Original Research

Effect of Dietary Supplementation of Turmeric (*Curcuma longa*) Powder on the Performance of Commercial Broiler Chicken

Dimpi Choudhury, Joga Dev Mahanta, Deben Sapcota, B. N. Saikia and Rafiqul Islam*

College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam, INDIA

***Corresponding author:** dr.rafiqulvets@gmail.com

Rec. Date:	Nov 29, 2017 15:28
Accept Date:	Feb 10, 2018 11:09
DOI	10.5455/ijlr.20171129032810

Abstract

A study was undertaken to investigate the effect of dietary supplementation of turmeric (Curcuma longa) powder on the performance of commercial broiler chicken. A total of 144 numbers of day-old commercial broiler chicks with uniform body weight were randomly divided into four groups viz. T_0 (standard basal diet as control), T_1 (basal diet + 0.25% turmeric powder), T_2 (basal diet + 0.50% turmeric powder) and T_3(basal diet + 0.75% turmeric powder) comprising 36 chicks in each group. The final body weight was significantly ($P \leq 0.05$) higher in T_3 group (2134.56 g) followed by T_2 (2049.36 g), T_1 (1963.97 g) and T_0 (1900.28 g). In respect of overall FCR, the T_3 group showed the best FCR value of 1.71 followed by T_2 (1.75), T_1 (1.81) and T_0 (1.88). The study revealed that there was increased body weight, improved FCR, highest BPEI and higher gross profit per bird offered with 0.75 per cent turmeric powder in feed.

Key words: Broilers, Body Weight, FCR, Gross Profit, Turmeric Powder

How to cite: Choudhury, D., Mahanta, J., Sapcota, D., Saikia, B., & Islam, R. (2018). Effect of Dietary Supplementation of Turmeric (curcuma longa) Powder on the Performance of Commercial Broiler Chicken. International Journal of Livestock Research, 8(7), 182-191. doi: 10.5455/ijlr.20171129032810

Introduction

Poultry production in India has become a profitable and most popular income generating sector for the educated unemployed youth. Most of the poultry farmers are interested in broiler production due to its quick returns, less space requirement and higher weight gains. The productive potential of poultry in India has not been fully exploited due to deficit feed resources and unutilization of available improved technologies for getting high productivity from the poultry at economical rate. Hence, it is essential to further enhance the feeding value of available feed resources so as to improve the efficiency of feed utilization and minimize the cost of feed per kilogram live weight gain. Phytobiotics have gained increasing interest as natural growth promoting feed additives in broiler production in recent years. These

have wide range of medicinal properties with no residual side effects and are best alternatives to antibiotic growth promoters (Rahman *et al*., 2014). Beneficial effects of these substances in poultry nutrition are due to their high content of pharmacologically active compounds stimulating appetite and feed intake, improving endogenous digestive secretion and activating immune responses (Nouzarian *et al*., 2011 and Toghyani *et al*., 2010). Turmeric (*Curcuma longa*) is one of such perennial herbs which contained an active component named curcumin (Wuthi-Udomler *et al*., 2000 and Mashhadani, 2015) and it range from 2 to 5% of the turmeric (Bagchi, 2012). The curcumin content of local variety of turmeric of Assam was found to contain 3.0% on dry weight basis. The therapeutic properties of curcumin included antibacterial, anticoccidial, antioxidant, hypocholesteremic and hypolipidaemic (Hussein, 2013; El-Khtam *et al*., 2014 and Qasem *et al*., 2015). It also posses anti-inflammatory (Holt *et al*., 2005), antiseptic, nematocidal, immunomodulatory and hepatoprotective properties (Daneshyar *et al*., 2011 and Rajput *et al*., 2013). Considering the above facts in view the present study was undertaken to determine dietary supplementation of garlic powder on the performance of broiler chicken fed at different levels with feeds.

Material and Method

The trial was conducted in the Experimental Poultry shed of Department of Poultry Science, C.V.Sc., Khanapara, Guwahati with 144 number of day-old broiler chicks having uniform body weight from a single hatch.

Table 1: Ingredients and nutrient composition of broiler starter and broiler finisher

Ingredients (kg)	Starter (0-28 days)	Finisher (29-42 days)
Maize	42	50.5
Rice polish	14	15
Ground nut cake	25	16
Soyabean meal	10	10.5
Fish meal	7	6
Mineral mixture	1.5	1.5
Common salt	0.5	0.5
Nutrient Composition		
Dry matter (%)	88.92	88.95
Crude protein (%)	23.04	20.12
Ether Extract (%)	4.89	5.01
Crude Fibre (%)	5.81	6.11
Nitrogen free extract (%)	59.44	60.52
Total ash (%)	7.01	6.98
Metabolizable energy (kcal/kg)*	2850.85	2913.41

**Calculated values (N.B. Vitamin premix (Vitablend vit A, B_2, D_3, K) was added @ 20 g per quintal of diet in both starter and finisher diet. Mineral mixture contained calcium 25%, Phosphorus 5%, Sodium chloride 23%, Iodine 10 ppm, Copper 100 ppm, Manganese 2000 ppm and Cobalt 10 ppm).*

DOI 10.5455/ijlr.20171129032810

The chicks were randomly divided into four groups viz. T_0, T_1, T_2 and T_3 comprising of 36 chicks in each group. Each group was further subdivided into 3 replicates of 12 chicks. The chicks were wing banded and reared under deep litter system of management. The control group (T_0) was fed with basal diet without any supplementation and the treatment group T_1, T_2 and T_3 were supplemented with local variety of turmeric powder at the rate of 0.25, 0.50 and 0.75 per cent respectively. The curcumin content of turmeric rhizomes was estimated following a standard procedure. The birds were fed as per recommendation of BIS (2007) feeding standards to meet the energy and protein requirements during starter phase (0- 28 says) and finisher phase (0- 42 days). The ingredient and nutrient composition for mash feed for starter and finisher basal diet is presented in Table 1. All the birds were offered ad libitum drinking water and feed throughout the experimental period of six weeks under uniform managemental condition. The birds were vaccinated against Ranikhet disease at the age of 6 days with LaSota strain and Infectious Bursal Disease at 14 days of age using IBD 'MB' intermediate strain. The performance of broiler in respect of weekly feed intake, weekly body weight and body weight gain, Feed Conversion Ratio (FCR), Broiler Performance Efficiency Index (BPEI), livability and economics of production were calculated as per standard methods. One Way Analysis of Variance was performed by software SAS Enterprise Guide 4.2.

Results and Discussion

Weekly Feed Intake and Total Feed Consumption

The mean weekly feed intake of the present study (Table 2) indicated that during the first week of age, the feed intake was lowest in T_1 group and highest in T_3 group Similar trend was seen in second week of age, except that feed intake was similar in T_0 and T_1 group.

Table 2: Mean weekly feed intake (g/bird) and total feed consumption (g/bird)

Week	Group			
	T_0 (Control)	**T_1**	**T_2 (TP- 0.50%)**	**T_3 (TP- 0.75%)**
1st	154.16	136.94	163.33	164.72
2nd	297.77	297.5	313.88	325
3rd	518.61	528.75	530.27	506.38
4th	743.33	726.94	728.89	710.83
5th	886.25	897.5	873.33	868.05
6th	986.94	973.47	975.69	1084.02
Total	3587.06	3561.11	3585.4	3659.02

During the sixth week of age, highest feed intake was hound in T_3 group (1084.02 g) and lowest in T_1 group (973.47 g). Thus it was found from all the weeks that supplementation of turmeric powder at 0.25, 0.50 and 0.75 per cent improved feed intake except fourth week of age compared to control group.

 DOI 10.5455/ijlr.20171129032810

Similar findings with respect to improvement of feed intake were observed by several workers (Sharma *et al*., 2015 and Hady *et al*., 2016). In contrary to the present observation, Kumar *et al*. (2005) and Nouzarian *et al*. (2011) reported no significant difference in feed intake between the control and treated groups of broiler chicken.

The total feed consumption per broiler for different experimental groups was found to be highest in T_3 group (3659.02 g) and lowest in T_1 group (3561.11g). This observation corroborated well with the findings of Hady *et al*. (2016). The increased feed intake might be due to the activity of turmeric as an antioxidant that stimulated protein synthesis (Osawa *et al*., 1995) by birds' enzymatic system. Moreover, turmeric powder possesses appetite stimulant, stomachic and carminative properties (Platel and Srinivasan, 2004 and Chakraborty *et al.*, 2011).

Weekly Body Weight and Body Weight Gain

The (Mean± S.E.) weekly body weight (Table 3) of different experimental groups did not differ significantly during the first and second week of age.

Table 3: (Mean ± S.E.) weekly body weight (g) of broilers under different treatments

Week	Group			
	T0 (Control)	**T1 (TP-0.25%)**	**T2 (TP-0.50%)**	**T3 (TP-0.75%)**
1st	$134.51^{a} \pm 1.98$	$134.38^{a} \pm 1.72$	$136.97^{a} \pm 1.48$	$138.94^{a} \pm 1.19$
2nd	$340.47^{a} \pm 6.34$	$343.61^{a} \pm 6.54$	$353.05^{a} \pm 6.88$	$338.33^{a} \pm 4.49$
3rd	$625.00^{a} \pm 11.12$	$637.50^{a} \pm 11.31$	$685.00^{b} \pm 10.45$	$677.50^{b} \pm 8.37$
4th	$1031.94^{a} \pm 17.38$	$1054.17^{ab} \pm 19.75$	$1094.44^{b} \pm 16.39$	$1098.61^{b} \pm 16.36$
5th	$1447.22^{c} \pm 25.66$	$1438.89^{a} \pm 29.08$	$1563.89^{b} \pm 20.17$	$1561.11^{b} \pm 23.15$
6th	$1900.28^{c} \pm 31.27$	$1963.97^{ac} \pm 39.36$	$2049.36^{ab} \pm 31.07$	$2134.56^{b} \pm 25.82$

Means bearing same superscripts in a row do not differ significantly

On third week, body weight differed significantly ($P<0.05$) among the different treatment groups. The T_2 and T_3 group achieved significantly ($P<0.01$) higher body weight (685.00 and 677.50 g) as compared to T_0 and T_1 group (625.00 and 637.50 g). During fourth, fifth and sixth week of age, the body weight of broiler chicken differed significantly ($P<0.01$) among the different experimental groups. The T_3 and T_2 group gained significantly ($P<0.01$) higher body weights as compared to control and T_1 group during fourth, fifth and sixth week of age. Similar observations were made by Jahan (2014) and Mashhadani (2015) who reported that supplementation of turmeric powder in the basal diet of broiler chicken improved final body weight of broiler chicken. Contrary to the present finding, Mehala and Moorthy (2008) and Nouzarian *et al*. (2011) reported that body weight was not affected by dietary supplementation of turmeric powder in broiler chicken.

The mean (± S.E.) weekly body weight gain (Table 4) of different experimental groups did not differ significantly in the first, second and fourth week of age. However, the mean body weight gain differed

 DOI 10.5455/ijlr.20171129032810

significantly (P<0.01) during third and fifth and sixth week of age among the different treatment groups. In the sixth week T_3 group showed significantly (P<0.05) higher body weight gain as compared to other experimental groups. The improvement in body weight and body weight gain of the broiler chickens due to supplementation of turmeric powder in the diets might be due to the increased length of the intestinal villi as well as decreased pH in the intestine (Sieo *et al*., 2005). Turmeric decreased the intestinal microbes' population and selectively increased *Lactobacillus* count (Sieo *et al*., 2005 and Namagirilakshmi *et al.*, 2010). This reduction in microbial load of broiler chickens could be due to the antibacterial effect of turmeric on intestinal microbiota (Faghani *et al*., 2014). Turmeric also enhanced the secretion of digestive enzymes and hence improved nutrient absorption and ultimately resulting in improved growth performance (Arslan *et al*., 2017). These findings corroborated well with the reports of Mondal *et al*. (2015), Sharma *et al*. (2015) and Sethy *et al*. (2016).

Table 4: (Mean ± S.E.) weekly body weight gain (g/bird) of broilers under different treatment groups

Week	Group			
	T0 (Control)	T1 (TP-0.25%)	T2 (TP-0.50%)	T3 (TP-0.75%)
1st	89.91^{a} ± 1.76	89.58^{a} ± 1.55	90.58^{a} ± 1.53	93.89^{a} ± 1.21
2nd	205.96^{a} ± 5.38	209.23^{a} ± 7.47	216.08^{a} ± 6.09	199.39^{a} ± 3.78
3rd	284.52^{a} ± 9.58	293.89^{a} ± 9.39	331.94^{b} ± 8.82	339.16^{b} ± 6.56
4th	406.94^{a} ± 12.34	416.67^{a} ± 15.65	409.44^{a} ± 10.85	421.11^{a} ± 11.99
5th	415.27^{a} ± 16.64	384.72^{a} ± 17.23	469.44^{b} ± 11.49	462.50^{b} ± 24.75
6th	453.06^{a} ± 26.00	525.08^{a} ± 21.75	485.47^{a} ± 23.18	573.45^{b} ± 23.66

Means bearing same superscripts in a row do not differ significantly

Feed Conversion Ratio

Among the different experimental groups, the mean weekly feed conversion ratio (Table 5) of T_1 group showed the best FCR values during the first (1.53) and second (1.42) week of age. On the third and fourth week, T_3 group showed the best values (1.50 and 1.69) as compared to other groups. On the fifth week, the mean FCR value of T_2 group (1.86) was best among all the experimental groups. In the sixth week of age, T_1 group (1.85) showed best FCR followed be T_3 (1.89), T_2 (2.00) and T_0 (2.18) group.

Table 5: Mean weekly feed conversion ratio of broilers under different treatment groups

Week	Group			
	T0 (Control)	T1 (TP-0.25%)	T2 (TP-0.50%)	T3 (TP-0.75%)
1st	1.71	1.53	1.81	1.75
2nd	1.45	1.42	1.45	1.63
3rd	1.82	1.8	1.6	1.5
4th	1.83	1.74	1.78	1.69
5th	2.13	2.33	1.86	1.88
6th	2.18	1.85	2	1.89
Overall	1.88	1.81	1.75	1.71

DOI 10.5455/ijlr.20171129032810

The overall FCR of the entire period of experiment was best in T_3 group (1.71) followed by T_2 (1.75), T_1 (1.81) and T_0 (1.88) group. The better feed conversion ratio can be attributed to the antimicrobial properties of turmeric powder which resulted in better absorption of the nutrients in the gut and finally leading to improvement in feed conversion ratio (Ong-ard *et al*., 2010). Turmeric could control and limit the growth and colonization of numerous pathogenic and non-pathogenic species of bacteria in chicken's gut resulting in balanced gut microbial ecosystem that leads to better feed utilization reflected by improved feed conversion ratio (Hussein, 2013). Similar observations were reported by several workers (Naderi *et al*., 2014; Arslan *et al*., 2017). On the other hand, addition of turmeric powder in the broiler ration did not show significant differences in feed conversion ratio according to findings of several workers (Mehala and Moorthy, 2008; Vashan *et al*., 2012 and Fallah and Mirzaei, 2016).

Broiler Performance Efficiency Index and Livability

Among the different treatment groups**,** T_3 group showed the highest BPEI (124.82) followed by T_2 (117.09), T_1 (108.50) and T_0 (101.08) group (Table 6).

Table 6: Broiler Performance Efficiency Index (BPEI) and Livability of broilers under different treatment groups

Parameters	Groups			
	T_0 (Control)	**T_1 (TP-0.25%)**	**T_2 (TP-0.50%)**	**T_3 (TP-0.75%)**
BPEI	101.08	108.5	117.09	124.82
Livability (%)	100	100	100	100

Similar findings with respect to improvement in efficiency index were observed by earlier researchers, Yaghobfar *et al.* (2011), Basak, (2015) and Attia *et al*. (2017) in broiler chicken. The higher value of BPEI in T_3 group was due to higher average body weight and better feed conversion ratio in broiler chicken during the entire experimental trial. The efficiency index of broiler chicken improved gradually as the level of supplementation of turmeric powder increased from 0.25% to 0.75% as compared to control group. The per cent livability of all the experimental groups was cent per cent 9100). Similar observations were reported by Mehala and Moorthy (2008) and Attia *et al*. (2017) in broiler chicken supplemented with diet containing turmeric powder as phytogenic growth promoter. This might be due to the antioxidant and antimicrobial effect of turmeric powder in the treated groups (Al-Jaleel, 2012). In addition, curcumin of turmeric had a role on the immune stimulating factor in immune system which reduced the mortality rate in chicken (Al-Kassie *et al*., 2011). Contrary to the present observation, Al-Jaleel (2012) found variable mortality rates in broiler chicken fed control and turmeric treated diets.

DOI 10.5455/ijlr.20171129032810

Economics of Production

The cost of production per broiler including the additional cost of turmeric powder was found to be (Rs.) 172.14, 172.09, 174.50 and 177.50 for T_0, T_1, T_2 and T_3 groups respectively (Table 7). The cost of production per broiler in T_3 and T_2 was numerically higher by about (Rs.) 5.36 and 2.36 as compared to T_0 group. However, gross profit per broiler was found to be highest in T_3 group (Rs. 35.96) followed by T_2 (Rs. 30.44), T_1 (Rs.24.30) and T_0 (Rs.17.86) group. Thus, among the four groups, the T_3 group showed best result in respect of higher gross profit per broiler. The gross profit per broiler was higher by ₹ 18.10 in T_3 group as compared to T_0 group. The better gross profit per broiler in T_3 group could be attributed to the better growth performance and improved FCR of broilers due to addition of turmeric powder in the ration. These findings corroborated with the results of earlier workers (Hossain *et al*., 2014 and Kassu *et al.*, 2016) who showed reduction in production cost per Kg weight gain, increased live weight, better FCR and higher net revenue in turmeric treated groups as compared to untreated group.

Table 7: Cost of production and gross profit (Rs.) per broiler under different treatment groups

Parameters	Group			
	T0 (Control)	**T1 (TP-0.25%)**	**T2 (TP-0.50%)**	**T3 (TP-0.75%)**
I. Expenditure				
Chick cost (A) = 1.05 x cost of one day-old chick (₹)	33.6	33.6	33.6	33.6
Feed cost (B) = Live weight in Kg x FCR x Cost per Kg of feed (₹)	116.09	115.28	116.59	118.37
Miscellaneous expenditure (C) = Add 15% of (A+B) (₹)	22.45	22.33	22.52	22.79
Additional cost of Turmeric powder (D)	--	0.88	1.79	2.74
Production cost per broiler (A+B+C+D) (₹)	172.14	172.09	174.5	177.5
II. Return				
Sale of one live broiler @ ₹ 100 per Kg	190	196.39	204.94	213.46
III. Gross profit per broiler (₹)	17.86	24.3	30.44	35.96

Conclusion

A biological trial was conducted to investigate the effect of feeding turmeric (*Curcuma longa*) powder on the performance of broiler chicken. A total of 144 numbers of day-old commercial broiler chicks with uniform body weight were randomly divided into four groups *viz.* T_0 (standard basal diet as control), T_1 (basal diet + 0.25% turmeric powder), T_2 (basal diet + 0.50% turmeric powder) and T_3 (basal diet + 0.75% turmeric powder) comprising 36 chicks in each group. The final body weight was significantly ($P<0.05$) higher in T_3 group (2134.56 g) followed by T_2 (2049.36 g), T_1 (1963.97 g) and T_0 (1900.28 g). In respect of overall FCR, the T_3 group showed the best FCR value of 1.71 followed by T_2 (1.75), T_1 (1.81) and T_0 (1.88). The study revealed that there was increased body weight, improved FCR, highest BPEI and higher gross profit per bird offered with 0.75 per cent turmeric powder in feed. Thus, it can be recommended that

 DOI 10.5455/ijlr.20171129032810

turmeric powder can be used as natural feed additive in feed at the level of 0.75% to improve the overall performance of broiler chicken. The effective level of incorporation of turmeric powder might be due to the hormesis effect.

Acknowledgement

The authors express thankfulness to the Dean, Faculty of Veterinary Science, AAU, Khanapara for providing necessary facilities to carry out the experiment.

References

1. Al-Jaleel, RAA. 2012. Use of turmeric (*Cucuma longa*) on the performance and some physiological traits on the broiler diet. *The Iraqi Journal of Veterinary Medicine*, 36(1): 51-57.
2. Al-Kassie, GAM, Mohseen, AM and Al-Jaleel, RAA. 2011. Modification of productive performance and physiological aspects of broilers on the addition of a mixture of cumin and turmeric to the diet. *Research Opinions in Animal and Veterinary Science*, 1(1): 31-34.
3. Arslan, M, Ul Haq, A, Ashraf, M, Iqbal, J and Mund, MD. 2017. Effect of turmeric (*Curcuma longa*) supplementation on growth performance, Immune response, Carcass characteristics and Cholesterol Profile in broilers. *Veterinaria*, 66(1): 16-20.
4. Attia, Youssef, A, Al-Harthi, Mohammed, A and Hassan, SS. 2017. Turmeric (*Curcuma longa Linn*.) as a phytogenic growth promoter alternative for antibiotic and comparable to mannan oligosaccharides for broiler chickens. *Revista Mexicana de Ciencias Pecuarias*, 8(1): 11-21.
5. Bagchi, A. 2012. Extraction of Curcumin. *Journal of Environmental Science Toxicology and Food Technol*ogy, 1(3): 15-23.
6. Basak, S. 2015. Evaluation of turmeric oil (Curcumol) in Poultry diets. https://www.linkedin.com/pulse/feed/channel/healthcare.
7. BIS. 2007. Indian Standard: Poultry Feed Specifications. 5th Revision. Bureau of Indian Standards, New Delhi.
8. Chakraborty, PS, Ali, SA, Kaushik, S, Ray, RK, Yadav, RP, Rai, MK, Singh, D, Bhakat, AK, Singh, VK, John, MD, Das, KC, Prasad, VG, Nain, SS, Singh, M, Chandra, PK, Singh, DK, Rai, Y, Singh, P, Singh, O, Singh, AKN, Shah, M, Pradhan, PK, Bavaskar, R, Debata, L, Nayak, C, Singh, V and Singh, K. 2011. *Curcuma longa*- A multicentric clinical verification study. *Indian Journal of Research in Homeopathy*, 5(1): 19-27.
9. Daneshyar, M, Ghandkanlo, MA, Bayeghra, FS, Farhangpajhoh, F and Aghaei, M. 2011. Effects of dietary turmeric supplementation on plasma lipoproteins, meat quality and fatty acid composition in broilers. *South African Journal of Animal Science*, 41(4): 420-428.
10. El-Khtam, AO, El-Latif, AA and El-Hewaity, MH. 2014. Efficiency of turmeric (*Curcuma longa*) and garlic (*Allium sativum*) on *Eimeria* species in broilers. *International Journal of Basic and Applied Science*, 3 (3): 349-356.
11. Faghani, M, Rafiee, A, Namjoo, A R and Rahimian, Y. 2014. Performance, cholesterol profile and intestinal microbial population in broilers fed turmeric extract. *Research Opinion of Animal and Veterinary Science*, 4(9): 500-503.
12. Fallah, R and Mirzaei, E. 2016. Effect of dietary inclusion of turmeric and thyme powders on performance, blood parameters and immune system of broiler chickens. *Journal of Livestock Sci*ence, 7: 180-186.
13. Hady, MM, Zaki, MM, Wafaa Abd EL-Ghany, WA, Reda and Korany, MS. 2016. Assessment of the broilers performance, gut healthiness and carcass characteristics in response to dietary inclusion of dried coriander, turmeric and thyme. *International Journal of Environmental and Agricultural Research*,, 2(6): 153-159.

DOI 10.5455/ijlr.20171129032810

14. Holt, MDPP, Seymour Katz, MD and Kirshoff, R. 2005. Curcumin Therapy in Inflammatory Bowel Disease: A Pilot Study. *Digestive Disease Science*, 50(11): 2191–2193.
15. Hossain, MM, Howlader, AJ, Islam, MN and Beg, MAH. 2014. Evaluation of locally available herbs and spices on physical, biochemical and economical parameters on broiler production. *International Journal of Plant Animal and Environmental Science*, 4(1): 317-323.
16. Hussein, SN. 2013. Effect of turmeric (*Curcuma longa*) powder on growth performance, carcass traits, meat quality, and serum biochemical parameters in broilers. *Journal of Advanced Biomedical and Pathological Research*, 3(2): 25-32.
17. Jahan, MY. 2014. Efficacy of kalo jeera seeds and turmeric supplementation on the performance of broiler. MS Thesis, Department of Pharmacology, Bangladesh Agricultural University, Mymensingh, Bangladesh.
18. Kassu,Y, Tamir, B and Tesfaye, E. 2016. Effect of Supplementing Natural Feed Additives: Black Cumin, Fenugreek and Turmeric on the Growth Performance and Economic Efficiency of Broiler Chickens. *Advanced Biological Research*, 10(5): 335-344.
19. Kumar, M, Choudhary, RS and Vaishnav, JK. 2005. Effect of supplemental prebiotic, probiotic and turmeric in diet on the performance of broiler chicks during summer. *Indian Journal of Poultry Science*, 40(2): 137-141.
20. Mashhadani, HE. 2015. Effect of different levels of turmeric (*Curcuma longa*) supplementation on broiler performance, carcass characteristic and bacterial count. *Egyptian Poultry Science Journal*, 35(1): 25-39.
21. Mehala,C and Moorthy, M. 2008. Production Performance of Broilers Fed with *Aloe vera* and *Curcuma longa* (Turmeric). *International Journal of Poultry Science*, 7 (9): 852-856.
22. Mondal, MA, Yeasmin, T, Karim, R, Siddiqui, MN, Raihanun-Nabi, SM, Sayed, MA and Siddiky, MNA. 2015. Effect of dietary supplementation of turmeric (*Curcuma longa*) powder on the growth performance and carcass traits of broiler chicks. *SAARC Journal of Agriculture*, 13(1): 188-199.
23. Naderi, M, Akbari, MR, Asadi-Khoshoei, E, Khaksar, K and Khajali, F. 2014. Effects of Dietary Inclusion of Turmeric (*Curcuma longa*) and Cinnamon (*Cinnamomum verum*) Powders on Performance, Organs Relative Weight and Some Immune System Parameters in Broiler Chickens. *Poultry Science Journal*, 2 (2): 153-163.
24. Namagirilakshmi, S, Selvaraj, P, Nanjappan, K, Jayachandran, S and Visha, P. 2010. Turmeric *(Curcuma longa)* as an alternative to in-feed antibiotic on the gut health of broiler chickens. *Tamilnadu Journal of Veterinary and Animal Science*, 6 (3): 148-150.
25. Nouzarian, R, Tabeidian, SA, Toghyani, M, Ghalamkari , G and Toghyani, M. *2011*. Effect of turmeric powder on performance, carcass traits, humoral immune responses, and serum metabolites in broiler chickens. *Journal of Animal and Feed Science, 20: 389-400.*
26. Ong-ard, L, Ngampong, K and Boonsong, K. 2010. Antimicrobial activity of curcuminoids from Curcuma longa L. on pathogenic bacteria of shrimp and chicken. *Kasetsart Journal of Natural. Sci*ence, 44: 364-371.
27. Osawa, T, Sugiyama, Y, Inayoshi, M and Kawakishi, S. 1995. Antioxidant activity of tetrahydrocurcuminoids. *Bioscience Biotechnology and Biochemistry*, 59: 1609-1612.
28. Platel, K and Srinivasan, K. 2004. Digestive stimulant action of spices: a myth or reality? *Indian Journal of Medical Research*, 119(5): 167-179.
29. Qasem, MAA, Alhajj, MS, El Nabi, ARG and Al-Mufarrej, SI. 2015. Effect of turmeric powder as a dietary supplement on performance indicators and immune responses in broiler chickens. *Journal of Animal and Veterinary Advances*, 14(2): 30-35.
30. Rahman, S, Mostofa, M, Fatema, MN, Latif, MA and Afrin, S. 2014. Effect of neem leaves, turmeric and cinnamon extract as a growth promoter in broilers. *Bangladesh Research Publications Journal*, 10(1): 7-13.

DOI 10.5455/ijlr.20171129032810

31. Rajput, N, Muhammad, N, Yan, R, Zhong, X and Wang, T. 2013. Effect of dietary supplementation of Curcumin on growth performance, intestinal morphology and nutrients utilization of broiler chicks. *Journal of Poultry Science*, 50(1): 44-52.
32. Sethy, K, Swain, P, Behera, K, Nayak, SM, Barik, SR, Patro, P and Meher, P. 2016. Effect of turmeric (*Curcuma longa*) supplementation on growth and blood chemistry of broilers. *Exploratory Animal and Medical Research*, 6(1): 75-79.
33. Sharma, A, Ranjan, S and Krishna , V. 2015. Evaluation of Growth Promoter-Boon and Its Effect on Growth Performance of Broilers. *International Journal of Advanced Biotechnology and Research*, 6(3): 366-371.
34. Sieo, CC, Abdullah, N, Tan, WS and Ho, YW. 2005. Influence of beta-glucanase producing Lactobacillus strains on intestinal characteristics and feed passage rate of broiler chickens. *Poultry Science*. 84: 734-741.
35. Toghyani, M, Tohidi, M, Gheisari, AA and Tabeidian, SA. 2010. Performance, immunity,serum-biochemical and haematological parameters in broiler chicks fed dietary thyme as alternative for an antibiotic growth promoter. *African Journal of Biotechnology*, 9: 6819-6825.
36. Vashan, SJH, Golian, A, Yaghobfar, A, Zarban A, Afzali, N and Esmaeilinasab, P. 2012. Antioxidant status, immune system, blood metabolites and carcass characteristic of broiler chickens fed turmeric rhizome powder under heat stress. *African Journal of Biotechnology*, 11(94): 16118-16125.
37. Wuthi-Udomler, M, Grisanapan, W, Luanratana, O and Caichompoo, W. 2000. Anti-fungal activities of plant extracts. *South East Asian Journal of Tropical Medicine Public Health*, 31 (1): 178-182.
38. Yaghobfar, A, Vashan, SJH, Golian, A, Nassiri, MR and Raji, R. 2011. Evaluation of turmeric powder in diets based soybean oil on performance, energy and protein efficiency ratio and immune system of broiler chicks. *Researches of the First International Conference*, 2(1): 2072-3875.

DOI 10.5455/ijlr.20171129032810