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Research Article

Dietary Supplementation of Turmeric Oil on Growth Performance, Carcass Characteristics and Economy of Broiler Chickens

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Abstract

The study was carried out to determine the effect of supplemental turmeric oil (TO) in replace to antibiotic growth promoters (AGPs) in the diets of broiler chicken. A total of 150-day-old Cobb- 500 broiler chicks collected from a local hatchery and randomly assigned into five dietary treatments with three replicates (10 chickens per replicate) for 4 weeks. The five treatments were basal diet (control); control plus doxycycline (2gm/L drinking water) as an antibiotic growth promoter (AGP); control plus 0.125% turmeric oil (TO 1), control plus 0.25% turmeric oil (TO 2) and control plus 0.50% turmeric oil (TO 3). Growth performance, internal organs weight and Benefit Cost Ratio (BCR) were analyzed. Body weight gain was improved significantly ($P < 0.05$) with 0.125% and 0.25% turmeric oil as compared to the control and AGP groups, but no significant difference was observed in feed intake, feed conversion ratio and livability percentage of broiler chicken. Neither liver and spleen weight nor abdominal fat were influenced by dietary TO but significantly ($P < 0.05$) higher heart, gizzard, intestine and bursa weight were found in chicken fed dietary TO compared to control and AGP group. Significantly ($P < 0.05$) higher BCR was found with the addition of 0.125% TO followed by the 0.25% TO in the diet of broiler chickens at 28 d of age. It is concluded that 0.25% TO could be considered as a potential feed additive for growth promotion and viable alternative to AGPs in the diet of broiler chickens.

Keywords: *Turmeric Oil; AGPs; Growth Performance; Benefit Cost Ratio; Broiler Chicken*

Introduction

Livestock plays an important role in the economy of Bangladesh where chicken rearing is a most prominent income-oriented activities in the rural areas of Bangladesh [1]. There is an incredible demand of animal protein which is free from hazardous chemicals and infectious agents [2]. Therefore, to ensure the maximum production of safe animal protein, feeding and management practices provided to the chicken are very important. Furthermore, antimicrobial growth promoters (AGPs) have been used in intensive poultry farming to make more profitable in the country. The AGP are the agents that inhibit bacteria by administering at a sub-therapeutic dose [3]. Generally, gut microbial population is interacting with AGPs and stimulating the feed intake which ensures the growth and production [4]. Moreover, AGPs have the capability to control important zoonotic pathogens such as Salmonella spp., Campylobacter spp. and *E. coli* [5]. However, the products contain antibiotics residues have the detrimental effect on consumer's health resulting in producing resistance in a number of human pathogens [6]. Thus, the European Commission banned all kinds of feed antibiotics in food animal production because of the increasing concern of antimicrobial resistance [7]. In addition, the complete ban of AGPs in animal feed in Bangladesh through the Fish

and Animal Feed Act 2010 and Animal Feed Rules 2013 have contributed to development of perceptions in consumers that suitable alternatives to antibiotics are being investigated. Among these alternatives, herbs and their essential oils have received notable attention since they have acquired more acceptability to the producers and consumers as natural additives in regards to feed and food safety.

It has been reported that the dietary incorporation of herbs and their associated essential oils may provide antimicrobial activity of their phytochemical components which have beneficial effects on poultry performance and health [8]. By contrast, some studies have not found positive effects of herbs and their related essential oils may be due to the dietary agents and experimental conditions and environment [9]. As alternative feeding strategy, various herbs and spices are well recognized to replace antibiotic growth promoters because of their potential antimicrobial properties in vitro against the various pathogens [10-13]. Therefore, beneficial effects of bioactive plant substances in animal feeding may include efficient feed utilization, improvement of digestive enzyme secretion; stimulate gut immunity, antimicrobial and antioxidant actions [14,15].

In Indian sub-continent, herbal plants or oil are traditionally used for therapeutic treatment for the last centuries. Besides, Bangladesh is very rich in herbal and medicinal plants that are very good sources of unconventional feed resources for livestock and poultry. So, inclusion of medicinal plants and oil such as turmeric oil (*Curcuma longa*) in poultry diet could be a good approach to find out alternatives to AGPs for enhancing the growth of commercial broiler chickens. Among the various culinary spices, turmeric oil (*Curcuma longa L*) is a perennial herb that belongs to the Zingiberaceae family. Its main active ingredients are curcumin and essential oils which is helpful to the health and well-being of both animals and humans [16]. Typical composition of dried turmeric rhizomes includes 6 - 10% fat, 3 - 6% volatile oil, 6 - 8% proteins, 3 - 6% fiber and 60 - 70% carbohydrates [17]. Curcumin has been identified as the major bioactive compound in turmeric with a multitude effects including antioxidant, anti-inflammatory, antimicrobial, gastroprotective, antiproliferative, antiarthritic and neuroprotective activities. In addition, Turmeric oil is another source of bioactive molecules including ar-turmerone, curlone, and ar-curcumene [18]. Various studies has been demonstrated that turmeric oil rich in antioxidant, antibacterial, antiviral, antifungal, antihyperlipidemic and wound healing properties [18-21]. However, there is a little to be known about the impact of turmeric oil as a natural feed additive in broiler live performances and immunity. Another component of turmeric is essential oil which is composed mainly by sesquiterpenes which has wide range of bioactivities, such as anticancer, anti-inflammatory, antioxidant, antifungal and antimicrobial properties [22,23]. As turmeric contains safe major lipophilic molecules and active profile which support its possible symbiotic potential. It is therefore, hypothesis that the dietary addition of turmeric oil may act as a natural antibiotic in poultry and help the growth promotion and immunity of birds with cost effective manner. Thus, the study was carried out to determine the effect of supplemental turmeric oil in replace to antibiotic growth promoters in the diets of broiler chickens.

Materials And Methods

Experimental place and date

The research was conducted at the Central Poultry Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh from July to December, 2018 with the approval of the Ethics Committee of Sher-e-Bangla Agricultural University Research System, Bangladesh.

Turmeric oil materials

The Turmeric oil materials were collected from the local company (Avon Animal Health, Dhaka, Bangladesh) and analyzed nutritional composition by AOAC [24]. The data is presented in table 1.

Nutritional composition	Amount[2]
CHO	Not detected (detection limit 0.1 %)
ME	8987.4 kcal/kg
CP	Not detected (detection limit 0.1 %)
Fat	99.86%
Sesquiterpene alcohol	50%
Zingeriberene and other Sesquiterpene hydrocarbons	30%
d-a-phellandrene	4%
Cineol	3%
d-sabinene	2%
d-borneol	2.5%
Valeric acid	0.1%

Table 1: *The nutritional composition of Turmeric oil[1].*

[1]Data were collected from the manufacturer (Avon Animal Health Company, Dhaka, Bangladesh). [2]Values (means, n = 3) are on DM basis.

Birds and housing

One hundred and fifty 1-d-old male broiler chicks (Cobb 500) were collected from a commercial hatchery. The birds were randomly assigned into 5 treatments with 3 replicates pen (10 birds/replicate pen). Throughout the study period, the birds were raised in an open sided rice husk-littered floor pen. Birds were allowed to fresh water and feed throughout the entire feeding trial. The room temperature was 35°C in the first week and decreased to 25°C up to 28 days of age. Continuous lighting was provided throughout the experimental period.

Dietary treatments

A corn-soybean meal basal diet (control), and Doxycycline (2gm/L drinking water) as AGP, 0.125%, 0.25% and 0.50% Turmeric Oil were added to the basal diet to form 5 dietary treatments. The basal diet was prepared to meet the NRC requirements [25] and was fed during the experimental periods (Table 2). The chicks were vaccinated at 4th and 2th days with the commercial Newcastle disease virus and infectious bronchitis vaccines through eye drops. The Gumboro vaccines were given through drinking water at days 9 and 17 of the experiment.

Ingredients	Starter diet (1-14 days)	Finisher Diet (15-28 days)
Moisture (%)	11.00	11.00
ME (Kcal)	3150	3175
CP (%)	22.5	22.1
Fat (%)	6.00	6.00
Ash (%)	8.00	8.00
Lysine (%)	1.20	1.10
Methionine (%)	0.49	0.47
Calcium (%)	1.20	1.20
Phosphorus (%)	0.75	0.75

Table 2: *Nutrient composition of basal diet[1].*

[1]Values (means, n = 3) are as fed basis.

Growth performance and carcass characteristics

The broiler chicks were weighed by group at the beginning of the study and recorded. Feed intake and body weight were recorded at 7, 14, 21 and 28 day at 6 am. Feed efficiency was calculated as the total feed intake to gain ratio. At the age of 28 d and after 8 h of fasting, 3 male birds from each replicate close to the mean BW were selected for slaughter and evisceration. Various parts of the carcasses, i.e., abdominal fat, gizzard (with contents), liver, heart, spleen, bursa of fabricious and intestine were dissected and weighed separately.

Benefit Cost Ratio (BCR)

All incomes and expenditures are considered to analyze the BCR. Cost of the chicks, feeds, litter, lime, medicine, vaccine, labor, water and electricity cost were considered as the expenditure. The expenditure per bird was calculated from the total expenditure of each replicate pen. The total income was calculated from sale value of broiler chicken and cost of litter. Total profit per bird was calculated by deduction of total expenditure from the total income of each replicate pen.

Data analysis

The data was subjected to statistical analysis by applying a one-way ANOVA using the SPSS, version 16.0. Differences between means were examined using Duncan's multiple comparison test and the significance were set at $P < 0.05$.

Results and Discussion

Growth Performance

The BW gain, feed intake, FCR and livability (%) were summarized in table 3. The BW gain was significantly ($P < 0.05$) higher in TO 1 and TO 2 groups compared to the control and AGP group, but no significant differences were found among the treatments for feed intake, feed conversion and livability of broiler (Table 3). Among the turmeric oil treated groups, TO 1 and TO 2 showed significantly ($P < 0.05$) higher results compared to the TO 3 group while TO 3 supplemented group showed no significant ($P < 0.05$) changes as compared to the control and AGP group.

Item	Treatments[1]					SEM[2]
	Control	AGP	TO 1	TO 2	TO 3	
BW gain (g/bird)	1527[c]	1564[b]	1601[a]	1612[a]	1561[bc]	9.10
Feed Intake (g/bird)	2167	2160	2198	2179	2203	9.35
FCR (feed/gain)	1.42	1.38	1.37	1.35	1.41	0.01
Livability (%)	100	100	100	100	100	0.00

Table 3: *Effect of Turmeric Oil (TO) supplementation on growth performance of broiler chickens (28d)*

[a,b,c]Means (n = 10) with different superscripts within a row differ significantly (P < 0.05).

[1]Control, without supplementation; AGP, Doxycycline (2gm/L drinking water as antibiotic growth promoters); TO 1, 0.125% Turmeric oil; TO 2= 0.25% Turmeric oil; TO 3= 0.50% Turmeric oil. [2]Standard error of mean.

Corresponding to our results, Ahmadi [26] showed that significantly increased weight gain when supplied 0.3 and 0.6 g/kg turmeric powder with the aflatoxin contaminated diets compared to the birds fed contaminated diets only but had no effect on feed intake. However, significant increase in body weight gain in the present study might be attributed to huge antioxidant activity of turmeric oil and stimulate protein synthesis by enzymatic system of birds [27]. Sinurat., *et al*. [28] reported that supplementation of *Curcuma longa* and *C. xanthorrhiza* powder as a feed additive for broiler did not affect feed intake or feed conversion ratio which is in agreement with our

results. In addition, Akbarian., *et. al*. [29] reported dietary *Curcuma xanthorrhiza* essential oil did not affect feed intake and FCR of broiler chickens during 28-38 d of age.

The most efficient FCR in broilers fed diets supplemented with TO 2 did not differ significantly between the groups shown that effect of phytogenic products as growth promoters could be related to more efficient use of nutrients in the gut, which results improved FCR. It has been reported that the ethanol turmeric extract confirmed high potential to inhibit some pathogenic bacteria of shrimp and chicken and thus turmeric powder exhibits antimicrobial properties [30]. Alike antibiotics, turmeric powder leads to better feed utilization by balancing gut microbial ecosystems. Therefore, inclusion of 0.125% and 0.25% TO have found numerically better results compared to 0.50% TO in the present study. Similarly, Durrani, *et. al*. [31] showed addition of 0.50% turmeric powder to broiler diets resulted in less FI and FCR both in early and later stage of the feeding trial, but weight gain decreased only in the finisher period. It appears that higher levels of dietary turmeric do not support the live performance of broiler chicken [32]. By contrast, Al-Sultan [33] reported that addition of 0.50% turmeric to broilers diet improved live performance and carcass characteristics of broiler chicken. Therefore, 0.1 and 0.2% turmeric powder supplied in the diet showed no harsh effect on broiler live performance [34]. However, in most of the earlier studies, turmeric powder was added to the broiler diets, but in the present study turmeric oil was used. Thus, some inconsistent results were observed in the present study in comparison to previous research might be due to the type, inclusion level and method of preparation of the turmeric materials. Daneshyar., *et al*. [35] stated that reduction of mortality rate due to ascites might be the addition of turmeric powder in broilers diets. However, livability did not differ significantly among the different dietary groups during the whole experimental period of the present study.

Carcass characteristics

No significant differences were found in the weight of liver, spleen and abdominal fat, but the heart, gizzard, intestine and bursa weight were significantly ($P < 0.05$) increased with the inclusion of turmeric oil in the ration of broiler chicks (Table 4). Similar to the present study, Ahmadi [26] reported that dietary supplementation of 0.6 g/ kg *Curcuma longa* did not affect the relative liver weight in comparison with control group. However, inclusion of turmeric oil used in the present study significantly ($P < 0.05$) affect the gizzard weight as compared to the control group. Some previous studies showed that dietary addition of turmeric herb or cinnamon essential oil did not affect the relative weight of gizzard in the chicken [31,36]. In addition, Turmeric infusions increased the percentage of entire small intestinal and ileum weight of the male broiler chicks [37] which is similar to the present study at lower levels of turmeric oil supplementation. Therefore, the higher gut weights in the turmeric-treated birds may be due to higher diameters of the gut wall and its integrity.

Item (g/bird)		Treatments[1]				SEM[2]
	Control	AGP	TO 1	TO 2	TO 3	
Liver	37.07	36.00	38.83	38.17	40.33	0.89
Heart	8.33^{b}	8.83^{b}	9.67^{b}	9.00^{b}	11.33^{a}	0.34
Gizzard (filled)	32.83^{b}	37.00^{b}	46.83^{a}	38.00^{b}	46.50^{a}	1.76
Intestine	106.83^{b}	113.00^{b}	129.17^{a}	108.83^{b}	110.50^{b}	2.67
Spleen	1.83	2.00	2.67	2.00	2.00	0.16
Bursa	2.33^{b}	2.00^{b}	1.83^{b}	3.17^{a}	2.50^{ab}	0.18
Abdominal fat	23.00	21.00	26.67	27.33	26.00	1.03

Table 4: *Effect of Turmeric Oil (TO) supplementation on carcass traits of broiler chickens (28d)*

a,b,c Means (n = 10) with different superscripts within a row differ significantly (P < 0.05).

[1]Control, without supplementation; AGP, Doxycycline (2gm/L drinking water as antibiotic growth promoters); TO 1, 0.125% Turmeric oil; TO 2= 0.25% Turmeric oil; TO 3= 0.50% Turmeric oil.[2]Standard error of mean.

Similar to our results, Akbarian, *et. al*. [29] found significantly heavier bursa compared to control group of broiler chickens fed 400 mg kg–1 *Curcuma xanthorrhiza* essential oil at 28-38 d of age. Although no significant difference was found in the spleen weight but numerically higher spleen weights were found in TO groups compared with control group. The spleen and bursa of Fabricius are primary lymphoid organ, plays a key role in enzymatic maturation and acquisition of immunological competence of T- and B-lymphocytes [38]. Significant deficiencies of the immune system functions of the chicken might be occurred due to disturbances in the development of spleen and bursa of Fabricius [39]. Lymphoid organs, antibody level, antioxidant status and blood metabolites are a good markers of health status of the animal. However, the impact of turmeric concentrations on lymphoid organs indicates that different concentrations of turmeric did not affect the weight of spleen and bursa of Fabricius. These results reveal that turmeric is a safe phytogenic feed additive for chickens and may enrich their immune response as measured by specific antibody titers [40]. It is also indicating that dietary 0.25% TO have the potential effect on immune organs and may enhance immune response of broiler chicken.

The results of BCR of feeding different experimental diets are presented in figure 1 where significantly (*P < 0.05)* improved BCR was found in chicks fed 0.25% TO compare to other supplementals groups including control diet. These improvements could be attributed to higher growth performance and feed utilization of broilers or reducing the amount of feed required to enhance BW gain. This result is agreement with previous findings of several researchers [41, 42-45] who reported that the inclusion of herbal feed additives in the diets recorded the least cost/kg BW gain of broiler chicks and the highest percent of economic efficiency compared with that of the un-supplemented diet. It is clear that addition of feed additives obtained from natural sources in the broiler diet decreased production costs as compared to that of the control diet [46]. However, in the present study, it is noted that supplemental 0.125% levels of TO resulted to reduction of feed cost followed by 0.25% levels of TO indicates the dietary turmeric oil is a viable alternative to AGPs in the diet of broiler chickens.

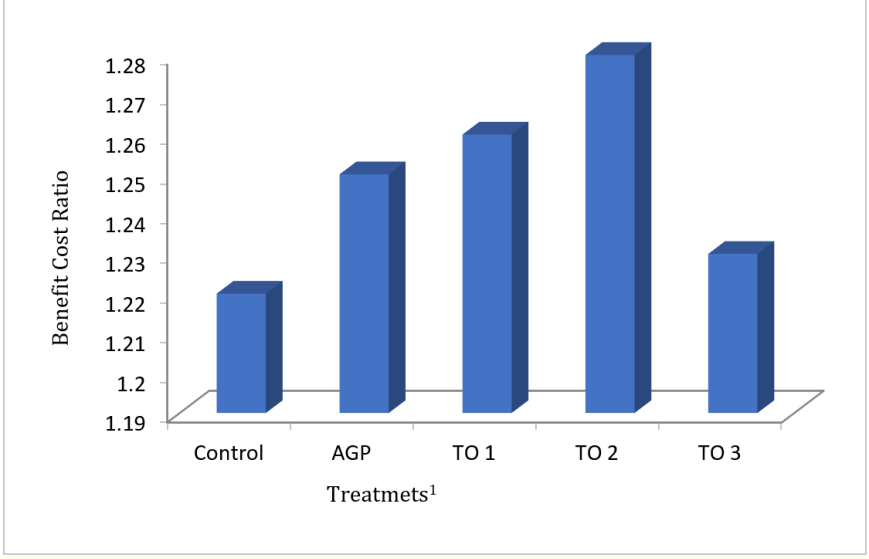

Figure 1: *Effect of Turmeric Oil (TO) supplementation on benefit cost ratio of broiler chickens (28d) a,b,cMeans (n = 10) with different superscripts within a bar differ significantly (P < 0.05).*

1Control, without supplementation; AGP, Doxycycline (2gm/L drinking water as antibiotic growth promoters); TO 1, 0.125% Turmeric oil; TO 2= 0.25% Turmeric oil; TO 3= 0.50% Turmeric oil.

Conclusion

It is concluded that supplementation of turmeric oil (*Curcuma longa*) improves the growth performance and immune organ weight of chicks when added at the rate of 0.25% level as a feed additive in the broiler diet.

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