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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Research Article
Improved Productivity and Health Performances of Broiler Chickens Administered with Jamu Ginger, Curcuma and Turmeric

[1]Andriyanto, [1]Firda Agustin, [1]Dedi Nur Aripin, [1]Pramesti Nugraheni, [1]Gusti Habibi Suryanata, [2]Ridi Arif, [1]Diah Nugrahani Pristihadi, [1]Aulia Andi Mustika and [1]Wasmen Manalu

[1]Department of Anatomy, Physiology and Pharmacology,
[2]Department of Animal Disease and Veterinary Public Health,
Faculty of Veterinary Medicine, Bogor Agricultural University, Jalan Agatis, Kampus IPB Darmaga, 16680 Bogor, Indonesia

Abstract

Background and Objective: Productivity and health performances of broiler chickens can be improved by using medicinal herb. An experiment was conducted to study the effect of administration of Jamu ginger or jahe (*Zingiber officinale*), Jamu curcuma or kencur (*Kaemferia galanga*) and Jamu turmeric or kunyit (*Curcuma domestica*) on the productivity and health performances of broiler chickens. **Materials and Methods:** One hundred days old chicks of Cobb strain were used in the experiment. The experimental chicks were divided into 4 treatments, (1) Control group i.e., the broiler chicks without administration of Jamu, (2) The broiler chicks administered with Jamu ginger, (3) The broiler chicks administered with Jamu curcuma and (4) The broiler chicks administered with Jamu turmeric. Jamu preparations were administered orally when the experimental broiler reached the age of 8 days. Jamu treatment was administered for 28 days through drinking water at a dose of 1 mL L^{-1}. Data were analyzed by using ANOVA and when the means were significant the data were further tested by using Duncan test. **Results:** The results showed that the experimental broiler chickens administered with Jamu curcuma and Jamu turmeric had improved feed conversion ratio by 19.52 and 14.76%, respectively, compared to control. The experimental broiler chickens administered with Jamu ginger had higher carcass weight ($p<0.05$) compared to those administered with Jamu curcuma, Jamu turmeric and control by 5.70, 61.10 and 8.21%, respectively. All experimental broiler chickens administered with Jamu had lower mortality rate compared to control. The administration of Jamu ginger, Jamu curcuma and Jamu turmeric decreased abdominal fat by 10.09, 5.05 and 28.08%, respectively, compared to control. The experimental broiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric had similar number of red blood cells and white blood cells, serum SGPT, SGOT and creatinine concentrations compared to control. Serum concentrations of urea in the experimental broiler chickens administered with Jamu turmeric were lower than the other treatments. **Conclusion:** It was concluded that the administration of Jamu ginger, Jamu curcuma and Jamu turmeric can be used as feed additives to increase the productivity and health performances of broiler chickens. Jamu ginger, Jamu curcuma and Jamu turmeric have a great potential to be used and developed as herbal preparations to improve the growth and performances of poultry animals.

Key words: Jamu ginger, curcuma, tumeric, broiler chicken, productivity, health performances

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Corresponding Author: Wasmen Manalu, Department of Anatomy, Physiology and Pharmacology, Faculty of Veterinary Medicine, Bogor Agricultural University, Jalan Agatis, Kampus IPB Darmaga, 16680 Bogor, Indonesia Tel: +62 8158848829 Fax: +62 251-8629462

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

INTRODUCTION

The poultry chickens industries are growing as part of global agribusiness in the world. Since 1990, the broilers production business is increasing in the world, especially in Asia. Broiler chickens have faster growth rates and development that can be harvested at the age of 30-35 days. In broiler chickens industries, feed is the most important part of the management systems[1]. Feed nutrients are substances required for growth and development of broiler chickens. In addition, the quality of nutrients used significantly affects the immunity and the health performances of broiler chickens.

Feed supplement and feed additive are nutrient substances used to improve the growth performances of broilers chickens. One of feed additives that are frequently used in broiler chicken is Antibiotic Growth Promoter (AGP)[2]. The administration of AGP in broiler chickens was reported to increase the bacterial resistance in human consuming the broiler's meat due to the residue of AGP in the broiler tissue[3]. The issues of antibiotic resistance make some countries to prohibit the use of AGP in broiler chickens and food producing animals. One of alternatives to substitute the use of AGP in animal husbandry to improve productivity and health performances is medicinal herb.

Indonesia has several traditional medicinal herbs that have been used by the society[4,5]. Traditionally, Indonesian people boil some medicinal herbs for curing many diseases, improving health quality and increasing the growth and development of their livestock. The single or combination of some medicinal herbs extracted in water is called Jamu. Our previous study shows that combination of ginger, curcuma and turmeric (called Jamu jahkenkun) increases productivity and physiological performances of broiler chickens[6]. Based on those results, the present experiment was conducted to study the effectiveness of Jamu with single composition of medicinal herb i.e., Jamu ginger or jahe (*Zingiber officinale*), Jamu curcuma or kencur (*Kaemferia galanga*) and Jamu turmeric or kunyit (*Curcuma domestica*) to increase productivity and health performances of broiler chickens.

MATERIALS AND METHODS

Preparation of broiler houses: This experiment was conducted in the Faculty of Veterinary Medicine, Bogor Agricultural University, Indonesia. The experimental broiler chickens were reared in broiler houses of Laboratory of Animal Management Unit and blood parameters were analyzed in the Laboratory of Physiology, Department of Anatomy, Physiology and Pharmacology. Two weeks before the experiment was conducted, the floor and wall of broiler's houses were cleaned from dust. Then, the wall and the floor were spread with limestone ($CaCO_3$) and sprayed by disinfectant as many as 3 times. One week before the experiment was conducted, the facilities of broiler's house were sterilized by using disinfectant.

Broiler chickens management: One hundred days old broiler chicks of strain Cobb were used in the experiment. At the age of 1 day, the broiler chicks were given sugar and salt water to stabilize their energy conditions. The experimental broiler chickens were vaccinated with ND-IB vaccines, Gumboro vaccines and ND Las Sota vaccines on days 3, 11 and 18, respectively. The compositions of feed used during the experiment were crude protein (20-22%), water (12%), ash (8%), crude fat (4-8%), crude fiber (4%), calcium (0.9-1.2%) and phosphor (0.7-1%).

Formulations of Jamu ginger, Jamu curcuma and Jamu turmeric: Formulations of Jamu ginger or jahe, Jamu curcuma or kencur and Jamu turmeric or kunyit were made with the same method and protocol. All of the formulations of Jamu were made 1 week before being administered to the experimental broiler chickens. Fresh medicinal herbs (ginger, curcuma and turmeric) were selected, cleaned, peeled and grated. The formulation of Jamu was made by mixing the grated medicinal herb (ginger or curcuma or turmeric) with distilled water. The ratio between grated medical herbs and distilled water were 1:1. Then, the mixtures of grated medicinal herbs and distilled water were heated at 60°C. The heating processes were repeated 3 times. Thereafter, the Jamu formulations were cooled in room temperature and filtered to collect the extract solutions. Finally, the Jamu formulations were stored in 4°C refrigerator until being used.

Treatment and data collection: At the age of 8 days, the experimental broiler chicks were administered with the experimental Jamu formulations through drinking water at a dose of 1 mL L^{-1} drinking water. The administration of Jamu formulations was conducted for 28 days until the age of 35 days. The experimental broiler chicks were assigned into a completely randomized design with 4 treatments, each with 25 replications. The 1st group was control group consisted of experimental broiler chicks without Jamu administration. The 2nd group consisted of experimental broiler chicks administered with Jamu ginger. The 3rd group consisted of experimental broiler chicks administered with Jamu curcuma. The 4th group consisted of experimental broiler chicks administered with Jamu turmeric.

The data were collected 1 day before treatment on 0 and 28 days after treatment on day 28th. Parameters measured were the productivity of broiler chicken, the functions of the kidney, the functions of the liver and hematological profile. The measured productivity parameters consisted of final body weight, daily Body Weight Gain (BWG), daily Feed Intake (FI), Feed Conversion Rate (FCR), mortality rate, Carcass Weight (CW), Abdominal Fat Weight (AFW), bile volume and liver weight. The parameters measured to evaluate the functions of the kidney were serum urea concentration, Blood Urea Nitrogen (BUN) concentration and creatinine concentration. Serum Glutamic Pyruvic Transaminase (SGPT) and Serum Glutamic Oxaloacetic Transaminase (SGOT) concentrations were measured to evaluate the functions of the liver. Hematogram profile consisted of total number of erythrocytes, hematocrit value, hemoglobin concentration, total number of leukocyte, heterophil, lymphocytes, monocytes, eosinophil and basophils.

Data analysis: Data were analyzed using ANOVA with a significance of $p<0.05$ on Minitab 16 software.

RESULTS

Productivity of broiler chickens: Final body weights, daily body weight gains, daily feed intakes and liver weights of the experimental broiler chickens administered with Jamu were similar to that of control ($p>0.05$). The weight of carcass in the experimental broiler chickens administered with Jamu curcuma, Jamu turmeric and Jamu ginger increased by 2.38, 1.98 and 8.21%, respectively, compared to control (Table 1). The experimental broiler chickens administered with Jamu ginger and Jamu turmeric had lower abdominal fat weight ($p<0.05$) compared to control broiler chickens and those administered with Jamu curcuma. The decrease in abdominal fat weight on experimental boiler chickens administered with Jamu ginger and Jamu turmeric were 1 and 28.07%, respectively, compared to control (Table 2). The formulation of Jamu curcuma and Jamu turmeric improved FCR by 19.52 and 14.76%, respectively, compared to control (Table 1). The experimental broiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric had lower mortality rate compared to control broiler chickens

Table 1: Feed consumption, growth, mortality, carcass weight, abdominal fat weight and liver weight of control and experimental broiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric

		Administration of Jamu (1 mL L^{-1} drinking water)		
Parameters	Control	Ginger	Curcuma	Turmeric
Final weight (g)	500.30±150.60[a]	1589.90±198.53[a]	1679.50±148.07[a]	1592.55±160.19[a]
Daily weight gain (g)	49.80±6.28[a]	53.80±7.18[a]	57.00±5.16[a]	53.60±6.88[a]
Daily feed intake (g)	94.20±41.18[a]	97.13±41.25[a]	100.30±46.13[a]	97.40±46.33[a]
Feed conversion ratio	2.10	2.12	1.69	1.79
Mortality (%)	20	4	4	12
Carcass weight (g)	1101.00±7.54[c]	1191.40±10.36[a]	1127.20±9.70[b]	1122.80±7.35[b]
Abdominal fat weight (g)	31.70±0.70[a]	28.50±0.33[b]	30.10±0.69[a]	22.80±2.89[c]
Liver weight (g)	36.00±2.33[a]	39.70±5.04[a]	35.70±5.88[a]	36.10±6.27[a]

[a,b]Different superscripts in the same row indicate a significant difference ($p<0.05$)

Table 2: Concentrations of serum urea, BUN, creatinine, SGPT and SGOT of control and experimental boiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric

			Administration of Jamu (1 mL L^{-1} drinking water)		
Parameters	Day post-treatment	Control	Ginger	Curcuma	Turmeric
Urea (mg dL^{-1})	0	15.40±0.57[a]	16.10±0.92[a]	16.00±1.44[a]	16.50±1.51[a]
	28	8.10±0.76[a]	8.20±0.98[a]	8.70±0.82[a]	12.40±2.03[b]
BUN (mg dL^{-1})	0	7.40±0.53[a]	7.40±0.53[a]	7.50±0.67[a]	7.70±0.71[a]
	28	3.80±0.35[a]	3.80±0.46[a]	4.10±0.38[a]	5.80±0.95[b]
Creatinine (mg dL^{-1})	0	0.20±0.06[a]	0.30±0.23[a]	0.40±0.46[a]	0.40±0.06[a]
	28	0.20±0.02[a]	0.20±0.12[a]	0.26±0.02[a]	0.29±0.05[a]
SGPT (U L^{-1})	0	19.50±1.50[a]	21.10±9.46[a]	15.40±7.35[a]	18.60±7.42[a]
	28	21.50±2.19[a]	27.70±15.14[a]	16.30±8.64[a]	19.70±9.69[a]
SGOT (U L^{-1})	0	101.80±14.15[a]	71.90±24.09[a]	95.20±4.85[a]	71.40±23.25[a]
	28	109.20±16.61[a]	104.30±15.31[a]	101.80±17.73[a]	113.00±21.97[a]

[a,b]Different superscripts in the same row indicate a significant difference ($p<0.05$)

Table 3: Erythrogram and leukogram profiles of the experimental broiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric on the beginning (day 0) and at the end (day 28) of the experiment

			Administration of Jamu (1 mL L^{-1} drinking water)		
Parameters	Day post-treatment	Control	Ginger	Curcuma	Turmeric
Total No. of erythrocyte ($\times 10^6$ mm^{-3})	0	2.20±0.14[a]	2.30±0.17[a]	2.90±0.73[a]	2.10±0.51[a]
	28	2.80±0.11[a]	2.90±0.19[a]	3.20±0.44[a]	2.60±0.25[a]
Hematocrit value (%)	0	17.10±1.94[a]	20.10±1.94[a]	19.10±3.93[a]	19.40±1.65[a]
	28	23.80±1.95[a]	23.10±1.71[a]	22.10±2.58[a]	21.20±2.57[a]
Hemoglobin levels (g%)	0	9.30±0.37[a]	9.40±1.27[a]	8.70±0.37[a]	9.40±0.86[a]
	28	13.00±0.73[a]	12.40±1.25[a]	10.98±2.01[a]	12.40±1.14[a]
Leukocyte ($\times 10^3$ cell μL^{-1})	0	5.64±0.26[a]	7.36±1.24[b]	5.24±1.16[a]	4.44±4.27[a]
	28	14.20±3.45[a]	11.20±6.39[a]	13.80±2.63[a]	17.20±3.17[a]
Heterophils ($\times 10^3$ cell μL^{-1})	0	17.20±4.54[a]	12.80±7.29[a]	15.40±1.81[a]	21.00±18.30[a]
	28	27.80±22.53[a]	24.80±14.06[a]	20.40±11.12[a]	27.00±14.14[a]
Lymphocytes ($\times 10^3$ cell μL^{-1})	0	69.40±32.50[a]	68.20±11.16[a]	88.40±6.54[a]	67.60±15.20[a]
	28	61.80±20.43[a]	68.20±14.13[a]	71.40±9.60[a]	66.00±18.54[a]
Monocytes ($\times 10^3$ cell μL^{-1})	0	6.80±2.86[a]	16.80±9.98[a]	5.80±7.25[a]	9.00±9.59[a]
	28	9.40±5.54[a]	7.00±1.22[a]	7.00±2.44[a]	5.40±2.96[a]
Eosinophil ($\times 10^3$ cell μL^{-1})	0	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
	28	0.00±0.00[a]	0.00±0.00[a]	1.00±1.41[a]	1.00±1.73[a]
Basophils ($\times 10^3$ cell μL^{-1})	0	0.40±0.89[a]	2.20±2.04[a]	0.60±0.54[a]	0.40±0.89[a]
	28	0.00±0.00[a]	0.00±0.00[a]	0.20±0.44[a]	0.40±0.54[a]

[a,b]Different superscripts in the same row indicate a significant difference ($p<0.05$)

without administration of Jamu. The mortality rate of the experimental broiler chickens administered with Jamu ginger, Jamu curcuma, Jamu turmeric and control broiler chickens without Jamu administration were 4, 4, 12 and 20%, respectively (Table 3).

Profiles of the kidney and the liver functions: The functions of the kidney and the liver were evaluated to explore the safety of Jamu ginger, Jamu curcuma and Jamu turmeric administrations in experimental broiler chickens. The functions of the kidney and the liver were evaluated based on the serum urea and BUN concentrations.

Before administration of Jamu formulations, all experimental broiler chickens had the same serum concentrations of urea, BUN, creatinine, SGPT and SGOT compared to control. On day 28 post-treatment, the experimental broiler chickens administered with Jamu turmeric had the highest serum urea and BUN concentrations. At the end of the experiment, the concentrations of creatinine, SGPT and SGOT in all experimental broiler chickens were similar ($p>0.05$).

The experimental broiler chickens administered with Jamu ginger, Jamu curcuma and Jamu turmeric had similar erythrogram and leukogram compared to control broiler chickens without Jamu administration. The administration of all Jamu on day 0 (at the beginning of the experiment) and day 28 (at the end of the experiment) did not affect the erythrogram and leukogram parameters.

DISCUSSION

The result of the present study shows that the experimental broiler chickens administered with Jamu ginger have the same final body weight, daily feed intake and FCR. However, the experimental broiler chickens administered with Jamu ginger have higher carcass weight and lower abdomen fat weight and mortality rate. Ginger contains several strong antioxidant compounds such as gingerol, gingerdiol and gingerdione[7] that can affect the parameters observed in the present experiment. The administration of ginger in broiler chickens is also reported to increase the growth rate and the status of antioxidant and decrease serum cholesterol concentration[8].

Supplementation of ginger powder in broiler feed increases growth performance, health status and carcass weight with a decrease in total serum cholesterol[9]. Previous study reports that the administration of ginger in the laying hens increases the egg production performances, antioxidant status and the quality of egg yolk[10]. Essential oil contained in ginger suppresses the number of pathogen bacterial in the intestine so that enhances the efficiency of feed digestion and nutrient absorption[11]. Formulation of ginger and garlic mixture decreases total cholesterol, triglyceride and abdominal fat without any change in haemogram parameters[12]. Generally, the administration of ginger improves production performances and health status of broiler chickens[13].

Therefore, the content of active substances in ginger can be used as a feed additive to improve productivity and health performances of broiler chickens.

The administration of Jamu curcuma also shows the same pattern of increased carcass weight, improved FCR and decreased mortality rate with a normal abdominal fat condition with the same final body weight and daily feed intake conditions. Curcuma potentially improves oxidant stability in broiler chickens by preventing the overproduction of reactive oxygen species[14]. Curcuma also increases the absorptive area of villus of the small intestine that eventually improves nutrients absorption in broiler chicken[15]. The antioxidant activity and improved feed digestion and nutrients absorption found in the previous studies strongly confirm that curcuma can be used to improve productivity and health performances of broiler chickens.

The administration of Jamu turmeric also increases carcass weight, improves FCR, decreases abdominal fat and decreases mortality rate of the experimental broiler chickens without changing final body weight and daily feed intake conditions. Turmeric contains curcumin that has activity as an antioxidant and anti-inflammation[16] that can improve the health of broiler. The antioxidant activity of curcumin protects the liver from aflatoxin exposure and increases liver function and broiler immunity[17].

Curcumin found in the turmeric powder is reported to have effects in increasing the width of intestine villus, improving nutrient absorption and enhancing body metabolism and lipolysis in the broiler chickens[15]. The other studies also reported that supplementation of turmeric increases carcass weight with a decrease in abdominal fat and total triglycerides contents[18,19]. The administration of turmeric does not significantly alter hematocrit value and decreases serum triglyceride, total cholesterol and LDL-cholesterol concentrations[20]. The supplementation of turmeric is shown to increase production performance and health status of broiler chickens[21]. The results found in the present experiment confirm that curcumin contained in the turmeric has a great potential to be used as a feed additive to improve production and health performances of broiler chickens.

CONCLUSION

Jamu ginger, Jamu curcuma and Jamu turmeric have great potential to be used as natural feed additives to improve productivity and health performances of broiler chickens.

SIGNIFICANCE STATEMENT

- The administrations of Jamu ginger, Jamu curcuma and Jamu turmeric have a great potential to be used to improve the growth and performances of poultry animals
- The experimental broiler chickens administered with Jamu ginger have higher carcass weight and lower abdominal fat weight and mortality rate
- The administration of Jamu curcuma also shows the same pattern of increased carcass weight, improved FCR and decreased mortality rate with a normal abdominal fat condition with the same final body weight and daily feed intake conditions
- The administration of Jamu turmeric also increases carcass weight, improves FCR, decreases abdominal fat and decreases mortality rate of the experimental broiler chickens without changing final body weight and daily feed intake conditions

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REFERENCES

1. Bell, D.D. and W.D. Weaver, 2002. Commercial Chicken Meat and Egg Production. 5th Edn., Springer, New York, USA., ISBN: 9780792372004, Pages: 1365.
2. Prabakaran, R., 2003. Good Practices in Planning and Management of Integrated Commercial Poultry Production in South Asia. Food and Agriculture Organization, Rome, Italy, ISBN: 9789251050095, Pages: 97.
3. Harrison, E.M., G.K. Paterson, M.T.G. Holden, J. Larsen and M. Stegger *et al.*, 2013. Whole genome sequencing identifies zoonotic transmission of MRSA isolates with the novel *mecA* homologue *mecC*. EMBO Mol. Med., 5: 509-515.
4. Wijayakusuma, H.M.H., 2000. Potensi tumbuhan obat asli Indonesia sebagai produk kesehatan. Di Dalam: Risalah Pertemuan Ilmiah Penelilian dan Pengembangan Teknologi Isotop dan Radiasi, Indonesia, Jakarta (ID), pp: 25-31.

5. Sitorus, H., M. Salim and L.P. Ambarita, 2011. Pola penggunaan tanaman obat tradisional di Desa Segara Kembang dan Desa Tungku Jaya di Kabupaten Ogan Komering Ulu. J. Pembangunan Manusia, 5: 1-12.
6. Andriyanto, I.M. Paramita, D.N. Aripin, P. Nugraheni and Z.U. Putri *et al*., 2016. Administration of *Jamu jahkenkun* to improve productivity and hematology profiles of broiler chickens. Int. J. Poult. Sci., 15: 126-133.
7. Kikuzaki, H. and N. Nakatani, 1996. Cyclic diarylheptanoids from rhizomes of *Zingiber officinale*. Phytochemistry, 43: 273-277.
8. Zhang, G.F., Z.B. Yang, Y. Wang, W.R. Yang, S.Z. Jiang and G.S. Gai, 2009. Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. Poult. Sci., 88: 2159-2166.
9. Zomrawi, W.B., K.A.A. Atti, B.M. Dousa and A.G. Mahala, 2013. The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks performance, carcass characteristic and serum constituents. J. Anim. Sci. Adv., 3: 42-47.
10. Zhao, X., Z.B. Yang, W.R. Yang, Y. Wang, S.Z. Jiang and G.G. Zhang, 2011. Effects of ginger root (*Zingiber officinale*) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poult. Sci., 90: 1720-1727.
11. Dieumou, F.E., A. Teguia, J.R. Kuiate, J.D. Tamokou, N.B. Fonge and M.C. Dongmo, 2009. Effects of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) essential oils on growth performance and gut microbial population of broiler chickens. Livest. Res. Rural Dev., Vol. 21, No. 8.
12. Ademola, S.G., G.O. Farinu and G.M. Babatunde, 2009. Serum lipid, growth and haematological parameters of broilers fed garlic, ginger and their mixtures. World J. Agric. Sci., 5: 99-104.
13. Mohamed, A.B., M.A.M. Al-Rubaee and A.Q. Jalil, 2012. Effect of ginger (*Zingiber officinale*) on performance and blood serum parameters of broiler. Int. J. Poult. Sci., 11: 143-146.
14. Zhang, J., Z. Hu, C. Lu, K. Bai, L. Zhang and T. Wang, 2015. Effect of various levels of dietary curcumin on meat quality and antioxidant profile of breast muscle in broilers. J. Agric. Food Chem., 63: 3880-3886.
15. Rajput, N., N. Muhammah, R. Yan, X. Zhong and T. Wang, 2013. Effect of dietary supplementation of curcumin on growth performance, intestinal morphology and nutrients utilization of broiler chicks. J. Poult. Sci., 50: 44-52.
16. Masuda, T., A. Jitoe, J. Isobe, N. Nakatani and S. Yonemori, 1993. Anti-oxidative and anti-inflammatory curcumin-related phenolics from rhizomes of *Curcuma domestica*. Phytochemistry, 32: 1557-1560.
17. Yarru, L.P., R.S. Settivari, N.K.S. Gowda, E. Antoniou, D.R. Ledoux and G.E. Rottinghaus, 2009. Effects of turmeric (*Curcuma longa*) on the expression of hepatic genes associated with biotransformation, antioxidant and immune systems in broiler chicks fed aflatoxin. Poult. Sci., 88: 2620-2627.
18. Emadi, M. and H. Kermanshahi, 2006. Effect of turmeric rhizome powder on performance and carcass characteristics of broiler chickens. Int. J. Poult. Sci., 5: 1069-1072.
19. Nouzarian, R., S.A. Tabeidian, M. Toghyani, G. Ghalamkari and M. Toghyani, 2011. Effect of turmeric powder on performance, carcass traits, humoral immune responses and serum metabolites in broiler chickens. J. Anim. Feed Sci., 20: 389-400.
20. Kermanshahi, H. and A. Riasi, 2006. Effect of turmeric rhizome powder (*Curcuma longa*) and soluble NSP degrading enzyme on some blood parameters of laying hens. Int. J. Poult. Sci., 5: 494-498.
21. Al-Sultan, S.I., 2003. The effect of *Curcuma longa* (Tumeric) on overall performance of broiler chickens. Int. J. Poult. Sci., 2: 351-353.