antibiotic compared to 0.5% garlic powder and their combination (0.25%GP +0.25% TP).Therefore, the present study recommends that implementation of these formulations in the field aspect for commercial broiler production which is safe, sound, and environmentally suitable for our country.

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