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Influence of Organic Dietary Supplementation on Physiological Performance in Japanese Quail (*Coturnix coturnix japonica*): A Critical Review

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ABSTRACT

Poultry supplemented with ginger and garlic improved growth and feed conversion ratio and decreased mortality rate. Garlic supplementation also responsible for enhancing the activity of pancreatic enzymes and provides an environment for better absorption of nutrients. Dietary fermented garlic supplementation in poultry ration can increase the intestinal villus height, villus area, cell area and cell mitosis in the intestine and results in better feed conversion efficiency. The inclusion of ginger root powder at levels 0.5% and 1% in the diet had no significant (P>0.05) effect on Hb, PCV, RBC, MCV, MCH and MCHC percentage. The combined effect of garlic and ginger mixtures has greater influence as an anti-hypercholesterolemic agent that successfully reduced the cholesterol in the serum and also been used to prevent high blood pressure, high cholesterol level and cholesterol oxidation which are the primary causes of atherosclerosis, the precursor of cardiovascular diseases in poultry. It has been confirmed that garlic supplementation enhances immune system in poultry chicken due to rich aromatic oils which enhance digestion of birds due to modulation of intestinal microbiota. So, Japanese quail feed supplemented with ginger and garlic has resulted better production performance in terms of feed conversion ratio, body weight gain, disease resistant with enhanced immunity for better consumption by human being and animals.

Key words: *Blood hematology, FCR, Garlic, Ginger, Immunity, Japanese quail*

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INTRODUCTION

Japanese quail (*Coturnix coturnix japonica*) are hardy birds that thrive in small cages and are inexpensive to keep. Existing breeds of Japanese quail cannot compete with the performance of the poultry chicken, but are more tolerant to poor managemental condition, being resistant to common poultry diseases like Marek's disease and New Castle disease *etc*. In general, there is no vaccination required in quail bird farming. Although birds raised with these feed additives achieved good performance, their potential side effects became a real public health problem world-wide and led to the ban of these products[1,2]. So, researcher are looking for natural organic dietary supplement for better performance of the poultry bird with less side effect for human being or animal consumption. To achieve high feed conversion ratio, better growth and good physiological performance with enhanced immunity the birds are provided with garlic and ginger dietary feed supplement which it more suitable for human consumption.

Ginger is a rhizomatous herbaceous plant, whose rhizome is used medicinally. Ginger contains several compounds and enzymes including gingerdiol, gingerol, gingerdione and shogaols[3,4]. These compounds have been reported to have antimicrobial, antioxidative and Pharmacological effects[5]. Garlic is best known as a spice and herbal medicine for treatment and prevention of an array of diseases[6]. The key active ingredient in garlic is a powerful plant chemical called allicin which rapidly decomposes to several organo-sulphur compounds with bioactivities and pronutrients[7].

Pronutrients are substances that could have the same effect as antibiotic feed additives and are defined as micro ingredients included in the formulation of animal feeds[8]. They also play an important role in enhancing the physiology and microbiology of the animals. They are also sometimes referred as phytogenic feed additives. Phytogenic feed additives are plant derived products used in animal feeding to improve their performance. Nutritional strategies aimed at reducing cost of animal production have led to high accumulation of fat in poultry[9]. Diets that have high cholesterol and saturated fats from animal products are known to contribute to unhealthy plasma lipid levels leading to increased plasma total cholesterol and low density lipoprotein (LDL) cholesterol[10]. Elevated blood cholesterol and triacylglycerol are associated with increased risk of cardiovascular disease[11]. Hence, an alternative means of correcting and preventing these diseases is very crucial in achieving a healthy society. Medicinal herbs such as garlic and ginger have been reported to possess lipid lowering effects[12]. Ginger and garlic can stimulate the digestive systems by controlling the digestive pH and the activity of digestive enzyme and the microbial activity[13]. Ginger and garlic supplementation enhanced body weight gain and feed conversion ratio in poultry birds[14]. Ginger and garlic has been found to lower serum and tissue cholesterol levels inhibit bacterial growth and reduce oxidative stress in birds[15].

Ginger and garlic supplementation in quails

Garlic (*Allium sativum* L.) belongs to the class Liliopsida, subclass Liliidae, superorder Liliianae, order Amaryllidales, family Alliaceae, subfamily Allioideae, and genus Allium[16]. Freshly crushed garlic (*Allium sativum*) is an important source of allicin, alliin, ajoene, diallylsulfide, dithiin and S-allylcysteine[17]. Chang and Cheong[7] reported that the most active ingredient of garlic i.e. allicin is rapidly decomposes to several organosulphur compounds with bioactivities. Garlic contains at least 33 sulfur compounds, several enzymes and the minerals calcium, copper, iron, potassium, magnesium, selenium and zinc; vitamins A, B_1 and C, fibre and water. It also contains 17 amino acids like lysine, histidine, arginine, aspartic acid, threonine, serine, glutamine, proline, glycine, alanine, cysteine, valine, methionine, isoleucine, leucine, tryptophan and phenylalanine[18]. It has a higher concentration of sulfur compounds than any other Allium species which is reason behind its pungent odour and medicinal properties[18]. Its medicinal power was well described on the walls of

ancient temples and on papyrus dating to 1500 BC[19]. Garlic is considered as a plant with antibiotic, anticancer, antioxidant, immunomodulatory, anti-inflammatory, hypoglycemic and cardiovascular protecting effects[20]. It was used by Greek physicians Hippocrates and Galen to treat intestinal and extra-intestinal diseases, still today it is been used to treat diarrhea. Ancient Japanese and Chinese used it to treat headache, flu, sore throat and fever. In Africa, it is used to treat abdominal discomfort, diarrhea and otitis. In India, it was used to treat common colds, hay fever and asthma. Garlic is nick named as Russian penicillin for its widespread use as a topical and systemic antimicrobial agent.

Ginger, the rhizome of *Zingiber officinale*, is one of the most widely used species of the *Zingiberaceae* family. Ginger is cultivated in areas of abundant rainfall. Ginger contains a number of pungent constituents and active ingredients. Ravindran and Babu[21] revealed that it`s key ingredients are volatile oils such as zingiberene, curcumene, borneolneral, geranial, geraniol, citronyl acetate, α-terpineol and linalool, and pungent compounds such as gingerols and shogaols. Major components of ginger are known for their antioxidant and antimicrobial property[22]. It is also being a common condiment for various foods and beverages. It has a long history of medicinal use dating back 2,500 years in China and India for conditions such as headaches, nausea, rheumatism, and common cold. The compound 6-gingerol appears to be responsible for its characteristic taste. Zingerone and shogaols are found in small amounts in fresh ginger and in larger amounts in dried or extracted products. Steam distillation of powdered ginger produces ginger oil, which contains a high proportion of sesquiterpene hydrocarbons, predominantly zingiberene. A simple experiment was conducted by Sharma *et al*[13] taking two hundred poultry chickens of 5 days old divided into 5 different feed treatment groups, namely: control, without red ginger (R-0) and treatment (R-0.5, R-1.0, R-1.5 and R-2.0) which were supplemented with 0.5, 1.0, 1.5 and 2.0% red ginger, respectively for five weeks and observed that the major component of ginger is zingiberen and zingerol that can stimulate the digestive systems by controlling the digestive pH and the activity of digestive enzyme and the microbial activity.

Effect of supplementation of ginger and garlic on body weight gain of quails

Different researcher had tried at different levels of garlic and ginger in the diet of birds but most consistent results were obtained at about 1% level of supplem[14,23,24]. Oleforuh-Okoleh *et al*[14] designed the experiment to investigate the growth performance, haematological and serum biochemical response of poultry chickens to aqueous extract of ginger and garlic took eighty day-old Marshal strain poultry chickens randomly allotted into four treatment groups consisting of four replicates with five birds per replicate infused 14 g of each test ingredient in 1 litre of hot boiled water for 12 hours and 50 ml of the filtrate/litre of drinking water was given to birds *ad-libitum* for 56 days. T1 (control), T2, T3, and T4 contained 0 and 50 ml of ginger and garlic at a ratio mixture of 1:1 in their drinking water respectively and observed a significant increase in final body weight, higher feed intake and better feed conversion ratio in T2 group. Though there was no significant difference ($p>0.05$) in the initial body weight of the birds, feeding the ginger and garlic @14g/kg of the diet significantly ($p<0.05$) increased the final body weight of the birds[14]. Similarly, Puvaca *et al*[25] observed improved growth and feed conversion ratio, and decreased mortality rate in case of poultrys supplemented with ginger. Also, Herawati[13] illustrated that hubbard strain poultrys fed 2% supplemental red ginger in the diet had significantly higher final body weight than those on the control diet in his experiment as explained above. Minh *et al*[26] reported that supplementation of dried ginger to poultry diets led to improved performance and reduced feed cost. Canogullari *et al*[27] conducted an experiment taking one hundred and twenty 10-weeks-old quails allocated to four dietary treatments. Quails were caged individually and

fed diets supplemented with 0 (control), 1, 2, 4% garlic powder for 12 weeks. There were significant (P<0.05) increased in feed consumption, feed efficiency and egg production. The better values for these parameters were obtained from the 1% garlic powder supplemented group. Fadlalla *et al*[28] showed that garlic at 0.3% in poultry feed resulted significant positive effect on growth performance and carcass yield. But El-Deek *et al*[29] revealed that diet containing 1 g/kg of ginger did not affect the growth performance of poultrys.

Pourali *et al*[30] suggested that allicin in garlic promotes the performance of the intestinal flora thereby improving digestion and enhancing the utilization of energy, leading to improved growth. Al-Moramadhi[31] observed increased body weight in poultry chicks supplemented with ginger orally at 100 mg/kg body weight for six weeks. Ademola *et al*[32] with three hundred and ninety six day-old poultry chicks of Hubbard strain randomly distributed into 11 dietary treatments, with 3 replicates in a treatment of 36 chicks supplemented with diets as T1, T2 and T3 at 1.0%, 1.5% and 2.0% of garlic on the other hand T4, T5 and T6 contained 1.0%, 1.5% and 2.0% ginger whereas T7 and T8 contained 1.0% and 1.5% garlic along with 0.25 % ginger was added to both diets ,while T9 and T10 contained 1.0% and 1.5% garlic respectively as well as 0.5% ginger were added to both diets, reported a numerical increase in final body weight and weight gain of poultrys when fed with a mixture of garlic and ginger. Mahmood *et al*[33] confirmed that powdered garlic at 0.5% level may be incorporated as growth promoter in the ration of Japanese quails more effectively as compared to any other level. Demir *et al*[34] postulated that garlic has been used for about 50 years as antibiotic growth promoters and to enhance growth performance in poultry and swine. Phytogenic substances are supposed to increase performance of birds by stimulating secretion of digestive enzymes, leading to enhanced digestion and absorption[35,36] . Bampidis *et al*[37] in their study came to conclusion that growth of poultrys supplemented with ginger got improved, but more effective at higher concentrations ranging 1-2% of the diet. Dibner and Richards[38] reported that garlic has been used since long time as antibiotic growth promoters and to enhance growth performance in poultry and swine. Farinu *et al*[39] suggested that supplementation of ginger at the levels of 5, 10, or 15 g/kg slightly improved growth performance of poultrys. Tollba and Hassan[40] observed improved growth and feed conversion ratio and decreased mortality rate in case of poultrys supplemented with ginger. Garlic supplementation also responsible for enhancing the activity of pancreatic enzymes thereby provides an environment for better absorption of nutrients[41].

Effect of supplementation of ginger and garlic on feed conversion efficiency of quails

The birds fed rations supplemented with garlic and black pepper combination utilized their feed more efficiently resulting in higher body weight[42]. A remarkable positive effect was observed when aqueous extract of plant mixture containing *Zingiber officinale*, *Carum apticum*, *Withania somnifera*, *Allium sativum* and *Berberis lyceum* used as a feed supplement on the performance of poultry chicks in term of weight gain, feed intake and Feed Conversion Ratio[14]. A similar type of result was discovered by Javed *et al*[43] who showed a positive effect of aqueous extract of plant mixture (*Zingiber officinale*, *Carum apticum*, *Withania somnifera*, *Trigonella Foenum-Graecum*, *Silybummari anum*, *Allium sativum* and *Berberis lyceum*) on the performance of poultry chicks in term of weight gain and Feed Conversion Ratio. Birds fed on the diet containing ginger extract (200mg/kg) and Mannon oligosaccharide exhibited higher body weight gain compared with those fed on control unsupplemented diet over the entire experimental period (p<0.05). FCR was also improved by ginger extract (200mg/kg) and Mannon oligosaccharide supplemented diets compared to the control group (p<0.05) (Ghasemi and Taherpour (2015). Barazesh *et al*[44] reported that adding

ginger to feed diet could improve FCR and blood lipid profile, whereas no changes were reported in feed intake as regard body weight gain and FCR in poultrys with aqueous extract of ginger at the levels of 0, 0.25, 0.5, 0.75 and 1% supplemented through drinking water[45]. In an experiment with 240 day-old Ross poultry chicks it had been observed that supplementation of garlic powder @ 0.5, 1 and 3% for 6 wks had better FCR than control unsupplemented group. Birds which were supplemented with garlic powder in the finisher diet had better FCR than those which were supplemented for the whole of the experiment[46]. Similarly, Onu[47] experimented with 120 poultry birds randomly assigned to four dietary treatments in a completely randomized design. T1 served as the control contained neither ginger nor garlic. Diets 2 (T2) and 3 (T3) contained 0.25% garlic and ginger respectively. Diet 4 (T4) contained a combination of 0.25% of garlic and ginger. He observed that ginger and garlic supplementation at 0.25% level in poultry finisher diets enhanced the growth rate and feed conversion ratio of the birds. Dietary fermented garlic supplementation in poultry ration can increase the intestinal villus height, villus area, cell area, and cell mitosis in the intestine and results in better feed conversion efficiency[48]. Onimisi *et al*[49] and Moorthy *et al*[50] reported significantly better feed conversion ratio in ginger supplemented poultrys as compared to their experimental control group respectively. Tekeli *et al*[51] stated that due to the active ingredients in ginger and garlic, there is formation of more stable intestinal flora and improved feed conversion efficiency in consequence of a better digestion. Garlic increases growth and improves feed conversion ratio by increasing height of villus of small intestine, activation of absorption process[40]. Vervaeke *et al*[52] revealed that as much as 6% of the net energy in animal diet can be lost due to bacterial utilization of glucose in the small intestine and also these bacteria require amino acids in relatively similar proportional amount as the animal according to Hays[53]. When garlic and ginger were added there may have been a nutrient sparing effect, therefore improving feed conversion ratio.

Effect of supplementation of ginger and garlic on blood haematology of quails

It has been found that organic dietary supplement of ginger and garlic has significant effect on blood hematological studies. Oleforuh-Okoleh *et al*[14] in his experiment as explained above found significant ($p<0.01$) increase in haemoglobin concentration, packed cell volume, white blood cell, and red blood cell of the ginger and garlic treated birds. Whereas George *et al*[54] incorporated that ginger at graded levels of 0g, 2g, 4g and 6g per kg feed and showed that haematological parameters (Hb and PCV) were not significantly influenced by the treatment. Zomrawi *et al*[55] took one hundred and twenty-eight unsexed day old poultry chicks (Ross 308) to evaluate the effect of ginger root powder as natural feed additives on growth performance, blood and serum constituents of poultry chickens. Four dietary treatments were formulated to meet the nutrient requirements of poultry chick containing ginger root powder at levels 0%, 0.5%, 1% and 1.5% and observed that the inclusion of ginger root powder at levels 0.5% and1% in the diet had no significant ($P>0.05$) effect on Hb, PCV, RBC, MCV, MCH and MCHC percentage. A similar experiment was adopted by Ademola *et al*[32] with three hundred and ninety six day-old poultry chicks of Hubbard strain randomly distributed into 11 dietary treatments, with 3 replicates in a treatment of 36 chicks supplemented with diets as T1, T2 and T3 at 1.0%, 1.5% and 2.0% of garlic on the other hand T4, T5 and T6 contained 1.0%, 1.5% and 2.0% ginger whereas T7 and T8 contained 1.0% and 1.5% garlic along with 0.25% ginger was added to both diets, while T9 and T10 contained 1.0% and 1.5% garlic respectively as well as 0.5% ginger were added to both diets, concluded that garlic and ginger at 1.5 and 2% respectively did not affect the red blood cells and haemoglobin concentration of the chickens.

Effect of supplementation of ginger and garlic on blood biochemistry of quails

Organic dietary supplementation of ginger and garlic had significant effect on blood biochemical study was revealed by Oleforuh-Okoleh *et al*[14] who observed that inclusion of ginger and garlic in the water of poultry chickens successfully reduced the cholesterol in the serum. Ghasemi and Taherpour[56] also reported lower cholesterol level ($p<0.05$) in the birds fed on ginger extract (100mg/kg) and MOS diets compared to control diet. Tavakol and Hamidreza[57] experimented with 160 one-day-old Ross 308 poultry chicks observed decrease in blood cholesterol concentration in birds supplemented with ginger for 42 days. Bamidele and Adejumo[24] took 225 birds, grouped into five treatments and each treatment had 3 replicates with 15 birds per replicate in a complete randomized design. The control diet did not contain garlic and ginger mixtures. Garlic supplements were added at 0.50%, 1.00%, 1.50% and 2.00% to dietary treatment T1, T2, T3 and T4 respectively. Ginger was added at 0.50% in the entire ration and found that the combined effect of garlic and ginger mixtures has greater influence as an anti-hypercholesterolemic agent. Javed *et al*[43] reported that ginger and garlic in the water of poultry chickens successfully reduced the cholesterol in the serum. Ademola *et al*[32] with three hundred and ninety six day-old poultry chicks of Hubbard strain observed that garlic and ginger showed hypolipidemic effects on the serum cholesterol, triacylglycerol and abdominal fat. The combined effect of garlic and ginger has been used to prevent high blood pressure, high cholesterol level and cholesterol oxidation which are the primary causes of atherosclerosis, the precursor of cardiovascular diseases[58]. According to Agarwal[59] and Sharma[12] medicinal herbs such as garlic and ginger have been reported to possess lipid lowering effects. Youn *et al*[60] reported that serum triglycerides were lowered significantly ($P<0.05$) by supplementing garlic powder to the diet. Garlic and garlic preparations significantly reduced plasma lipids, especially total cholesterol and low density lipoprotein (LDL) in humans[61,62].

Garlic extract was fed to 5-wk-old male poultrys for 3 wk and exhibited hypocholesterolemic effects, mainly through the inhibition of the key enzymes, such as hepatic 3-hydroxy-3- methylglutaryl coenzyme A (HMG-CoA) reductase, cholesterol 7α-hydroxylase, and fatty acid synthetase in cholesterol and lipid synthesis in an experiment[63]. It has been found to lower serum and tissue cholesterol levels was confirmed by Jamal and Omar[64] and Stanacev *et al*[15] which is responsible for inhibition of bacterial growth, inhibit platelet growth and reduce oxidative stress[65]. Jamal and Omar[64] investigated the effect of garlic powder by taking 270 day-old Cobb-500 chicks, partitioned into three experimental groups of 90 birds in each. The control group was fed with a commercial starter and finisher diet. The second and third groups were supplemented with garlic powder @ 0.2% and 0.4% respectively. It showed a significant decrease in the level of LDL, decrease in the level of triglycerides, decrease in the level of cholesterol, increase in the level of HDL in birds. Stanacev *et al*[15] reported that garlic manifested hypocholesterolemic effects on chickens. Mansoub[66] illustrated reductions in total cholesterol when poultrys were supplemented with 1 g garlic /kg of diet. Canogullari *et al*[27] conducted an experiment taking one hundred and twenty 10-weeks-old quails allocated to four dietary treatments. Quails were caged individually and fed diets supplemented with 0 (control), 1, 2, 4% garlic powder for 12 weeks and observed reduced total lipid concentration of plasma by 1.60, 14.23 and 16.31%, and plasma triglyceride concentration by 3.77, 6.01 and 8.85%, respectively with experimental diet containing 1, 2 or 4% garlic powder compared with the control diet. Fenwick and Hanley[67] and Fenelli *et al*[68] gave the statement that when garlic is chopped or crushed, the allinase enzyme present in garlic is activated and acts on alliin (present in whole garlic) to produce allicin.

These compounds provide garlic its characteristic odour and flavour as well as most of its biological properties and have been identified as having the hypocholesterolemic effect in human and animal products. The allicin may reduce the levels of serum cholesterol, triglyceride and LDL and it may have significant amount of cholesterol oxidation products. Therefore, the decrease in LDL cholesterol could also mirror the antioxidant effects of garlic supplementation[69]. Bordia *et al*[70] concluded that garlic powder can facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass. Yalcin *et al*[71] reported a significant decrease ($P<0.05$) in serum triglycerides by the supplementation of garlic powder. Moreover, Chowdhury *et al*[72] and Lewis *et al*[73] deduced that serum cholesterol was decreased with feeding garlic to layers. Konjufca *et al*[74] reported that although performance was not affected when poultry diets were supplemented with 1.5, 3 and 4.5% garlic powder, their serum and liver cholesterol decreased significantly by decreasing the activity of 3-hydroxy-3-methlyglutaryl reductase. Also, Sklan *et al*[75] found the dietary garlic paste to be effective in reducing the amount of cholesterol in laying hens and egg yolk. Qureshi *et al*[63] suggested that garlic paste (3.8%) or solvent-extracted garlic reduced the amount of serum cholesterol by 18 and 23% in poultrys respectively.

Medicinal plants reduce harmful bacteria in gastrointestinal tract, reduce amino acid and protein degradation, with this mechanism most of the amino acids and proteins will be absorbed[76]. Saeid *et al*[77] observed that aqueous extract of ginger significantly reduced the level of cholesterol in the blood of poultries. Zhang *et al*[78] observed increased serum protein concentration in 144 day-old Arbor Acres poultries supplemented with ginger root at the level of 5 g/kg of diet. Akhani *et al*[79] reported that ginger treatment significantly decreased serum cholesterol.

Effect of supplementation of ginger and garlic on carcass characteristics of quails

Improvement of poultries performance and carcass merits can be achieved by supplementation of diets with ginger powder[34,73,80,81]. Using ginger powder in poultries diet had no significant effect on performance but it improves meat quality and carcass yield[82]. Bordia *et al*[70] reached in a conclusion that garlic powder can facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass. Oleforuh-Okoleh *et al*[14] in his experiment as explained above discovered that the dressing percentage was significantly ($p<0.05$) increased when ginger and garlic were fed in powder form. The abdominal fat was greatly reduced in supplemented birds. Baba *et al*[83] took two hundred twenty-five poultries and observed significantly higher dressing % and breast weight in 0.5% ginger supplemented birds than control. Raeesi *et al*[46] in his experiment with 240 day-old Ross poultry chicks observed that supplementation of garlic powder @ 0.5, 1 and 3% for 6 wks had better carcass yield ($p<0.001$). Supplementation of 1% garlic powder caused higher thigh yield ($p<0.001$) while the poorest thigh yield belonged to 3% supplemented group. Groups received 1% garlic powder significantly had higher breast yield than others ($p<0.001$). Breast yield was also higher in groups received garlic in their finisher diet than others ($p<0.001$). Zhang *et al*[78] observed increased carcass yield and reduced abdominal fat in 144 day-old Arbor Acres poultrys supplemented with ginger root at the level of 5 g/kg of diet. Garlic as an alternative of growth promoters in poultry revealed its excellent effects on growth, digestibility and carcass characteristics[84]. Demir *et al*[34] and Lewis *et al*[73] found garlic powder as a natural growth promoter can be a potential alternative for common artificial growth promoters like antibiotics and in this respect, it can improve performance and carcass characteristics in poultry chickens.

Effect of supplementation of ginger and garlic on immunity of quails

Ginger and garlic supplements in poultry chicken diets have been recognized for their strong stimulating effect on the immune and digestive systems in birds[85]. Ghasemi and Taherpour[56] undertook an experiment of 375 day old male poultry chicks randomly assigned to five treatments. They revealed an increased in antibody titres against IBD vaccine in the birds supplemented with ginger extract @ 200mg/kg. A similar study was also undertaken by Azhir *et al*[86] using 96 day-old Ross 308 poultrys to assess the effect of ginger root powder (*Zingiber officinale*) on humoral immunity of poultry chickens. They observed an increased of HI titres in the birds supplemented with ginger rhizome powder @ 10 g/kg for 35 days. Birrenkot *et al*[87] reported that including garlic in the laying hens resulted in increased humoral immunity in birds. Similarly, Gardzielewska *et al*[88], Aji *et al*[89], Ashayerizadeh *et al*[90], Hanieh *et al*[91] and Ayaşan[92] observed increased immunity in poultries supplemented with ginger and garlic. Increased immune response in poultry birds supplemented with ginger oil @ 10mg/kg/day, 20mg/kg/day and 40mg/kg/day. This may be due to modulation of intestinal microbiota[93]. Gardzielewska *et al*[88] also confirmed that garlic supplementation enhances immune system in poultry chicken due to rich aromatic oils which enhance digestion of birds.

CONCLUSION

The applications of herb and spices products, as possible alternatives to antibiotic, have increased in poultry diets, which resulted in improved production and health. Japanese quail feed supplemented with ginger and garlic has resulted better production performance in terms of feed conversion ratio, body weight gain, disease resistant with enhanced immunity for better consumption by human being and animals. Exploitation of lipid lowering agents of garlic and ginger in poultry diets may be used as a measure to reduce levels of serum cholesterol, triacylglycerol and abdominal fat of poultry birds. Increase in the hematological parameters viz. Hb, RBC and PCV was found to be significantly higher in supplemented groups than that of the treated groups. The immunity parameters were also found to be better in ginger and garlic supplemented groups (either alone or in combination) than that of control (without ginger and garlic) group. So, japanese quail feed supplemented with ginger and garlic has resulted better production performance in terms of feed conversion ratio, body weight gain, disease resistant with enhanced immunity for better consumption by human being and animals.

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