EPH - International Journal of Agriculture and Environmental Research
ISSN (Online): 2208-2158
Volume 03 Issue 01 June 2017

DOI: https://doi.org/10.53555/eijaer.v4i1.23

EFFECT OF GINGER (*ZINGIBER OFFICINALE*) AND GARLIC (*ALLIUM SATIVUM*) ON PRODUCTIVE PERFORMANCE AND HEMATOLOGICAL PARAMETERS OF BROILER

Belal SA[1]*, MN Uddin[2], MK Hasan[3], MS Islam[4] and MA Islam[5]
*[1]*Department of Poultry Science, Sylhet Agricultural University, Sylhet-3100, Bangladesh*
[2]*Department of Livestock Production and Management, Sylhet Agricultural University, Sylhet- 3100, Bangladesh*
[3]*Department of Physiology and Pharmacology, Bangabandu Sheikh Mujibur Rahman Agricultural University, Bangladesh*
[4]*Livestock Research Institute, Dhaka, Bangladesh*
[5]*Equal contribution in this manuscript*

Corresponding Author:-
Email: sabelal.sau@gmail.com

Abstract:-

The present study was carried out to investigate the effect of ginger and garlic on the productive performance, carcass characteristics and hematological parameters of broilers. Ginger and garlic were provided alone and combination of both through the diet and drinking water in the form of powder and infusion respectively. A total of 200 one-day-old Cobb-500 straight-run broiler chicks were randomly allocated to five experimental treatments with four replications of 10 chicks per replicate (n=40). Treatments were: T_0 (control group without test ingredients), T_1 and T_2 : (birds received 15 g kg^{-1} of ginger and garlic in powder form in feed) T_3 and T_4 : (birds received 15 g kg^{-1} of ginger and garlic combination in powder form in feed and in water based infusion at 50 ml L^{-1} of drinking water respectively). Blood samples were collected on 21 and 35th day post feeding from 5 birds per replication for hematological parameters analysis. At the end of trial, 20 birds from each treatment (5 birds per replicate) were slaughtered for the determination of carcass characteristics. Ginger and garlic had significantly improved ($p<0.05$) on body weight (BW), feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) on 14, 21, 28, 35th d of experiment respectively. The usage of the test ingredients had a significant effect ($p<0.05$) on carcass weight, abdominal fat and dressing percentage except proximate components of breast and thigh muscle. A better performance was observed when chicks were fed in powder form than those fed the water based infusion. Significant variations ($p<0.05$) existed among the treatments in mean hematological parameters total erythrocyte count (TEC), hemoglobin (Hb), total leukocyte count (TLC), packed cell volume (PCV), erythrocyte sedimentation rate (ESR), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) respectively. However, there was no significant effect of ginger and garlic on MCV at 21 d and heterophil, basophil at 35 d. Substantial positive affect was observed on broilers performance when ginger and garlic were fed in powder form without any adverse effect and boosted their traits monitored as well as general well-being.

Keywords: - *Garlic, Ginger, Performance, Hematological parameter, Carcass quality, Broilers.*

INTRODUCTION

Poultry industry can harvest first class protein for human nutrition as well as a source of revenue in many countries and also play an important role in economic growth of any country (Tarhyel *et al.,* 2012). In Bangladesh, demand of broiler meat is increasing rapidly because of increased income, population growth and urbanization. Thus, broiler farming seems to be a substantial part of meat production and consumption in the country. Broiler production has grown rapidly in the past two decades; these improvements are mostly due to numerous researches which further enhanced the feed utilization and growth rate. Feed is the key constituent of overall costs of poultry farming responsible for about 80% of the total expenses (Asghar *et al.,* 2000). But broiler entrepreneurs are always interested approaches for better growth and economic production. The awareness in feed additives flourished over the last decade of the past century. The feed additives which help in improving the efficiency of feed utilization and ensuring more net return and minimizing the feed cost are the main challenges, for which many research strategies have been trying to address through the supplementation of feed additives in the diets of broiler chicken. Antimicrobial compounds produced by microorganisms (Barragry and Powers, 1994) and antibiotic based growth promoters (Sojoudi *et al.,* 2012) have been commonly used as feed additives for many years. In the past, antibiotics were the utmost regularly used as feed additives to improve the meat and egg production. However, the use of antibiotics is facing serious criticism (Iji *et al.,* 2001) and restricted due to drug residue in carcass and also modification of natural gut micro flora (Botsoglou *et al.,* 2002). Recently many countries banned the use of antibiotics because of their harmful side effects and increased awareness about the alternatives of antibiotics such as, herbs and medicinal plants to eliminate these threats (Manseh *et al.,* 2012). Now a days, to overcome the poor performance and antibiotic resistance, attempts were made to explore the natural growth promoters (probiotics, prebiotics or there combination and medicinal plants as feed additives). Nutritionists are shifting their attention from the utilization of chemical to phytogenic growth promoters in recent years (Iji *et al.,* 2001). Ginger and garlic can be used as good alternatives for common artificial growth promoters like antibiotics (Demir *et al.,* 2003).

Ginger is the rhizome of the plant (*Zingiber officinale*), consumed as a delicacy, medicine, or spice. Ginger contains several enzymes including gingerdiol, gingerol, gingerdione and shogaols (Rivlin, 2001; Zhao *et al.,* 2011) and preliminary research indicates nine compounds that bind to serotonin receptors which influenced the gastrointestinal function[5]. These compounds have been reported to have antimicrobial, antioxidative and pharmacological effects (Al-Amin *et al.,* 2006; Tapsell *et al.,* 2006; Ali *et al.,* 2008). According to Al-Amin *et al.* (2006) *in vitro* tests showed that ginger extract might regulate the quantity of free radicals and the peroxidation of lipids and have anti-diabetic properties. Ginger has useful pharmacological potent chemical substances for use in poultry. Rivlin, (2001) also demonstrated that gingerols increased the gastrointestinal motility and had antibacterial properties in laboratory animals.

Garlic (*Allium sativum)* has been used as spice and primitive medicine. It has possessed antibacterial, antifungal, antiparasitic, antiviral, antioxidant, anti-cholesteremic and vasodilator characteristics (Khan *et al.,* 2007; Hanieh *et al.,* 2010). Garlic has biologically active compounds like sulfur containing compounds (Alliin, Allicin and Diallylsulfides) that act as antimicrobial effects against many viruses, bacteria, fungi, parasites and antioxidant, antithrombotic and vasodilator characteristics. Allicin, obtained from garlic, rapidly decomposed several volatile organosulphur compounds with bioactivities (Chang and Cheong, 2008).

Ginger and garlic supplementation in the broiler diets have been documented for their strong stimulating effect on the immune and digestive systems of birds (Horton *et al.,* 1991; Gardzielewska *et al.,* 2003). Therefore, the objective of this study was to evaluate the effect of adding ginger and garlic powder or aqueous extract alone and in combination on growth performance, carcass quality, feed conversion ratio and hematological parameters of broiler chickens.

Materials and Methods

Experimental birds and diets

Following a completely randomized design, 200 one-day-old straight-run broiler chicks of uniform body weight were distributed at random into five treatments (40 chicks in each) and housed in specially designed broiler wire cages for 5 weeks. Five dietary treatments were identified as T_0, T_1, T_2, T_3, and T_4 (Table 1). All experimental birds were fed broiler starter (1-21 d) and finisher feed (22-35 d). The ingredients and nutrient composition of broiler starter and finisher diet is shown in Table 2. Each dietary treatment was allocated four replicates (10 chicks/replication).

Feeding and management

The chicks were kept for seven days to acclimatize by brooding and fed commercial broiler starter diet and given plain drinking water only. The experimental shed is made of concrete floor, zinc roof, wire net sides, with dimensions of (24 m×15 m×3 m) and situated in an east-west orientation and divided into twenty wire cages, each with dimensions of (1 m×1 m×0.8 m) and 10 birds were randomly allocated. The experimental feed mixtures and clean drinking water were supplied to the birds *ad libitum* throughout the study period to meet the nutrient requirement.

Data collection

Chicks were weighed on the day of their arrival and at the end of each week regularly to estimate weekly body weight gain. Weekly feed intake was recorded. Total live weight gain was recorded at the end of the trial. Data recorded for weight gain and feed intake were used to calculate the weekly feed conversion ratio (FCR). At the end of trial, 5 birds were randomly selected from each replicate. Birds were fasted for 12 h before sacrificed. Birds were sacrificed by decapitation and manually eviscerated. Then, after removal of head, shanks and offal, ready to cook carcass was determined. Dressing percentage was calculated by ready to cook weight/live BW of birds ×100.

Source and processing of test ingredients
Ginger and garlic used in this study was bought from a local spice market in raw form and test ingredients were prepared according to the procedure described by Oleforuh-Okoleh *et al.* (2014). In brief, the peeled ginger and garlic were washed, cut into small pieces and dried adequately in the sun light. After drying grinding and passing through 1 mm sieve to make fine powder. The water based infusion was prepared by adding one liter of boiled hot water to 15 g of ground ginger and garlic in separate non-metallic containers, and allowed to cool at room temperature for overnight. Then the infusion was filtered by a filter paper, and then administered through drinking water at the dose of (50% ginger + 50% garlic) 50 ml L^{-1}. Water based infusion was made available to the birds for 12 h d^{-1}. Fresh infusion was prepared on daily basis.

Chemical Analysis
Ginger and garlic powder which was used in this experiment was analyzed for moisture and ash according to the methods of the Association of Official Analytical Chemists (AOAC).
Nutritional information of garlic and ginger are available in Table 3.

Blood collection and hematological parameter analyses
Blood was collected with sterile syringe and needle randomly from the brachial vein from every treatment groups of birds and immediately transferred to anticoagulant 1:10 (4% sodium citrate solution) containing sterile test tube. Determination of total erythrocyte count (TEC) ($10^{10}/mm^3$), hemoglobin (Hb) (g %), total leukocyte count (TLC) ($10^3/mm^3$), packed cell volume (PCV) (%), and erythrocyte sedimentation rate (ESR) (mm in 1st h) were performed according to the International Council for Standardization in Hematology, 1993[21]. Rest of the haematological parameters such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MVHC), together with absolute count of heterophils, eosinophils, basophils, lymphocytes and monocytes were determined by the routine methods (Nazify, 1999).

Statistical analysis
Data were analyzed by an ANOVA procedure using SAS (SAS 9.1, USA). Duncan's multiple range test (Duncan, 1955) was used to determine significant differences between means. The values were expressed as the mean±SE. Differences of $p<0.05$ were considered as statistically significantly.

Results and Discussion
Effect of ginger and garlic on feed intake, body weight gain and feed conversion ratio Total feed intake of experimental broiler birds in T_2, T_1 and T_3 groups was significantly ($p<0.05$) higher as compared to T_0 and T_4 group (Table 4) at 14 d, 21 d, 28 d and 35 d respectively. Feed intake in T_0, T_1, T_3 and T_4 group was similar and did not differ significantly at 14 d. However, feed intake varies prominently in T_0, T_1, T_2, T_3 and T_4 group at 21 d, 28 d and 35 d due to different form of feed supplied. Results revealed that sometimes the smell and/or taste of ginger and garlic alter the palatability and feed intake of broilers. The results are in reconciliation with different researchers who have reported that ginger powder in the diet of broiler had a substantial positive effect on feed consumption (Herawati and Marjuki, 2011; Mohamed *et al.,* 2012). Similarly, some researchers have observed non-significant effect of garlic supplementation on feed intake in broilers (Onu, 2010; Aji *et al.,* 2011; Rahimi *et al.,* 2011).

Total body weight gain (g) of experimental broiler birds fed diet supplemented with ginger (T_1) revealed significantly ($p<0.05$) higher values as compared to T_0, T_3 and T_4 (Table 4) at 14 d, 21 d, 28 d and 35 d. Whereas, non-significant difference was noticed between T_3 and T_4 groups at 14 d, and T_2 and T_4 groups at 28 d. Maximum body weight gain of broiler birds fed on ginger might be due to the active components existent in the ginger, which triggers the digestive enzymes and increases overall digestion and absorption of some valuable nutrients present in this supplied diets, consequently boosted the body weight gain. It has been observed that diet supplemented with ginger activated the lactic acid bacteria and declined pathogenic bacteria (*Escherichia coli,* coliform) and therefore improved the absorption of nutrients lead to better weight gain of the birds (Tekeli *et al.,* 2011). Results were persistent with those of Sadeghi *et al.* (2011), Arshad *et al.* (2012) and Mohamed *et al.* (2012) and specified that use of ginger to the diet had a significant ($p<0.05$) positive effect on the broiler body weight gain as compared to the control.

The feed conversion ratio (FCR) is presented in Table 4. Experimental birds in T_4 group showed significantly ($p<0.05$) higher FCR at 14 d, 21 d, and 35 d as compare to T_1, T_2 and T_3 groups (Table 4). The supplementation of ginger and garlic alone in the diet of birds significantly ($p<0.05$) lower FCR as compared to control. Though, better FCR was observed in T_4 group followed by T_2 and T_1 groups. Similar results have been reported by Mansoub and Nezhady, (2011), and Aji *et al.* (2011) who stated that garlic has non-significant effect on FCR. Similarly, Thayalini *et al.* (2011) and Ademola *et al.* (2009) did not detect any significant improvement in the FCR of broilers fed diet supplemented with ginger powder as compared to the control group.

Effect of ginger and garlic on carcass characteristics
Carcass characteristics result is presented in Table 5. There were significant ($p<0.05$) difference in the carcass characteristics among all the treatment groups when compared with respective control. The live weight, carcass weight and dressing percentage were significantly higher in T_1 group than the T_2, T_3, T_4 and control group. Abdominal fat was higher in control than those of birds fed supplemented diet ($p<0.05$). There was no effect of supplemented diet on

moisture, CP and EE in thigh and breast meat. Feeding test ingredients to the experimental broiler birds in powder form and through water-based infusion significantly ($p<0.05$) affected all the growth performance traits studied. Birds fed the ginger and garlic in powder form showed significantly higher body weight ($p<0.05$) than those fed through water based infusion. The dressing percentage was also significantly ($p<0.05$) higher when ginger and garlic were fed in powder form. However, abdominal fat was significantly declined when fed water based infusion and gave a better result among the groups ($p<0.05$). Similar response was observed by OleforuhOkolehi *et al.* (2014).

Effect of ginger and garlic on haematology parameters

The hematological parameters of broiler administered ginger and garlic at different forms are presented in Table 6. There was significantly increased ($p<0.05$) in the total erythrocyte count (TEC), hemoglobin (Hb), total leukocyte count (TLC), packed cell volume (PCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MVHC), eosinophil (E), lymphocyte (L) in the ginger and garlic supplemented groups compared to the control. The number of erythrocytes (E) in chicken is influenced by the conditions of the animal (Mitruka *et al.,* 1977). The increase in TEC, PCV, and Hb contents of the blood of broiler birds fed the ginger and garlic is an indication of enhanced oxygen carrying capacity of the cells which translated to a better availability of nutrients to the broiler birds consequently affecting their well-being (Oleforuh-Okolehi *et al.,* 2015). Larsson *et al.* (1985) also reported that PCV values are an indicator of oxygen carrying capacity of the blood and important in measuring the stress on animal health. The ginger could be useful in improving blood circulation on account of its inhibitory effects on platelet accumulation (Muhammed and Lakshmi, 2007). Similar inhibitory effect was detected in garlic by Lawson *et al.* (1992).

Conclusion

Based on the performance in respect to feed intake, body weight gain, feed conversion ratio and hematological parameters, it was summarized that, ginger supplementation was superior in comparison to garlic alone and combination with ginger. However, there was no significant effect in MCV at 21 d and heterophil, basophil at 35 d. Therefore, it was concluded that supplementation of ginger (*Zingiber officinale)* powder improved the performance of broilers than the water based infusion and may recommend addition in broiler diet for improved nutritional and physiological traits. This study discovers the possible application of ginger and garlic as a source of phytobiotic feed additive to replace the chemical antibiotic and other growth promoter to enhance the productive performance and hematology of broiler. This study will help the researcher to uncover the powder and water infusion form of ginger and garlic supplementation as a feed additive in broiler chick's diet that many researchers were not able to explore. Thus, a new concept on the application form of phytobiotic feed additive may be arrived at.

Acknowledgement

The author would like to thank the Department of Poultry Science, Faculty of Veterinary, Animal and Biomedical Sciences, Sylhet Agricultural University, Sylhet-3100, Bangladesh for supporting this research.

References

[1]. Ademola SG, Farimu GO, Babatunde GM. Serum lipid, growth and haematological parameters of broilers fed garlic, ginger and their mixtures. World Journal of Agricultural Sciences, 2009; 5(1): 99-104.
[2]. Aji SB, Ignatius K, Ado YA, Nuhu JB, Abdulkarim A, Aliyu U, Gambo MB, Ibrahim MA, Abubakar H, Bukar MM, Imam HM, Numan PT. Effects of feeding onion and garlic on some performance characteristics of broiler chickens. Research Journal of Poultry Sciences, 2011; 4(2): 22-27.
[3]. Al-Amin ZM, Thomson M, Al-Qattan KK, Peltonen-Shalaby R, Ali M. Anti-diabetic and hypolipideamic properties of ginger (*Zingiber officinale*) in streptozotocin-induced diabetic rats. British Journal of Nutrition, 2006; 96: 660-666.
[4]. Ali BH, Blunden G, Tanira MO, Nemmar A. Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale Roscoe*). A review of recent research. Food Chemical and Toxicology, 2008; 46: 409-420.
[5]. AOAC. Official methods of analysis of the AOAC, 15th ed. Methods 932.06, 925.09, 985.29, 923.03. Association of official analytical chemists. Arlington, VA, USA, 1990.
[6]. Arshad M, Kakar AH, Durrani FR, Akhtar A, Sanaullah S, Niamatullah M. Economical and immunological impact of ginger extract on broiler chicks. Pakistan Journal of Science, 2012; 64(1): 46-48.
[7]. Asghar A, Farooq M, Mian MA, Perveez, Khurshid A. Economics of broiler production of Mardan division. Journal of Rural Development and Administration, 2000; 32: 56-64.
[8]. Barragry TB and Powers T. Veterinary drug therapy. Lea and Febiger, Philadelaphia, PA, USA, 1994.
[9]. Botsoglou NA, Florou-Paneri P, Christaki E, Fletouris DJ, Spais AB. Effect of dietary oregano essential oil on performance of chickens and on iron-induced lipid oxidation of breast, thigh and abdominal fat tissues. British Poultry Science, 2002; 43: 223-230.
[10]. Chang KJ and Cheong SH. Volatile organosulphur and nutrient compounds from garlic by cultivating areas and processing methods. Federation of American Societies for Experimental Biology, 2008; 22: 1108-1112.
[11]. Demir E, Sarica S, Ozcan MA, Suicmez M.. The use of natural feed additives as alternatives for an antibiotic growth promoter in broiler diets. British Poultry Science, 2003; 44(S1): 4445.
[12]. Duncan DB. Multiple Range and Multiple F Tests. Biometrics 11:1, 1955.

[13]. Gardzielewska J, Pudyszak KT, Majewska M, Jakubowska, J Pomianowski. Effect of plantsupplemented feeding on fresh and frozen storage quality of broiler chicken meat. Electronic Journal of Polish Agricultural Universities, 2003; 6: 12-12.
[14]. Hanieh H, Narabara K, Piao M, Gerile C, Abe A, Kondo Y. Modulatory effects of two levels of dietary Alliums on immune responses. Animal Science Journal, 2010; 81: 673-680.
[15]. Herawati and Marjuki. The effect of feeding red ginger (*Zingiber officinale* Rosc) as phytobiotic on broiler slaughter weight and meat quality. International Journal of Poultry Science, 2011; 10(12): 983-985.
[16]. Horton GMJ, Fennell MJ, Prasad BB. Effect of dietary garlic (*Allium sativum*) on performance, carcass composition and blood chemistry changes in broiler chickens. Canadian Journal of Animal Science, 1991; 71: 939-942.
[17]. Iji PA, Saki A, Tivey DR. Body and intestinal growth of broiler chicks on a commercial starter diet. 1. Intestinal weight and mucosal development. British Poultry Science, 2001; 42: 505-513.
[18]. International Council for Standardization in Haematology (Expert Panel on Blood Rheology). ICSH recommendations for measurement of erythrocyte sedimentation rate. International Council for Standardization in Haematology (Expert Panel on Blood Rheology). Journal of Clinical Pathology, 1993; 46: 198-203.
[19]. Khan SH, Sardar R, Anjum MA. Effects of dietary garlic on performance and serum and egg yolk cholesterol concentration in laying hens. Asian-Australasian Journal of Animal Sciences, 2007; 21: 22-27.
[20]. Larsson Å, Haux C, Sjöbeck ML. Fish physiology and metal pollution: results and experiences from laboratory and field studies. Ecotoxicology Environ Safety, 1985; 9(3): 250-281.
[21]. Lawson LD, Ransom DK, Hughes BG. Inhibition of whole blood platelet-aggregation by compounds in garlic clove extracts and commercial garlic products. Thrombology Research, 1992; 65: 141-156.
[22]. Manseh MK, Kazemi S, Asfari M. Influence of poly germander (trucrium polium) and watercress *(Nasturtium officinale)* extract on performance, carcass quality and blood metabolites of males' broilers. Research Opinions in Animal and Veterinary Sciences, 2012; 2: 66-68.
[23]. Mansoub NH and Nezhady MAM. The effect of using thyme, garlic and nettle on performance, carcass quality and blood parameters. Annual Biological Research, 2011; 2(4): 315-320.
[24]. Mitruka BM, Rawnsley HM, Vadehra BV. Clinical biochemical and haematological reference values in normal experimental animals. Masson Publishing USA Inc. 272, 1977.
[25]. Mohamed AB, Mohammed AM, Ali Jalil Q. Effect of ginger (*Zingiber officinale*) on performance and blood serum parameters of broiler. International Journal of Poultry Science, 2012; 11(2): 143-146.
[26]. Morakinyo AO, Akindele AJ, Ahmed Z. Modulation of antioxidant enzymes and inflammatory cytokines: Possible mechanism of anti-diabetic effect of ginger extracts. African Journal of Biomedical Research, 2011; 14: 195-202.
[27]. Muhammed M and Lakshmi P. Ginger (*Zingibe officinale*): Product Write-Up. Retrieved from http://beta.rodpub.com/public/uploads/908437ginger.pdf, 2007.
[28]. Nazify S. Hematology and Biochemistry birds. Published by University of Tehran, Iran, 1999.
[29]. Oleforuh-Okoleh VU, Chukwu GC and Adeolu AI. Effect of ground ginger and garlic on the growth performance, carcass quality and economics of production of broiler chickens. Global Journal of Bioscience and Biotechnology, 2014; 3(3): 225-229.
[30]. Oleforuh-Okoleh VU, Ndofor-Foleng HM, Olorunleke SO, Uguru JO. Evaluation of growth performance, haematological and serum biochemical response of broiler chickens to aqueous extract of ginger and garlic. Journal of Agricultural Science, 2015; 7(4):167-173.
[31]. Onu PN. Evaluation of two herbal spices as feed additives for finisher broilers. Biotechnology Animal Husbandry, 2010; 26(5-6): 383-392.
[32]. Rahimi S, Teymouri ZZ, Karimi TMA, Omidbaigi R, Rokni H. Effect of the three herbal extracts on growth performance, immune system, blood factors and intestinal selected bacterial population in broiler chickens. Journal of Agricultural Science and Technology, 2011; 13: 527-539.
[33]. Rivlin RS. Historical perspective on the use of garlic. Journal of Nutrition, 2001; 131(35): 957954.
[34]. Sadeghi GH, Karimi A, Jahromi SP, Aziz T, Daneshmand A. Effect of cinnamon, thyme and turmeric infusions on the performance and immune response in of 1 to 21 day-old male broilers. Brazilian Journal of Poultry Science, 2011; 14(1): 15-20
[35]. Sojoudi MR, Dadashbeiki M, Bouyeh M. Effects of different levels of symbiotic, TechnoMos on broilers performances. Research Opinions in Animal and Veterinary Sciences, 2012; 5: 243-148.
[36]. Tapsell LC, Hemphill I, Cobiac L, Patch CS, Sullivan DR, Fenech M, Inge KE. Health benefits of herbs and spices: The past, the present, the future. The Medical Journal of Australia, 2006; 185: 4-24.
[37]. Tarhyel R, Hen SA, Tanimomo BK. Effect of age on organ weight and carcass characteristics of Japanese quail (Coturnix Japonica). Scientific Journals-Agis, 2012; 1(1): 21-26.
[38]. Tekeli A, Kutlu HR, Celik L. Effects of *Z. officinale* and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Current Research in Poultry Science, 2011; 1(1): 12-23.
[39]. Thayalini K, Shanmugavelu S, Saminathan PM, SitiMasidayu MS, Nor Idayusni Y, Zainuddin H, Nurul Akmal CA, Wong HK. Effects of *Cymbopogon citratus* leaf and *Zingiber officinale* rhizome supplementation on growth performance, ileal morphology and lactic acid concentration in broilers. Malaysian Journal of Animal Science, 2011; 14: 43-49.
[40]. Zhao X, Yang ZB, Yang WR, Wang Y, Jiang SZ, Zhang GG.. Effects of ginger root (*Zingiber officinale*) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poultry Science, 2011; 90: 1720-1727.

Table 1: Layout of experimental design

Treatments	Test ingredients	n= 10×4	Total birds
T_0	Control (without test ingredients)	10 birds × 4 replicates	40
T_1	Ginger powder at 15 g kg^{-1} of basal diet	10 birds × 4 replicates	40
T_2	Garlic powder at 15 g kg^{-1} of basal diet	10 birds × 4 replicates	40
T_3	50% ginger + 50% garlic powder at 15 g kg^{-1} of basal diet	10 birds × 4 replicates	40
T_4	50% ginger + 50% garlic infusion at 50 ml L^{-1} of drinking water	10 birds × 4 replicates	40

Table 2: Composition of basal experimental diet (Cobb 500 management guide)

Item	Starter	Finisher
Ingredients (%)		
Maize	56.85	61.90
Soyabean meal	37.85	32.80
Soyabean oil	4	1.40
Calcium	1.00	0.84
Limestone	1.00	1.00
NaCl	0.20	0.20
DL-Methionine	0.41	0.39
L-Lysine	1.08	0.95
Vitamin-mineral premix[a]	5	5
Nutrition composition		
ME (kcal kg^{-1})	2988	3176
CP (%)	21.00	18.00
Methionine (%)	0.46	0.43
Lysine (%)	1.20	1.05
Available P (%)	0.50	0.40

[a]Each kilogram contains calcium, 196 g; phosphorous, 64 g; sodium, 30 manganese, 1,200 mg; cobalt, 20 mg; iodine, 40 mg; selenium, 8 mg; vitamin A, 200,000 IU; vitamin D3, 80,000 IU; vitamin E, 1,600 mg; vitamin K3, 34 mg; vitamin C, 1,300 mg; vitamin B1, 35 mg; vitamin B2,
135 mg; vitamin B6, 100 mg; vitamin B12, 670 go; nicotinic acid, 1,340 mg; calcium pantothenic acid, 235 mg; choline chloride, 8,400 mg; folic acid, 34 mg; biotin, 3,350 µg; and methionine, 30 g.

Table 3: Proximate composition of garlic and ginger

Nutritional composition/Parameter	Composition	
	Garlic (per 100 g)	Ginger (per 100 g)
Energy (kcal)	362	374
Carbohydrate (%)	72.85	67.90
Protein (%)	16.5	8.20
Moisture (%)	5.63	6.50
Fat (%)	0.75	1.40
Total ash (%)	4.15	6.10
Acid insoluble ash (%)	0.25	0.50

Table 4: Effect of garlic and ginger on broilers performance receiving diet and drinking water

Parameter	Period	Treatment				
		T_0	T_1	T_2	T_3	T_4
Body weight (g)	14 d	368.85±1.50^{d}	400.46±1.05^{a}	385.06±1.02^{b}	370.42±1.15^{c}	374.65±2.60^{c}
	21 d	617.99±1.33^{e}	793.37±2.21^{a}	693.66±2.25^{c}	720.39±1.75^{b}	623.83±1.59^{d}
	28 d	1166.03±3.67^{d}	1315.05±1.38^{a}	1192.92±3.92^{c}	1218.51±2.05^{b}	1200.69±3.03^{c}
	35 d	1695.32±2.17^{e}	1814.27±2.77^{a}	1709.67±2.77^{d}	1759.34±1.22^{b}	1731.52±1.29^{c}
Weight gain (g)	14 d	328.85±1.50^{d}	360.46±1.05^{a}	345.06±1.02^{b}	330.42±1.15^{c} d	334.65±2.60^{c}
	21 d	577.99±1.33^{e}	753.37±2.21^{a}	653.66±2.25^{c}	680.39±1.75^{b}	583±1.59^{d}
	28 d	1126.03±3.67^{d}	1275.05±1.38^{a}	1152.92±3.92^{c}	1178.51±2.05^{b}	1160.69±3.03^{c}
	35 d	1655.32±2.17^{e}	1774.27±2.77^{a}	1669.67±2.77^{d}	1719.34±1.22^{b}	1691.52±1.29^{c}
Feed intake (g)	14 d	434.87±0.87^{b}	434.10±1.89^{b}	443.11±1.90^{a}	437.63±1.45^{b}	436.60±1.48^{b}
	21 d	835.72±3.55^{e}	987.32±3.56^{a}	934.63±4.70^{c}	962.19±6.20^{b}	870.26±7.11^{d}
	28 d	1795.83±2.93^{c}	1895.14±2.92^{a}	1813.35±4.06^{b}	1812±4.11^{b}	1806.75±3.58^{b}
	35 d	2864.25±0.99^{e}	2909.42±1.44^{c}	2884.21±1.43^{d}	2983.59±1.10^{a}	2953.62±1.37^{d}
FCR	14 d	1.18±0.004^{a}	1.08±0.01^{c}	1.15±.01^{b}	1.18±0.004^{a}	1.17±0.01^{ab}
	21 d	1.35±0.003^{b}	1.25±0.004^{c}	1.35±0.01^{b}	1.34±0.01^{b}	1.40±0.01^{a}
	28 d	1.54±0.004^{a}	1.44±0.01^{e}	1.52±0.01^{b}	1.49±0.003^{d}	1.50±0.004^{c}
	35 d	1.69±0.001b^{c}	1.60±0.003^{d}	1.69±0.003^{c}	1.70±0.001^{b}	1.71±0.001^{a}
Feed (g):gain (g)	14 d	1.32±.006^{a}	1.21±0.01^{c}	1.28±0.01^{b}	1.32±0.01^{a}	1.31±0.01^{ab}
	21 d	1.44±0.004^{b}	1.31±0.004^{d}	1.43±0.01b^{c}	1.42±0.01^{c}	1.49±0.01^{a}
	28 d	1.50±0.01^{a}	1.49±0.01^{e}	1.57±0.01^{b}	1.54±0.004^{d}	1.55±0.01^{c}
	35 d	1.73±0.001b^{c}	1.64±0.003^{d}	1.73±0.003^{c}	1.74±0.005^{b}	1.74±0.002^{a}
Mortality (%)		0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Mean values are Mean±SE. Values in the same row different superscript letters are significantly different at $p<0.05$. Lack of superscript letter indicates no significant difference.

Table 5: Effect of garlic and ginger on carcass characteristics receiving diet and drinking water (0-35 days)

Parameter		Treatment				
		T_0	T_1	T_2	T_3	T_4
Live weight (g)		1695.32±2.1	1814.27±2.7	1709.67±2.7	1759.34±1.2	1731.52±1.2
Carcass weight (g)		1181.36±4.6	1407.81±6.6	1277.82±6.1	1334.60±6.1	1257.07±3.7
Dressing (%)		69.68±0.31^{e}	77.60±0.31^{a}	74.74±0.38^{c}	75.88±0.34^{b}	72.60±0.24^{d}
Abdominal fat (%)		52.43±0.28^{a}	26.99±0.32^{b}	25.71±0.32^{c}	23.52±0.36^{d}	18.44±0.44^{e}
Proximate component (%)						
Breast Meat	Moistur	72.50±0.27	71.57±0.58	72.89±1.06	72.86±0.93	73.37±1.52
	CP	21.50±0.74	22.10±1.12	21.95±0.77	21.95±0.99	21.67±0.94
	EE	1.38±0.12	1.47±0.17	1.36±0.11	1.38±0.14	1.56±0.10
Thigh Meat	Moistur	73.54±0.27	73.91±1.34	72.64±1.90	71.99±1.21	73.98±1.42
	CP	17.82±0.54	18.91±0.59	18.24±0.49	18.58±0.76	18.31±0.43
	EE	2.81±0.15	2.68±0.15	2.81±0.17	2.73±0.17	2.93±0.17

Mean values are Mean±SE. Values in the same row different superscript letters are significantly different at $p<0.05$. Lack of superscript letter indicates no significant difference.

Table 6: Effect of garlic and ginger on hematological parameters receiving diet and drinking water

Parameter	Period	Treatment				
		T_0	T_1	T_2	T_3	T_4
TEC	21 d	2.68±0.04^{cd}	3.85±0.17^{a}	3.00±0.16^{c}	3.39±0.09^{b}	2.62±0.12^{d}
(10^{10}/mm^3)	35 d	2.81±0.06^{c}	4.65±0.17^{a}	3.60±0.07^{b}	3.69±0.07^{b}	2.88±0.05^{c}
Hb	21 d	7.66±0.08b^{c}	8.33±0.07^{a}	7.74±0.15^{b}	8.18±0.09^{a}	7.38±0.08^{c}
(g %)	35 d	7.81±0.06^{d}	9.46±0.10^{a}	8.34±0.08^{c}	9.08±0.04^{b}	7.70±0.09^{d}
TLC	21 d	19.39±0.23^{a} b	19.52±0.20^{a}	17.84±0.20^{c}	19.01±0.30^{a} b	18.68±0.26^{b}
(10^3/mm^3)	35 d	19.96±0.14^{a}	19.86±0.13^{a} b	18.34±0.05^{c}	19.61±0.10^{b}	19.78±0.07^{a} b
PCV	21 d	28.04±0.25^{b}	29.13±0.25^{a}	28.36±0.15^{a} b	27.94±0.42^{b}	28.45±0.17^{a} b
(%)	35 d	28.59±0.12^{a}	29.92±0.13^{a}	28.56±0.08^{a}	28.44±1.56^{b}	28.65±0.10^{a}
ESR	21 d	3.57±0.17^{a}	1.56±0.07^{c}	2.16±0.12^{b}	1.19±0.06^{d}	2.49±0.13^{b}
(mm in 1st h)	35 d	3.08±0.06^{a}	0.00±0.00^{d}	2.67±0.05^{b}	1.52±0.04^{c}	3.20±0.05^{a}
MCV	21 d	106.46±0.45	97.00±0.05	94.46±2.10	96.90±1.81	106.45±0.47
(μ^3)	35 d	105.66±0.11 a	87.00±0.04^{b}	84.46±0.05^{d}	85.90±0.05^{c}	105.55±0.03 a
MCH	21 d	28.17±0.37^{a} b	28.65±1.13^{a}	26.83±0.34^{b}	23.71±0.31^{c}	26.92±0.31^{a} b
(µµg)	35 d	27.67±0.06^{a}	29.95±0.10^{c}	27.63±0.05^{b}	24.31±0.05^{a}	27.61±0.05^{a}
MCHC	21 d	27.67±0.50^{b}	29.45±0.62^{a}	26.04±0.32^{c}	27.63±0.09^{b}	26.27±0.19^{c}
(%)	35 d	26.97±0.09^{c}	28.25±0.07^{a}	25.34±0.09^{d}	27.63±0.09^{b}	26.70±0.20^{c}
(g %)	35 d	7.81±0.06^{d}	9.46±0.10^{a}	8.34±0.08^{c}	9.08±0.04^{b}	7.70±0.09^{d}
TLC	21 d	19.39±0.23^{a} b	19.52±0.20^{a}	17.84±0.20^{c}	19.01±0.30^{a} b	18.68±0.26^{b}
(10^3/mm^3)	35 d	19.96±0.14^{a}	19.86±0.13^{a} b	18.34±0.05^{c}	19.61±0.10^{b}	19.78±0.07^{a} b
PCV	21 d	28.04±0.25^{b}	29.13±0.25^{a}	28.36±0.15^{a} b	27.94±0.42^{b}	28.45±0.17^{a} b
(%)	35 d	28.59±0.12^{a}	29.92±0.13^{a}	28.56±0.08^{a}	28.44±1.56^{b}	28.65±0.10^{a}
ESR	21 d	3.57±0.17^{a}	1.56±0.07^{c}	2.16±0.12^{b}	1.19±0.06^{d}	2.49±0.13^{b}
(mm in 1st h)	35 d	3.08±0.06^{a}	0.00±0.00^{d}	2.67±0.05^{b}	1.52±0.04^{c}	3.20±0.05^{a}
MCV	21 d	106.46±0.45	97.00±0.05	94.46±2.10	96.90±1.81	106.45±0.47
(μ^3)	35 d	105.66±0.11 a	87.00±0.04^{b}	84.46±0.05^{d}	85.90±0.05^{c}	105.55±0.03 a
MCH	21 d	28.17±0.37^{a} b	28.65±1.13^{a}	26.83±0.34^{b}	23.71±0.31^{c}	26.92±0.31^{a} b
(µµg)	35 d	27.67±0.06^{a}	29.95±0.10^{c}	27.63±0.05^{b}	24.31±0.05^{a}	27.61±0.05^{a}
MCHC	21 d	27.67±0.50^{b}	29.45±0.62^{a}	26.04±0.32^{c}	27.63±0.09^{b}	26.27±0.19^{c}
(%)	35 d	26.97±0.09^{c}	28.25±0.07^{a}	25.34±0.09^{d}	27.63±0.09^{b}	26.70±0.20^{c}
Differential Leukocyte Count (%) at 35 d						
H		20.79±0.52	20.78±0.11	20.69±0.15	21.25±0.13	20.60±0.15
E		2.25±0.07^{b}	2.49±0.07^{a}	2.12±0.08^{b}	2.49±0.04^{a}	1.79±0.04^{c}
B		1.08±0.04	1.02±0.04	1.06±0.07	1.10±0.03	1.01±0.05
L		65.59±1.18^{a} b	65.62±1.18^{a} b	65.24±1.15^{b}	65.96±1.13^{a}	63.54±1.10^{c}
M		2.10±0.04^{a}	1.97±0.04^{ab}	2.10±0.04^{a}	2.06±0.04^{a}	1.93±0.05^{b}

TEC; Total erythrocyte count, Hb; Hemoglobin, TLC; Total leukocyte count, PCV; Packed cell volume, ESR; Erythrocyte sedimentation rate, MCV; Mean corpuscular volume, MCH; Mean corpuscular hemoglobin, MVHC; Mean corpuscular hemoglobin concentration, H; Heterophil, E; Eosinophil; B; Basophil, L; Lymphocyte, M; Monocyte.
Mean values are Mean±SE. Values in the same row different superscript letters are significantly different at $p<0.05$. Lack of superscript letter indicates no significant difference.