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EFFECTS OF *Curcuma zedoaria* (SHOTI) ON GROWTH PERFORMANCE AND HEMATO-BIOCHEMICAL PARAMETERS IN BROILER

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A B S T R A C T

The experiment was conducted on "Cobb-500" broiler chicks to study the effects of *Curcuma zedoaria (shoti)* on growth performances and haemato-biochemical parameters. A total of twenty broilers chicks (16 days old) were randomly divided into five equal groups (n=4). Three groups of broilers fed shoti powder at the rate of 10%; 20%; 30% (w/w) with other ingredients for 22 days. Broilers chicks fed on maize-soybean were considered as positive control while non-protein control was regarded as negative control. The results showed that body weight of broilers fed 10% and 20% shoti meal grew very close to those of control (maize-soybean) group. After having completed the feeding trial, the birds were sacrificed to collect blood sample for and biochemical analysis .Weights of different organs and length of intestine were also measured. Results showed that decreased dressed weight, weight of skin and liver were found in 30% shoti treated group compared to protein control group. Intestinal weight was highest in 30% shoti treated group but length was similar to the protein control group. Total erythrocytes count, hemoglobin content and PCV value were found decreased in shoti treated group compared to protein control group but ESR value was highest in 10% shoti treated group. Total cholesterol was found to be decreased in the birds fed on shoti compared to protein control and significantly higher than non-protein control group. Triglyceride value decreased in 10% shoti treated group compared to protein and non-protein control group. Increased HDL value was found in 10% shoti treated group compared to control groups and 20 % and 30 % shoti treated groups. Result of this experiment showed that body weight of birds significantly ($p<0.05$) increased in all shoti treated groups**.** Further investigations are necessary by using different percentages of shoti and other shoti type feed to determine the effects of this feed supplement on animal's physiology.

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INTRODUCTION

Broiler farming is one of the most rapidly growing sectors in Bangladesh which provides high quality protein as well as generates employments especially in rural area. Broiler rearing farmers are using different types of growth promoter including antibiotic and some other drugs which have negative effects on human being (Schwarz *et al.*, 2001). To reduce the use of chemical agent as growth promoter, now a days, farmers return back to plant origin items like ancient centuries. *Curcuma zedoaria* is locally known as shoti or wheet. It is a starchy rhizomatous/tuberous from the Zingiberaceae family, commonly known as ginger family. The chemical composition of *Curcuma zedoaria* (shoti) meal is found to be low in protein, fat, trace minerals and therefore mainly as a source of energy. The rhizomes of *Curcuma aeruginosa* are highly aromatic due to the high amount of 1, 8-cineol as 25.20% (Ibrahim *et al.,* 2003). *Curcuma spp*. contains turmerin (a water-soluble peptide), essential oils (such asturmerones, atlantones and zingiberene) and curcuminoids including Curcumin with the formula: [1,7-bis-(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-Dione] and the curcuminoids can be defined as phenolic compounds derived from the roots of *Curcuma spp*. (Sharma *et al.,* 2005). The antioxidant activity of shoti has been reported. The results of bioactivity tests revealed that some of the plant crude extracts showed strong biological activities. Nevertheless, most of the isolated pure compounds showed only weak to moderate activity. Larvicidal test results both on the plants crude extracts showed that non polar extracts exhibited high toxicity with a LC50 value between 26.4 µg/ml and 34.9 µg/ml. On the other hand, curcumin and curcumenol showed antimicrobial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. According to Angel *et al.* (2012), results obtained for antioxidant activity test revealed that curcumin possessed stronger antioxidant activity.

Curcuma zedoaria grows mainly in the East-Asian countries including China, Vietnam, India, Bangladesh, Indonesia, Malaysia and Japan (Islam *et al.,* 2005; Tipthara *et al.,* 2007*)*. Blood values were found to be highly significant in reduction of total cholesterol, blood urea nitrogen (BUN), but increased in triglyceride (TG). The body weight of broilers fed 10% shoti meal grew very close to those of control (maize-soybean) group. The body weight gain was decreased gradually broiler chicken fed with 10% shoti , 20% shoti, 30% shoti compared to the protein control group. The birds given shoti meal consumed less feed than those provided with a maize diet and feed efficiency and body weight gain as % of initial weight remained significantly lower than the maize -soybean control. Broilers showed orange breast when fed on 30% shoti meal which was not been recorded from others fed shoti meal and as well as the control and stunted (Islam, 2012). Shoti meal generally has adverse effects on apparent digestibility compared with the control diets for Broilers. Nitrogen excretion in the droppings was significantly elevated in birds fed shoti based diets. Lipid digestibility was reduced by ingestion of shoti meal. Therefore, the aim of this designed experiment was to render the effects of shoti on the performance of broilers growth and on hematological parameters (TEC, Hb, ESR and PCV). Besides that, the effect of shoti on serum (total cholesterol, triglyceride, HDL and LDL) was also assessed.

MATERIALS AND METHODS

The experiment was conducted to investigate the effect of Shoti in Cobb -500 Broiler chicks during February 2013 to March 2013 in the department of Physiology, Bangladesh Agricultural University, Mymensingh. A 22 days feeding study was carried out to assess the effects of raw *Curcuma zedoaria* (Shoti) meal upon overall growth, hematological (total erythrocyte count, hemoglobin concentration, erythrocyte sedimentation rate, packed cell volume) and biochemical (cholesterol, triglyceride, high density lipoprotein, low density lipoprotein) parameters.

Shoti meal preparation

Curcuma zedoaria (Shoti) was collected from Bangladesh Agricultural University (BAU) campus and were cleaned and chopped into pieces, sun dried and pulverized in a flour meal. The procedure followed was exactly as that of (Latif *et al.,* 1979). The crude protein content of the shoti meal thus prepared was found to be 83 gm/ Kg feed. Maize starch, corn oil, soybean meal, amino acids, minerals and vitamins were bought locally and were of general purpose grade. Test and control diets were formulated by substitution of maize starch.

Table 1. The composition (gm/kg) of experimental diets for growing broilers

Dietary ingredients	Experimental diets				
	Control diets		Test diets		
	Maize-Soya protein	Non-protein control	Shoti (10%)	Shoti (20%)	Shoti (30%)
Shoti meal	0	0	100	200	300
Ground maize	530	105	430	330	230
Soybean meal	353	0	353	353	353
Maize oil	70	147	70	70	70
Di-calcium phosphate (DCP)	28.8	0	28.8	28.8	28.8
Sodium chloride	3.7	3	3.7	3.7	3.7
Vitamin-mineral premix	3	10	3	3	3
Lysine	10	0	10	10	10
Methionine	1.9	0	1.9	1.9	1.9
Maize starch	0	735	0	0	0
Total	1000.4	1000	1000.4	1000.4	1000.4

Experimental design

Twenty broiler chicks, aging 16 days were randomly divided into five equal groups (n=4). Two groups were considered as control (Protein and Non protein) and rest were considered as treated groups. Body weight of individual bird was recorded at the beginning and at the end of experiment. The birds were sacrificed to collect blood sample for hematological and biochemical analysis. Live weight, weight of skin, dressed carcass, legs, liver, intestine with its length were recorded.

Preparation of the experimental house and equipment

Experimental house was brushed, sweeping properly and cleaned with tap water. After washing with clean water, the pens were disinfected by using chlorine solution (50 ppm). The room was left vacant for 7 days. Later, it was again disinfected with Timsen solution (1 gm/litre water) left to dry up properly. During this time, all the feederers, waterers and other necessary equipment were properly cleaned, washed and disinfected with Finis solution and dried before use.

Management

The commercial management procedures were followed during the whole experimental period. Fresh and dried rice husk was used as a litter at a depth of 2 cm. The litter was stirred three times a week to prevent cake formation. As per need old litter material was changed using new rice husk to prevent fungal or coccidian attack. Each pen was 2.5 ft x 2 ft and was allotted for four birds. Therefore, the space given for each bird was 1 square ft. The birds were always exposed to a continuous lighting of 12 hours a day. During night electric bulbs were used to provide necessary light. In order to maintain required temperature and humidity inside the pens, all the windows of the laboratory were kept open during day and during night a 100 watt bulb was provided as a source of heat. One trough feeder and one round waterier were provided for each replicate pen. Proper hygienic and sanitation programs were followed during the experimental period. To prevent the outbreak of disease strict biosecurity was maintained during the experimental period by visitors restriction and cleaning.

Measurement of body weight

The body weight of each bird was measured with the help of electric balance on the 16 of age (0 day of experiment) and at the end of the experiment. The birds were sacrificed, processed and then weights (Live weight, weights of dressed carcass, liver, skin, legs, intestine) were taken by electric balance to study the meat yield and intestinal length was also recorded.

Total weight gain in % = [(Average final weight- Average initial weight) ÷ Average initial weight]×100

Collection of blood samples

Blood from each bird was collected at slaughter. A number of sterile test tubes containing anticoagulant (3.8% Trisodium citrate solution) at a ratio of 1:10 were taken. About 5.0 ml of blood was collected for hematological studies. The hematological studies were performed with in two hours of collection.

Preparation of serum samples

About 3 ml of blood was collected in the sterile glass test tube. The blood containing tubes were placed in a slanting position at room temperature for clotting. Then the tubes were incubated overnight in refrigerator (40C) and the serum was collected. The sample was centrifuged at 1000 rpm for 15 minutes to have a more clear serum. The serum samples were separated and stored at -200C till analysis.

Hematological parameters

Total erythrocyte count (million/mm3)

Total erythrocyte count was performed as per technique described by Lamberg and Rothstein (1977). Briefly, the tip of the dry clean red pipette was dipped into the blood sample and blood was drawn up to 0.5 mark. Hayem"s solution was immediately drawn exactly up to 101 marks. The content of the pipette were mixed thoroughly by shaking 8-knot motion for 3 minutes. After discarding 2 or 3 drops of the fluid from the pipette a small drop was placed at the edge of the cover glass was filled by the fluid. The cells were counted using 45X objectives.

Hemoglobin content (gm/dl)

The hemoglobin content was Determined as per method described by Lamberg and Rothstein (1977). The 0.1% normal hydrochloric acid (HCl) solutions were taken in a graduated diluting tube up to 2g mark. Well homogenized blood was then drawn by the Sahli pipette up to 20 cmm mark. The tip of the pipette was wiped with sterile cotton and the blood was up expelled into HCl of the graduated tube. The pipette was rinsed 2-3 times. This blood and acid were thoroughly mixed. This tube containing acid hematin mixture was kept standing in the comparator for 5 minutes. Distilled water was added drop by drop and the solution was mixed well until the color of the mixture matched to the standard color of the comparator. The result was expressed in gm percentage (gm %).

Packed cell volume (%)

Packed cell volume was determined as per technique described by Lamberg and Rothstein (1977). Briefly, the citrated blood was drawn into the special loading pipette. The tip of the pipette was inserted to a clean, dry Wintrobe hematocrit tube. The Wintrobe hematocrit tube was filled with blood by pressing the rubber bulbs of loading pipette and as the tube fills from the bottom. The tube was filled exactly up to the 10 mark. The tube was then placed in a centrifuge machine and centrifuged at 3000 rpm for 30 minutes. Then the tubes were taken out of the centrifuge machine and PCV was recorded. The result was expressed in percentage (%).

Serum biochemical parameters

Total serum cholesterol

The Cholesterol was determined using the procedure described by Trinder (1969); 10 µl ready serum sample was taken in each cuvette (1 cm light path) with the help of micropipette. Then 1000 µl reagent was taken to each cuvette and mixed thoroughly by shaking. The cuvettes were incubated at 370C for 5 minutes. After incubation, each mixture was placed in the Biochemistry Humalyzer-3000 (Human type, Germany) against the blank reagent at 500 nm, 546 nm wave length. Then result was recorded from display. The result was expressed in mg/dl.

Serum triglyceride

The triglyceride was determined after enzymatic hydrolysis with lipases. The indicator is a quiononeimine formed from hydrogen peroxide, 4-aminophenazone and 4-chlorophenol under the catalytic influence of peroxidase. The triglyceride of blood serum is determined by Biochemistry Humalyzer-3000 (Human type, Germany) according to the technique described by Trinder (1969). This procedure is similar to total serum cholesterol. The result was expressed in mg/dl.

HDL- cholesterol

Two hundred µl serum samples was mixed with 500 µl diluted precipitant in the test tube. Then the mixture was allowed to sit for 10 minutes at room temperature and then centrifuged for 10 minutes at 4000 rpm. 100 µl clear supernatant was separated within two hours in such way 20 supernatant was from 20 serum sample. 100µl supernatant was taken in the cuvette (1 cm light path) by micropipette. Then 1000 µl reagent (Cholesterol) was mixed with supernatant by shaking. After mixing, the mixture was incubated in Reflectron ® Humalyzer 3000 (Human type, Germany) for 5 minutes at 370C. Then the mixture was placed in the Reflectron ® against the blank reagent at a wave length of 500 nm. Then result was recorded in mg/dl which displayed in the Humalyzer-3000. The result was expressed in mg/dl.

LDL- cholesterol

The LDL was determined by subtracting the HDL cholesterol value from the subtracted value of triglyceride from total serum cholesterol that was divided by five.

LDL-cholesterol= (Total serum cholesterol-Triglyceride-HDL-Cholesterol)/5

Statistical analysis

All data were expressed as mean ± SE, and differences among the groups of birds were compared using one-way ANOVA with post-hoc Duncans test. Paired t- tests were used to compare pre-treatment and post-treatment value of different groups. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using SPSS software version 17 (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

The experiment was conducted to study the effects of shoti supplementation on live and dressed weight and weights of liver, Skin, legs, intestine and intestinal length, hematological (total erythrocyte count, hemoglobin content, packed cell volume and erythrocyte sedimentation rate) and bio-chemical (total cholesterol, triglyceride, high density lipoprotein and low density lipoprotein) parameters in broilers.

Effects on body weight

Body weight and total weight gain in % of different groups of birds is presented in table.

Table 2. Effects of shoti on weight gain (mean ± SE) in different groups of broilers (n=4)

Broiler groups	Parameters		
	Initial body weight (gm)	Final body weight(gm)	Total weight gain in%
A (Protein control)	489.4 ± 16.5a	1517.0 ± 14.6a	210.8 ± 11.1a
B (Non-protein control)	490.3 ± 6.4a	521.0± 63.0c	28.42 ± 16.3c
C (Shoti 10%)	500.3 ± 3.0a	1461.0± 84.3ab	189.0 ± 15.9ab
D (Shoti 20%)	489.7 ± 14.9a	1375.0± 86.0ab	180.2 ± 9.5ab
E (Shoti 30%)	495.8 ± 5.9a	1267.0± 74.2b	155.5 ± 15.1b

The values with different superscript letter(s) in the same column differ significantly ($p < 0.05$)

Body weight on (day 16 of age) day 0 of experiment was more or less similar. On day 38, the highest body weight was recorded in group A and lowest in control group B but among the treated groups the lowest body

weight was recorded in group E. All the values among the groups differ significantly ($p<0.05$) compared to group B (non-protein control) but differences among treated groups were insignificant ($p>0.05$).
A similar conclusion was drawn by Latif *et al*. (1979) who found that shoti meal had a more drastic effect on body weight. The food conversion ratio was 0.32 and 0.04, when shoti meal was incorporated at the level of 10% and 20% diet in 19 days. Latif *et al.* (1979) also observed that when rats given shoti based diet lost weight rapidly and of the five rats, two died within four days of test period. Islam (2012) also reported such type of variable responses of broiler chickens intestine to shoti.

Effects of shoti on different organs

Table 3. Effects of shoti on weights (mean ± SE) of different organs in different groups of broilers (n=4)

Broiler groups	Parameters				
	Dressed weight (gm)	Liver weight (gm)	Skin weight (gm)	Leg weight (gm)	Intestine weight (gm)
Group A	786.9± 55.0a	40.1 ±1.3a	192.8± 9.5a	54.4± 1.1a	76.8± 2.2c
Group B	214.1± 6.5c	14.7± 1.5c	67.0 ± 6.0d	20.9± 0.6c	39.4± 2.0d
Group C	762.4± 15.1a	36.6± 1.8a	191.6± 6.6ab	51.7± 1.0ab	80.6± 1.9c
Group D	750.9± 42.7a	37.7± 2.0a	171.8± 2.4b	52.7± 2.3a	90.8± 4.2b
Group E	580.6± 43.3b	29.5± 1.1b	140.8± 5.3c	46.8± 2.2b	103.40 ± 3.2a

The values with different superscript letter(s) in the same column differ significantly ($p <0.05$)

The dressed weight (mean ± SE) of different groups of birds is presented in table 3. The dressed weight increased significantly ($p <0.05$) in all treated groups compared to group B (non -protein control). The highest dressed weight was recorded in group A (786.9 ± 55.0) which was followed by group C and D. The present finding resembled to that of Islam (2012). In shoti treated group highest dressed weight was recorded in group C (10% shoti) and lowest in group E (30% shoti).

The intestinal weight (mean ± SE) of different groups of birds is presented in table 3. The intestinal weight increased significantly ($p<0.05$) in all groups compared to group B (non-protein control). The highest intestinal weight ($p<0.05$) was recorded in group E and lowest in group B. The present finding is first report. Its ingestion appeared to result in poorer than expected in digestion, absorption of dietary protein and lipid and to cause disturbance of the intermediary metabolism. Such systemic effects lead to a significant body compositional change within 19 days (Rahman, 2012).

Effects on intestinal length

Table 4. Effects of shoti on length (mean ± SE) of intestine in different broiler groups (n=4)

Broiler groups	Length of Intestine (cm)
Group A	165.9 ± 0.9a
Group B	104.1 ± 1.0b
Group C	176.0 ± 1.2a
Group D	176.0 ± 0.7a
Group E	170.9 ± 0.9a

The values with different superscript letter in the same column differ significantly ($p <0.05$)

Difference in intestinal length recorded in this experiment differs with the earlier reports of Rahman (2012), who observed that the inclusion of shoti meal decreased the length of the intestine ($p<0.05$) compared to that of control birds fed on maize-soybean meal.

Effects on hematological parameters

The effects of shoti on total erythrocyte count, hemoglobin content, erythrocyte sedimentation rate (ESR) and packed cell volume (PCV) are presented in table 5.

Table 5. Effects of shoti on haematological parameters (mean ± SE) in different groups of broilers (n=4)

Broiler groups	Haematological parameters			
	RBC (Million/ mm3)	**Hb** (gm%)	**ESR** (mm in first hour)	**PCV** (%)
A (Protein control)	2.8±0.1a	7.3±0.2a	4.3±0.3b	28.0±0.6a
B (Non-protein control)	2.0±0.1c	6.7±0.1b	7.3±0.7a	23.7±0.7c
C (Shoti 10%)	2.3±0.1b	7.0±0.1b	6.3±0.1a	25.0±0.6 bc
D (Shoti 20%)	2.5±0.1b	6.9±0.2ab	5.0±0.1b	26.3±0.4ab
E (Shoti 30%)	2.4±0.1b	6.9±0.3b	4.3±0.3b	25.7±0.3b

Values with different superscript litter(s) in the same column differ significantly ($p < 0.05$)

Total erythrocyte count of different groups of birds is presented in table 5. On the final day of experiment (38 days of age) the highest total erythrocyte count (TEC) was recorded in group A and lowest in group B. Significant ($p <0.05$) differences were observed among the treated groups compared to control groups (protein and non-protein group). The total erythrocyte count (TEC) in group A varied significantly ($p<0.05$) from all other groups. But difference among the groups C, D and E were insignificant ($p>0.05$) but significant higher to that of group B (non-protein control group). This finding is first report. The highest hemoglobin content was recorded in group A (Protein Control) and lowest in group B (non-protein control). Significant ($p<0.05$) differences were observed in the groups except group D (Shoti 20%) compared to non- protein control group. The differences among groups C, D, E in shoti treated groups were insignificant ($p>0.05$). This finding is first report.

Packed cell volume (mean ± SE) of different groups of birds is presented in table 5. The highest packed cell volume (PCV) was in group A (protein control) and lowest in group B (non-protein control). Difference among groups C, D and E in shoti treated groups were insignificant ($p>0.05$) but significant among the groups A, B and E ($p<0.05$). This finding is first report. Islam (2012) who found ulceration of duodenum in birds fed on shoti (30%) meal and duodenum section from growing broiler fed on shoti (30%) meal for 19days showing villi became atrophied. A common cause of red blood cell maturation failure is failure to absorb vitamin B12, Folic acid from the gastrointestinal tract (Guyton and Hall, 2006). In group B (non-protein control) there is lack of essential protein for erythrocytes synthesis so total erythrocytes count (TEC) in group B (non-protein control) is lowest. Due to ulceration of duodenum in birds fed on shoti meal there is less absorption of vitamin B12, and folic acid which are essential for erythrocytes maturation. As a result there was total erythrocyte count (TEC) in groups C, D, E in shoti treated groups were insignificant ($P>0.05$) but significant higher to that of group B (non-protein control group).

Erythrocyte sedimentation rate (mean ± SE) of different groups of birds is presented in table 5. The highest erythrocyte sedimentation rate (ESR) was in group B (non-protein control) and lowest was in group E (Shoti 30%) and group A (protein control). A common cause of red blood cell maturation failure is failure to absorb vitamin B12, Folic acid from the gastrointestinal tract. Iron is important for the formation of hemoglobin. Iron is absorbed from all parts of the small intestine (Guyton and Hall, 2006). Due to gastro-intestinal ulceration in shoti treated groups C, D, E the total RBC were insignificant ($p>0.05$).

Effects on bio-chemical parameters

Table 6. Effects of shoti on bio-chemical parameters (mean±SE) of broilers (n=4)

Broiler groups	Parameters		
	Total cholesterol(mg/dl)	Triglyceride(mg/dl)	HDL(mg/dl)
A (Protein control)	123.3 ±4.4a	70.7± 4.6ab	32.9± 1.6bc
B (Non-protein control)	86.8 ± 5.4b	83.5± 4.2a	28.9± 2.8c
C (10% Shoti)	68.6 ± 3.3c	47.6± 5.1c	46.6± 0.5a
D (20% Shoti)	80.7 ±6.2bc	59.8± 3.4bc	32.6 ± 2.7bc
E (30% Shoti)	76.8 ± 4.6bc	72.4± 4.3ab	37.1 ± 2.5b

Values with different superscript litter(s) in the same column differ significantly ($p < 0.05$)

Total cholesterol (mean ± SE) in all groups of birds is presented in table 6. The highest total cholesterol was in group A (protein control). Total cholesterol decreased significantly ($p < 0.05$) in all groups compared to group A. However, the differences among shoti treated groups were insignificant ($p>0.05$). Serum triglyceride (mean ± SE) in all groups of broilers is presented in table 6. Significantly ($p<0.05$) higher triglyceride was found in group B compared to all others and though differences among others in triglyceride concentration was recorded but was insignificant ($p>0.05$). High density lipoprotein (mean±SE) in all groups of birds is presented in table 6. Highest HDL was in group C (10% shoti) and lowest in group B (non-protein control). In the treated groups there was insignificant change between group D and E. HDL value was lower in group D and E compared to group C. This finding agreed with the earlier report of Ling *et al*. (2012) who found that curcumin oil significantly decreased the levels of serum total cholesterol, low-density lipoprotein cholesterol, triglyceride, and free fatty acid and increased that of high-density lipoprotein cholesterol. Stiintifice and Seria (2010) found that *Curcuma zedoaria*, Rosc meal in the broiler ration did not significant affected to percentage of abdominal fat but the additional *Curcuma zedoaria*, Rosc meal until 4.5% in the ration significantly reduced the level of cholesterol in broiler meat. Rukkumani *et al*. (2004) reported the hypolipidemic effect of curcumin mixed with a high cholesterol diet decreased serum total cholesterol and LDL-C but increased serum HDL in rat. Kalpana *et al*. (2005) reported the effects of a Curcumin on biochemical marker enzymes and lipid profiles on nicotine-induced toxicity in Wistar rats. Curcumin and curcumin analog administration significantly reduced marker enzyme activity and reduced plasma lipid levels in the nicotine -treated rats. Nagata and Saito (2005) reported the correlation between amount of curcumin intake and its physiological effects on indices of liver function, serum and liver lipid profil es in rats. HDL-cholesterol concentrations of rats fed curcumin diets were significantly higher than those of the control group, and serum TG concentration of rats fed the curcumin diets was significantly lower. These results indicate that curcumin intake can improve serum lipid profiles effectively. Emadi and Kermanshahi (2007) reported the effect of turmeric rhizome powder (TRP) on the activity of some blood enzymes in broiler chicken using corn-soybean meal based diet.

CONCLUSION

Body weight, food intake and efficiency of food conversion decreased with increase in the level of shoti meal in the diet. It may be concluded that supplementation of *Curcuma zedoaria* (Shoti) in broiler feed may be used for economical and efficient production of broilers. Besides that further study should be made taking different percentage of shoti to make broiler feed more efficient and economic.

COMPETING INTEREST

The authors declared that there is no conflict of interest.

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