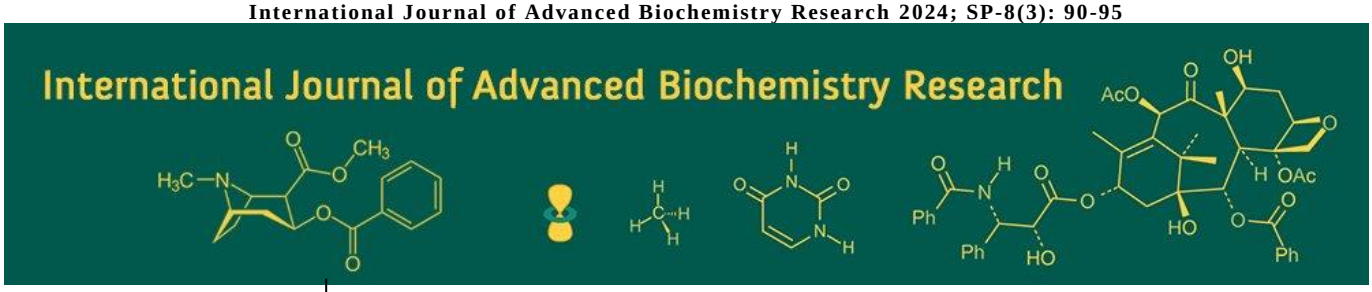

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Effect of feeding ginger (*Zingiber officinale*) powder on haematological parameters and serum lipid profile of broiler chicken

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Abstract
The study utilized one hundred and eighty- day-old commercial broiler chicks of the Ven Cobb Strain. They were divided into four experimental groups: a control group and three treatment groups, with each group having three replicates consisting of fifteen chicks each. The chicks were housed in floor pens with ad libitum access to feed and water throughout the duration of the trial. Four experimental diets were formulated: T_0, representing the standard broiler ration; T_1, incorporating 0.5% ginger powder; T_2, containing 1% ginger powder; and T_3, comprising 1.5% ginger powder. These dietary formulations were prepared in accordance with the standards outlined in the Bureau of Indian Standards (1992). The investigation revealed no significant differences in blood haemoglobin and erythrocyte count among the experimental groups. The white blood cell (WBC) count was recorded as 17.25, 25.05, 27.40, and 23.55 x 103/µl in the T_0, T_1, T_2, and T_3 groups respectively. Broilers in the T_2 group exhibited significantly higher packed cell volume (PCV %) compared to the T_0, T_1, and T_3 groups ($p<0.05$). Additionally, the T_2 group demonstrated significantly lower cholesterol content compared to the T_0, T_1, and T_3 groups ($p<0.05$). Serum triglyceride levels were significantly lower in the T_1 group (25.76 mg/dl) followed by T_0 (77.17 mg/dl), T_2 (62.82 mg/dl), and highest in the T_3 group (92.39 mg/dl) ($p<0.05$). The cost of feed per kilogram of live weight gain was highest for the T_3 group (Rs. 51.37), followed by T_0 (Rs. 48.13), T_1 (Rs. 46.54), and lowest for the T_2 group (Rs. 46.23). The net profit per bird was highest in the T_2 group (Rs. 29.70), followed by T_1 (Rs. 27.83), T_0 (Rs. 21.49), and lowest in the T_3 group (Rs. 17.11). Thus, it can be concluded that incorporating one percent ginger powder in the broiler diet enhances overall performance and profitability.

Keywords: Broiler, ginger powder, haematology, serum lipids, economics

Introduction
Feed additives have been recognized to enhance growth rate, optimize feed conversion efficiency, and enhance nutrient metabolism (Church and Pond, 1988) [8]. A diverse array of compounds are incorporated into feed additives, encompassing growth enhancers and prophylactic agents. These encompass probiotics, antibiotics, coccidiostats, antioxidants, enzymes, hormones, buffers, organic acids, mold inhibitors, herbal remedies, synthetic micronutrients, among others. Antibiotic-based growth promoters have come under significant scrutiny and raised widespread concerns, primarily due to studies revealing their adverse effects, including the development of microbial resistance and potential human health hazards (Rahmatnejad *et al*., 2009) [17]. Researchers in the field of poultry science are actively seeking safer alternatives to antibiotics, such as growth enhancers that do not pose risks to chicken or human health. Over the past decade, there has been a growing focus on the utilization of natural herbs and medicinal plants as feed additives to maximize chicken production potential (Khan *et al*., 2012) [11]. The potential of herbal compounds to serve as safer alternatives to conventional growth promoters is plausible due to their suitability, palatability, cost-effectiveness, low toxicity profile, and minimal health risks. Several herbal additives contain components that stimulate the synthesis of digestive enzymes, thereby enhancing digestion and appetite (Baretto *et al*., 2008) [6]. Additionally, these additives act as immunostimulants without compromising growth (Nidaullah *et al*., 2010) [14]. Notable herbal feed supplements include thyme, ginger, garlic, fenugreek, among others.

Ginger exhibits anti-hypercholesterolemic properties, effectively reducing blood cholesterol levels (Zomrawi *et al*. 2012) [22].

Ginger comprises various active compounds, including gingerol, shogaols, gingerdiol, and gingerdione, contributing to its diverse benefits such as cholesterol reduction, hence its increasing popularity (Kikuzaki and Nakatani, 1996) [12]. The overarching objective is to enhance the nutritional quality of animal products while maintaining their current production levels (meat, milk, or eggs).

Ginger, a rhizome with multifaceted therapeutic properties, emerges as a promising candidate. Various formulations, doses, and durations of ginger supplementation have been explored in broilers and layers (Khan *et al*., 2012) [11]. Combining garlic and ginger resulted in enhanced chick development and significant reductions ($p<0.001$) in blood triacylglycerol, total and LDL cholesterol, and abdominal fat pad accumulation (Ademola *et al*., 2009) [1]. Thus, the purpose of the current experimental project was to investigate the effects of powdered ginger (*Zingiber officinale*) on serum lipid profiles, haematological markers, and the economics of producing broilers.

Materials and Methods

In this study, hematological parameters (hemoglobin, red blood cell count, white blood cell count, and packed cell volume) and lipid profile (cholesterol, triglycerides, high-density lipoprotein, and low-density lipoprotein) were evaluated to assess the impact of incorporating ginger powder into the diets of broiler chickens as a herbal feed additive. The experiment titled "Effect of dietary supplementation of ginger (*Zingiber officinale*) powder on hematological parameters and serum lipid profile of broiler chickens" was conducted by the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Maharashtra Animal and Fishery Sciences University (MAFSU), Parbhani, Maharashtra State, India, to investigate this relationship.

Procurement of feed ingredient

The ginger powder was purchased from local market.

Experimental birds

At the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Maharashtra Animal and Fishery Sciences University (MAFSU), Parbhani, 180-day-old Vencobb straight run commercial broiler chicks were utilized for a 42-day (6-week) trial. These chicks were procured from M/s Yogeshwari Hatcheries PVT. LTD., located in Jaynagar, Parli Vaijnath, Dist. Beed, Maharashtra. Upon arrival, individual chick weights were recorded, and they were then randomly allocated into three treatment groups (T_1, T_2, and T_3), each comprising three replicates of fifteen chicks, ensuring equal initial body weights among the groups. The total birds were allocated to different treatment groups are presented in Table 1.

Table 1: Experimental details

Sr. No.	Treatment group	Treatment details	Replicates	No. of birds in each replicate	Average body weight (g)
1	T_0	Standard broiler ration	3	15	45.79±0.11
2	T_1	Standard broiler ration + ginger powder @ 5 g/kg feed	3	15	45.13±0.43
3	T_2	Standard broiler ration + ginger powder @ 10 g/kg feed	3	15	45.41±0.10
4	T_3	Standard broiler ration + ginger powder @ 15 g/kg feed	3	15	44.99±0.10

Housing and management

Prior to the arrival of the broiler chicks, sanitation measures were implemented, involving cleaning, washing, disinfection, and fumigation of the floor, pens, waterers, feeders, and brooders. Rice husk and sawdust were utilized as litter materials in the deep litter system housing the birds. Consistent management practices, including feeding, watering, and lighting, were uniformly applied to all experimental groups throughout the duration of the trial.

Each of the four pens allocated for housing the experimental chicks possessed a floor area measuring one square foot. Within each pen, three replicates were established, with each containing fifteen birds assigned to different treatment groups. Electric hover brooders served as the primary heat source for brooding, providing both light and warmth. Brooding conditions were sustained within the respective pen for each replication and treatment group until the chicks reached two weeks of age. Subsequently, all birds were provided with adequate nighttime lighting. During the course of the experiment, the experimental birds were offered fresh, clean, and chilled drinking water ad libitum. Upon arrival at the hatchery on their first day of life, all experimental chicks were administered vaccinations against Marek's disease. Additionally, vaccinations for Newcastle disease were administered on days seven and eight, followed by vaccinations for Gumboro disease on days fourteen and twenty-four.

Diets and feeding regime

The required feed ingredients for the experiment were procured in bulk from a nearby market, and diets were formulated in the college's feed mixing facility as per the specifications outlined in Table 2. During the initial two days post-hatch, all broiler chicks were provided with ground maize. Subsequently, they were transitioned to an experimental feed formulated in accordance with the Bureau of Indian Standards (BIS) guidelines until day 42. All groups were provided with their respective diets without any imposed restrictions. Ginger powder was incorporated into the diets of the T_1, T_2, and T_3 treatment groups at concentrations of 5g/kg, 10g/kg, and 15g/kg, respectively, during the feed preparation process. Consistently, each treatment group received the same pre-measured quantity of ration daily.

Table 2: Percent composition of experimental rations

Sr. No.	Particulars	Control Group	
		Starter	Finisher
1.	Maize	52.8	60.3
2.	Soyabean meal	36	28.85
3.	Meat bone meal	3.5	3.1
4.	Vegetable oil	1	1
5.	Methionine	0.9	0.8
6.	Lysine	1.2	1.2
7.	Limestone powder	1.65	1
8.	Di-Calcium Phosphate	1.5	1.5
9.	Salt	0.4	0.4
10.	Trace Mineral Mix.	0.4	0.4
11.	Vitamin Mix.	0.3	0.3
12.	Choline choride	0.15	0.15
	Total	100	100
	Protein	23.06	20.09
	M.E.Kcal/Kg	2800.14	2899.65
	E:P ratio	121.59:1	145.17:1

Observations recorded

Haematological Parameter

Hematological evaluations were performed at the conclusion of the sixth week of the experimental period. Diagnostic kits obtained from M/s Moreshwar Specialty Pathology Laboratory were utilized to assess hematological parameters. The manufacturer of the analyzer system provided recommendations for the technique and reagent set used for each parameter. Details regarding the estimation techniques employed were provided.

Collection of Blood

At the conclusion of the sixth week, blood samples were randomly collected from two birds within each duplicate group. Vacuum tubes containing potassium salts of ethylene diamine tetra acetate (EDTA) were utilized to draw three milliliters of blood from the wing vein as an anticoagulant. Hematological assessments were conducted by Moreshwar Specialty Pathology Laboratory in Parbhani.

Haematological Estimation

a) Haemoglobin: The cyanmethaemoglobin technique was used to measure the haemoglobin content of blood (Martha *et al*., 2012).

b) Red Blood Cells: Red blood Cell was estimated by using haemocytometer.

c) White Blood Cells: White blood Cell was estimated by using haemocytometer.

d) Packed Cell Volume: Packed cell volume was determined by Wintrobe microhaematocrit method (Martha *et al.*, 2012).

Lipid Profile

Biochemical analyses were performed at the termination of the sixth week of the study. Diagnostic kits supplied by M/s Moreshwar Specialty Pathology Laboratory in Parbhani were employed for estimating biochemical parameters. The Systronics Clinical Analyzer 636 was utilized for conducting the biochemical assessments. The manufacturer's instructions for the analyzer system were adhered to regarding the technique and selection of reagents for each parameter. The employed estimating techniques are detailed below.

Collection of Blood

At the termination of the sixth week, blood samples were obtained from two birds within each replication group. Two clot activator tubes were utilized to collect three milliliters of blood drawn from the wing vein using a syringe without the addition of an anticoagulant. Subsequently, after a three-hour period, well-drawn and clear serum samples were carefully transferred into clean and dry Eppendorf tubes. These samples were then stored in a deep freezer at -20°C until the time of biochemical analysis. Biochemical values of blood serum were estimated using calorimetric methods with commercial kits.

Biochemical Estimations

a) Serum Cholesterol: Serum cholesterol was estimated by cholesterol oxidase/peroxidase method.

b) Serum Triglycerides: Serum triglyceride was estimated by glycerol 3 phosphate oxidase/peroxidase method (Trinder 1960) [20].

c) Serum HDL: Serum high density lipoprotein was estimated by cholesterol oxidase/peroxidase method.

d) **Serum LDL:** Serum low density lipoprotein was estimated by cholesterol oxidase/peroxidase method.

Economics of broiler production

The total expenses incurred during the experimental period for raising the chicks were determined by considering the cost of acquiring the chicks, the total expenditure on feed consumed by the birds, the cost of litter, vaccination expenses, and medication costs. However, labor costs were omitted as the experiment was conducted by students. The mean cost of feed per chick was calculated using market prices for feed on a per kilogram basis, which incorporated the cost of the ginger infusion. The gross revenue per chick was determined based on the prevailing market rate per kilogram of live bird.

Chemical Analysis

The chemical analysis of the experimental broiler rations were carried out as per AOAC (1995) [5] for all the proximate principles.

Statistical Analysis

According to Snedecor and Cochran (1994) [19], the Complete Randomised Design (CRD) approach was used to statistically analyse the data gathered during this experiment. Week and treatment were considered as the two factors.

Results and Discussion

Proximate composition of experimental broiler ration

Broiler starter ration

Table 3 displays the composition of the experimental ration that underwent analysis. The data in Table 3 indicate that the experimental broiler starter feed provided adequate nutrient levels for growth, as per the standards outlined by the Bureau of Indian Standards (1992) [7] for broilers.

Table 3: Percent chemical composition of experimental starter ration on dry matter basis

Nutrients	Percent in ration			
	T_0 (control)	T_1	T_2	T_3
Crude protein	23.18	23.30	22.12	22.24
Crude fibre	2.85	2.61	2.55	2.20
Ether extract	3.36	3.52	3.40	3.56
Total ash	6.10	6.61	6.97	6.13
Acid insoluble ash	1.90	1.76	1.83	1.80
Nitrogen free extract	64.60	64.96	63.87	63.03
Calcium	1.09	1.11	1.12	1.10
Phosphorus	0.60	0.86	0.91	0.90
ME Kcal/kg	2822.50	2820.50	2795	2785

Broiler finisher ration

Table 4 provides the percentage composition of the experimental grill finisher ration. The data presented in Table 4 indicate that the experimental broiler finisher ration contains sufficient nutrients for growth, consistent with the guidelines established by the Bureau of Indian Standards (1992) [7] for broilers.

Table 4: Percent chemical composition of experimental finisher ration on dry matter basis

Nutrients	Percent in ration			
	T_0 (control)	T_1	T_2	T_3
Crude protein	20.30	20.27	20.19	20.28
Crude fibre	3.20	3.43	3.45	3.53
Ether extract	3.44	3.27	3.40	3.36
Total ash	6.30	6.31	6.09	6.90
Acid insoluble ash	2.05	2.15	2.10	2.12
Nitrogen free extract	66.76	66.84	67.79	67.02
Calcium	1.07	1.16	1.14	1.17
Phosphorus	0.62	0.97	0.96	0.99
ME Kcal/kg	2910.15	2918.05	2896.50	2896.10

Haematological Parameters

At 42 days of age, the mean blood parameters of broiler chickens were assessed, encompassing measurements of hemoglobin (Hb), erythrocyte count (RBC), leukocyte count (WBC), and packed cell volume (PCV). The values obtained are presented in Table 5. Analysis of variance indicated non-significant variations in blood Hb concentration levels and packed cell volume (PCV) percentages across different dietary regimens.

The ginger powder supplementation at 1% in the T_2 group resulted in the lowest red blood cell (RBC) count (2.30x10^6/µl), followed by the T_3 group at 1.5% (2.46x10^6/µl), the control group (T_0) (2.53x10^6/µl), and the T_1 group at 0.5% supplementation (2.59x10^6/µl). White blood cell (WBC) counts were measured at 17.25, 25.05, 27.40, and 23.55x10^3/µl in the T_0, T_1, T_2, and T_3 treatment groups, respectively. Significant differences (p<0.05) were observed among treatments, indicating that ginger powder supplementation influenced the values of these parameters.

Table 5: The values obtained are presented

Parameter	Treatments Groups				
	T_0	T_1	T_2	T_3	CD
Hb (g/dl)	8.3±0.70	8.0±0.27	8.7±0.42	8.4±0.39	NS
RBC (x10^6/µl)	2.53±0.17	2.59±0.19	2.30±0.15	2.46±0.23	NS
WBC (x10^3/µl)	17.25^{b}±0.67	25.05^{a}±1.96	27.40^{a}±0.94	23.55^{a}±8.92	3.860
PCV %	25.88^{b}±0.37	28.85^{ab}±0.70	31.20^{a}±1.70	30.05^{a}±10.74	3.259

NS- non significant

Note: The means bearing different superscript (a, b and ab) in the row differ significantly (p<0.05)

The present findings align with those of Al-Moramadhi (2010) [3], who reported a significant (p<0.05) increase in packed cell volume in the group supplemented with powdered ginger. However, the observed results for hemoglobin concentration in the current study were not consistent with the findings of Al-Moramadhi (2010) [3], who reported a considerable (p<0.05) enhancement in hemoglobin concentration with the addition of ginger roots to the diet. Moreover, the current findings are not in accordance with those of Zomrawi *et al*. (2012) [22] and Zomrawi *et al*. (2013) [23], who reported that the administration of ginger root powder did not significantly alter blood parameters such as packed cell volume, hemoglobin concentration, and red blood cell count.

Lipid Profile

Table 6 presents the mean serum cholesterol, triglyceride, HDL cholesterol, and LDL cholesterol levels in broilers at 42 days of age, influenced by the inclusion of ginger powder in their diet. The groups with the lowest serum cholesterol values were the T_2 group at 1% supplementation (64.68 mg/dl), followed by the T_1 group at 0.5% supplementation (70.74 mg/dl), the control group (T_0) (98.71 mg/dl), and the T_3 group at 1.5% supplementation (131.24 mg/dl). The serum triglyceride levels in the T_0, T_1, T_2, and T_3 treatment groups were 44.17, 25.76, 62.82, and 92.39 mg/dl, respectively.

At 42 days of age, the mean blood HDL levels were 66.02 mg/dl for treatment T_1, 63.22 mg/dl for T_2, 64.27 mg/dl for T_3, and 55.47 mg/dl for the control group T_0. Analysis of variance indicated no significant change in blood HDL-cholesterol levels across treatments. However, there was a notable (p<0.05) decrease in LDL-cholesterol levels across the treatment groups. The current findings demonstrate a significant (p<0.05) reduction in cholesterol concentration in T_1 and T_2 when medicinal plants were added to the grill feed, leading to a decrease in serum cholesterol levels.

The findings of several other authors support the current results (Rafiee *et al*., 2014; Rafiee *et al*., 2013; AL-Moramadhi, 2010; Saeid *et al*., 2010) [16, 15, 3, 18]. The present results align with previous research conducted by Saeid *et al*. (2010) [18], which demonstrated a significant (p<0.05) reduction in total cholesterol and triglyceride levels and an increase in HDL cholesterol levels with ginger extract supplementation. This study's findings are partially consistent with those of Al-Moramadhi (2010) [3], who reported a significant (p<0.05) reduction in cholesterol levels with the administration of powdered ginger roots.

Table 6: Lipid Profile of Experimental Birds

Parameter	Treatments Groups				CD
	T_0	T_1	T_2	T_3	
Cholesterol (mg/dl)	98.71^{b}±8.71	70.74^{c}±4.68	64.68^{c}±8.22	131.24^{a}±8.53	22.768^{**}
Triglyceride (mg/dl)	44.17^{c}±1.13	25.76^{d}±2.98	62.82^{b}±4.89	92.39^{a}±6.05	12.397^{**}
HDL (mg/dl)	55.47±1.50	63.22±4.00	64.27±2.88	66.02±2.63	NS
LDL (mg/dl)	45.64^{b}±1.29	49.62^{a}±0.88	44.54^{b}±1.22	42.98^{b}±0.95	3.240^{*}

NS- non significant

Note: The means bearing different superscript (a, b and c) in the row differ significantly *(p<0.05) ** (p<0.01)

Economics of broiler production

When assessing the profitability and expenses, three dietary treatment groups and the total feed consumption by broilers under control were considered. Additional costs associated with day-old chick acquisition, medications, vaccinations, and litter supplies were allocated among all treatment groups and the control group. However, as this was a postgraduate research project, expenses related to labor, power, and other overhead costs were not factored into the economic evaluation of broiler production. The feed costs per kilogram were Rs. 26.92, 28.52, 30.12, and 31.72 for the control, T_1, T_2, and T_3 groups, respectively. The net profit per bird for the treatment groups T_1, T_2, T_3, and control were Rs. 21.49, 27.83, 29.70, and 17.11, respectively. Among the treatment groups, those receiving T_2 had the highest net profit per bird (Rs. 29.70), following treatments T_1, T_0, and T_3. The calculations for profit or loss per bird for various treatments accounted for factors such as chick cost, average feed intake per bird, medication costs, vaccination expenses, etc., taking into consideration the average body weight and the average price obtained.

The production costs per bird were observed to be lowest in the control group (Rs. 122.94) and highest in the T_3 group (Rs. 136.03). Following treatments T_1 (Rs. 27.83), control T_0 (Rs. 21.49), and T_2 (Rs. 29.70), the T_3 group exhibited the lowest net profit per bird (Rs. 17.11). The findings indicate that the T_2 treatment group (diet incorporating 1% ginger powder) was the most economically favorable, followed by the T_1 treatment group (diet containing 0.5% ginger powder), the control group (T_0), and the T_3 treatment group (diet containing 1.5% ginger powder) as the least profitable group. Thus, the economic outcomes of the different treatment groups were significantly influenced by ginger powder supplementation, particularly a diet containing 1% ginger powder. It can be inferred that the dietary group containing one percent powdered ginger, denoted as T_2, exhibited the highest returns per bird. Despite T_1 and T_2 having lower feed costs per kilogram of live weight gain compared to T_3, overall. These results are partially consistent with the findings of Arshad *et al*. (2012) [4], Elmakki *et al*. (2013) [9], and Nidaullah *et al*. (2010) [14].

Conclusion

The study titled "Effect of feeding ginger (*Zingiber officinale*) powder on hematological parameters, serum profile, and economics of broiler chicken" was conducted to assess the impact of ginger (*Zingiber officinale*) powder on lipid profile, broiler production economics, and hematological parameters. The inclusion of ginger (*Zingiber officinale*) powder in the diet led to a significant reduction in serum cholesterol levels of broiler chickens. Addition of one percent powdered ginger (*Zingiber officinale*) to the diet was found to be a cost-effective intervention.

References

1. Ademola SG, Farinu GO, Babatunde GM. Serum lipid, growth, and haematological parameters of broilers fed garlic, ginger, and their mixtures. World J Agric Sci. 2009;5(1):99-104.
2. Allian CC. Clin Chem. 1974;20:471.
3. AL-Moramadhi SAH. The effect of Zingiber Officinali roots infusion on some physiological parameters in broiler chickens. Kufa J Vet Med Sci. 2010;1(2):67-76.
4. Arshad M, Kakar AH, Durrani FR, Akhtar A, Shakirullah, Sanaullah, Niamatullah M. Economical and immunological impact of ginger extract on broiler chicks. Pak J Sci. 2012;64(1):46-48.
5. A.O.A.C. Association of Official Analysis Chemist. Official method of analysis. 16th ed. Washington, D.C.: A.O.A.C.; 1995.
6. Barreto MSR, Menten JFM, Racanici AMC, Pereira PWZ, Rizzo PV. Plant extracts used as growth promoters in broilers. Braz J Poult Sci. 2008;10:109-115.
7. Bureau of Indian Standards (BIS). Indian Standard poultry feed specification. IV Revision. New Delhi: Manak Bhavan; c1992.
8. Church DC, Pond WG. Basic animal nutrition and feeding. 3rd ed. New York, NY: Wiley; 1988. pp:267-275.
9. Elmakki AM, Abdelatti KA, Dousa BM, Elagib HAAA, Malik HEE, Elamin KM. Effects of dietary ground ginger (*Zingiber officinale*) root additive on broiler performance. 2013;1(1):76-83.
10. Jacobe NJ, Van Demark PJ. Arch Biochem Biophys. 1960;88:250.
11. Khan RU, Naz S, Nikousefat Z, Tufarelli V, Javdani M, Qureshi MS, Laudadio V. Potential applications of ginger (*Zingiber officinale*) in poultry diets. World's Poult Sci J. 2012;68:245-252.
12. Kikuzaki H, Nakatani N. Cyclic diarylheptanoids from rhizomes of *Zingiber officinale*. Phytochemistry. 1996;43:273-277.

13. Martha DO, Adetokundo SA, Olabanji OS, Takpejewho EG, Sunday OT. The effect of supplementation of enzyme on performance and some blood chemistry parameters in broiler finisher chickens fed ginger by-product meal (*Zingiber officinale*). Int J Biosci. 2012;2(7):59-65.
14. Nidaullah H, Durrani FR, Ahmad S, Jan IU, Gul S. Aqueous extract from different medicinal plants as anticoccidial, growth promotive, and immunostimulant in broilers. ARPN J Agric Biol Sci. 2010;1(5):53-55.
15. Rafiee A, Rahimian Y, Zamani F, Asgarian F. Effect of use ginger (*Zingiber officinale*) and thymus (Thymus vulgaris) extract on performance and some hematological parameters on broiler chicks. Sci Agri. 2013;4(1):20-25.
16. Rafiee A, Kheiri F, Rahimian Y, Faghani M, Valiollahi MR, Miri Y. The effect of ginger root (*Zingiber officinale*) and cumin (*Cuminum cyminum*) powder on performance, some haematological traits and intestinal morphology of broiler chicks. Res Opin Anim Vet Sci. 2014;4(2):96-100.
17. Rahmatnejad E, Roshanfekr H, Ashayerizadeh O, Mamooee M, Ashayerizadeh A. Evaluation the effect of several non-antibiotic additives on growth performance of broiler chickens. J Anim Vet Adv. 2009;8(9):1757-1760.
18. Saeid JM, Mohamed AB, AL-Baddy MA. Effect of aqueous extract of ginger (*Zingiber officinale*) on blood biochemical parameters of broiler. Int J Poult Sci. 2010;9(10):944-947.
19. Snedecor GW, Cochran WS. Statistical Methods. 8th ed. Colcatta: Oxford and IBH Publishing Co.; 1994.
20. Trinder P. Amn Clin Biochem. 1960;6:24.
21. Warner M, Gabrielson DG, Eastman G. Clin Chem. 1981;27:268.
22. Zomrawi WB, Abdelatti KA, Dousa BM, Mahala AG. The effect of ginger root powder (*Zingiber officinale*) supplementation on broiler chicks performance, blood and serum constituents. Online J Anim Feed Res. 2012;1(6):457-460.
23. Zomrawi WB, Abdelatti KA, Dousa BM, Mahala AG. The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks performance, carcass characteristic and serum constituents. J Anim Sci Adv. 2013;3(2):42-47.