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Sustainability of broiler birds fed ginger powder supplemented diets

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ABSTRACT

Performance of broiler birds fed diet supplemented ginger powder in the diet of broiler birds and their effects on different productive parameters, biochemical constituents and economics of production was reviewed. Data collected on the chemical constituent found in ginger powder, active ingredient responsible for interfering the body mechanism, the adequate levels of ginger powder to be added in the diet of broiler birds, the different methods of ginger powder addition, like inclusion in the diet or mixing in water or any other method was considered. Results on body weight, gain in body weight, feed intake, feed conversion efficiency, some blood constituents as Haemoglobin and packed cell volume were incorporated. Supplementation of ginger powder on dressing percentage and carcass yield along with organ weigh were also considered. Finally, the cost benefit for every unit of production was also considered. From the reviews, it may be concluded that dietary supplementation of ginger powder was found to be beneficial in terms of performance as body weight gain, feed intake, feed conversion efficiency, live ability, performance index, carcass characteristics and organ weight, blood constituents like haemoglobin, packed cell volume and overall net profit of rearing broiler chicken as compared to the non-turmeric powder added chickens.

Keywords: Body weight; Feed conversion efficiency, Ginger powder, Haemoglobin, Packed cell volume.

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Introduction

Broiler birds production has undergone developments over the last few decades. Constant improvements in nutrition and genetic selection have led to a fast growth rate in modern broiler strains, to the extent that the average time required to grow a broiler birds to 2 kg has reduced from 63days to 37 days (Shariatmadari, 2012). The growth is 6-8 percent in egg production and 10-12 percent in broiler production per annum against the growth of agriculture as a whole which is around 2.5 percent (Kotaiah, 2016). The per capita egg consumption has gone up from 30 to 68 and the chicken from 400 grams to 2.5 kilogrammes. Human nutritionists recommend 180 eggs and 10 kgchicken per year. Most of the countries consume over240 eggs and 20 kg chicken per year (Kotaiah, 2016).

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Poultry sector has been extremely beneficial for the common masses and also contributed to earning foreign exchange through exports. It serves as an important tool to provide household nutritional security and supplementary incomes especially to the vulnerable section of society.

Feeds containing no chemical additives are increasingly used in poultry nutrition. For this reason, herbs and natural feed additives are been investigated as natural sources biologically important substances (Demir *et al*., 2005). There is a great demand to produce high quality poultry meat and eggat low prices without having to rely on antibiotics and other growth promoters in poultry feed and water (Mehala and Moorthy, 2008). There is also discriminate use of inorganic products to get more profit and awareness towards safe food and healthy lifestyle has increased the demand for organic products.

In view of this, herbal and plant derivatives could be valuable alternative in promoting growth and health of poultry as it has no ill effect. Feed additives are added in broiler diets to improve its productive performance by increasing growth rate,

better feed conversion efficiency and greater live ability. Use of spices as an additive in the diet of chicken is very common (Chowlu *et al*., 2018; Jamir *et al*., 2019; Munglang and Vidyarthi, 2019; Rio *et al*., 2019; Shohe *et al*., 2019).

Active principles of the plant or chemical compounds present in certain parts or the effect of therapeutic activity that accompanies them (Zhang *et al*., 2009, Ahaotu and Lawal, 2019). Spices and herbs benefits in health of broiler and other functions such as anti-oxidation ability, antimicrobial activity (Dorman and Deans, 2000), enhancing digestion by stimulating endogenous enzymes (Brugalli, 2003). Spices are very common and useful additives in broiler diets (Zhang *et al*., 2009). Feed additives are added in animal feeds to improve their nutritive value, boost animal performance by increasing their growth rate, better feed conversion efficiency, greater livability and lowered mortality in poultry birds.

Zingiber officinale is a perennial plant commonly known as ginger. The plant belongs to the family *Zingiberaceae,* which are aromatic herb with fleshy, tuberous or non-tuberous rhizomes and often have tuber bearing roots (Ke *et al*., 2000). The part of the ginger plant that isused in both cooking and herbal medicine is the root or rhizome and the horizontal stem from which the roots grow. The rhizome of ginger has been used in traditional herbal medicine. The health promoting perspective of ginger is attributed to its rich phyto chemicals; based on flavoring substances. Fresh gingers are grouped into two wide range categories as volatiles and non-volatiles oils. Apart from taste, gingers have medicinal properties such as *gingerol* and *shogaol*.

Ginger speeds digestion and enhances by a protein digestive enzyme (*zingibaine*) found in ginger. It has antibacterial and anti-inflammatory actions and ginger rhizome is knownto lower cholesterol level in man. Ginger rhizome is widely used as a spice or condiment (Larsen *et al*., 1999). Herbs Hand Healing (2011) reported that ginger contains volatitle oils like *borneol, camphene, citral, eucalyptol, linalool, phenllandrene, zingiberine, zingiberol* (*gingerol, zingirone* and *shogaol*) and resin. It was also reported to enhance anti-bacterial and anti-inflammatory actions and it is thought to assist other anti-bacterial, such as antibiotics, by up to 50 percent.

Ginger contains about 12 antioxidant constituents, the combined action of which has been regarded as being more powerful than vitamin C. Ginger is highly valued for its aroma, pungency, high oil and oleoresin content. Adanlawo and Diaro (2007) reported that ginger contains 5.28 percent crude protein (CP), 5.54 percent ether extract (EE), 5.97percent ash and 66.26 percent total carbohydrate. Therefore, there is a beneficial effect of dietary supplementation of ginger on performance of broiler birds. Ginger as a natural feed additive may be of immense benefit and value in poultry nutrition especially for broilers due to their anti-bacterial, anti-inflammatory, antiseptic, anti-parasitic and immune-modulatory properties (Onu, 2010). Ginger has good pharmacological properties and can be a useful natural growth promoter and safe alternative to antibiotics.

Body Weight and Growth Rate

Effect of supplementation of ginger powder at 5 g/kg level of diet and found that the final weight was 1830.6 and 1983.3 g/bird in control and treated groups, respectively and concluded that inclusion of ginger powder in the broiler ration tended to increase growth rate of broilers (Zhang *et al.* (2009). Thayalini *et al.* (2011) concluded that there was no improvement in the overall performance of birds fed either *Zingiber officinale* rhizome or *Cymbopogoncitratus* leaf supplements when compared to the birds fed the control feed. Wadhwa *et al.* (2011) studied the effect of ginger powder supplementation at the rate 250(G1), 500(G2) and 720(G3) g/q of broiler reared for 42 days of age and found that the weight gain was 16.69, 35.10 and 24.60 percent higher in G1, G2and G3 as compared to control.

Bamidele and Adejumo (2012) observed that dietary supplementation of garlic and ginger mixture at 0.50 garlic + 0.50 ginger, 1.00garlic + 1.00 ginger, 1.5 garlic + 0.75 ginger and 2.00garlic + 0.75 ginger percent level had no significant($P>0.05$) effect on body weight (600.00, 535.38,625.00, 562.83 and 630.00 g) and weight gain (566.00,501.38, 592.83, 529.83 and 596.13 g) of broiler birds. Mohamed *et al.* (2012) observed that dietary supplementation of ginger at 0, 0.1 and 0.2 percent level of the broiler chicken diet had significant ($P<0.05$) difference in final weight *i.e.* 1875.00,2022.83 and 2075.90 g/bird among the treatment.

Zomrawi *et al.* (2012) observed that there was significant decrease ($P>0.05$) in weight gain for bird fed 0.5 percent ginger root powder but weight gain

for bird fed with 1.0 and 1.5 percent ginger root powder increased as compared to control group. Fakhim *et al.* (2013) evaluated the effect of different concentration of aqueous extract of ginger (0, 0.25, 0.5, 0.75 and 0.1 %) supplemented in drinking water and found that the weight gain was 2174.0, 2099.2, 2186.2, 2180.0 and2193.0 g, respectively. George *et al.* (2013) observed that supplementation of ginger at 0, 2, 4, and 6 g/kg diet significantly (P<0.05) increased the body weight (1949.67, 2074.67, 2195.00 and 2350.00 g/bird) and weight gain (1.916.67, 2,041.67, 2, 162.00 and 2.317 g)of broiler birds. Rafiee *et al.* (2013) confirmed the effect of using ginger and thymus extracts on broiler performance and observed significant effect on growth rates. Selim *et al.* (2013) conducted a study on efficiency of aqueous extract of ginger root (GAE), aqueous extract of beetroot (BAE) and tomato puree (TP) as natural antioxidant source in broiler diet.

Zomrawi *et al.* (2013) reported that performance of broiler birds improved when gingerroot powder was included in the broiler diet at 1percent level as compared to control group. Ahmed *et al.* (2014) indicated that supplementation of ground ginger root powder at 0, 0.5, 0.75 and 1 percent level in broiler chick diet had no significant effect on bodyweight (1103.35, 1140.22, 1141.25 and 1146.97 g/bird)and gain in weight (1064.35, 1101.22, 1102.25 and1107.85 g/bird) of broiler.

Rebh *et al.* (2014) observed that supplementation of ginger root powder at the rate0, 7.5, 1.25, 1.75, 2.25 g/kg in ration of broiler had significantly (P<0.05) positive effect on the bodyweight (1192.66, 1385.8, 1170.4, 1264.2, and 1176.86g/bird) and weight gain (228.65, 253.90, 223.88,242.81 and 224.93 g/kg) of broiler.

Adeyemo *et al.* (2016) observed that there was no significant difference in all performance indices from different drying methods except for average body weight which was significantly (P<0.05) influenced. Karangiya *et al.*(2016) showed that body weight gain (g/bird) was significantly (P<0.05) higher in garlic (1649.17 g) and ginger (1724.17 g) supplemented group as compared to control (1606.70 g) and garlic and ginger mixture(1598.36 g) supplemented group. Zidan *et al.* (2016) found that supplementation of ginger root powder at15g/kg diet significantly (P<0.05) increased the bodyweight gain and growth performance of the broiler birds as compared to control group.

Talukdar *et al.* (2017) reported that supplementation of ginger at the rate of 1 percent of broiler ration improved body weight (1746.0 g) significantly (P<0.05) as compared to control (1520.8 g) group and could be a possible alternative to antibiotic growth promoter in the feeding of broiler birds. Al-Khalifa *et al.* (2018) reported that overall growth of bird was not adversely affected by the addition of ginger in the diet of broiler. Bodyweight gain of birds supplemented with ginger was significantly (P<0.05) higher than that of control group. Belal *et al.* (2018) observed that supplementation of ginger at 15 g/kg level of diet had significantly (P<0.05) increase body weight and weight gain as compared to control group.

Rio *et al*. (2019) reported that the mean initial body weight of day old broiler chicks were 0.052, 0.055, 0.054 and 0.051 kg/bird on diet supplemented with ginger powder at the rate of zero (T1), 2.5 (T2), 5.0 (T3) and 7.5 (T4) g/kg feed, respectively. The corresponding weight of the birds on the 6th week of age was 2.504, 2.536, 2.637 and 2.693kg/bird. The overall body weight of the broiler birds was 0.417, 0.413, 0.440 and 0.449 kg/bird/week, respectively. From the results, it indicated that average body weight was significantly (P<0.05) the highest in T4 group followed by T3, T2 and the least inT1 group. Further, they also reported that the mean weekly body weight gain at first week of age was0.098, 0.097, 0.104 and 0.105 kg for T1, T2, T3 and T4groups, respectively and the corresponding mean gain in body weight was 0.408, 0.399, 0.430 and 0.411kg/bird. From the result, it was revealed that the dietary supplementation of ginger resulted in significantly(P<0.05) higher gain in body weight in T4 group followed by T3, T1 and the least in T2 group; however, there was non-significant difference between T1 and T2groups.

Feed Intake and Feed Conversion Ratio

Ademola *et al.* (2009) observed that inclusion of garlic and ginger in broiler diet had no significant difference in the feed intake and feed conversion ratio. Kehinde *et al.* (2011) conducted an experiment to evaluate the effect of graded level of ginger in the diets of cockerel chicks on feed intake and revealed that ginger supplementation at 0.0, 1.50, 3.00 and 4.50 percent had shown no adverse and significant effect on daily feed intake. Bamidele and Adejumo (2012) observed that dietary supplementation of garlic and ginger mixture at

0.50 garlic + 0.50 ginger, 1.00 garlic+ 1.00 ginger, 1.5 garlic + 0.75 ginger and 2.00 garlic +0.75 ginger percent level had no significant effect on feed intake (4327.12, 3119.81, 4653.93, 3709.39 and4975.02 g) and feed conversion ratio (7.64, 6.33, 7.88,7.01 and 8.39). Mohamed *et al.* (2012) conducted a study to evaluate the effect of ginger at 0.0, 0.1 and 0.2percent levels in the diets on feed intake of broiler chicks. The broiler received diet 0.2 percent ginger consumed significantly less feed in comparison to diet at 0.1 percent and with no supplementation.

Zomrawi *et al.* (2012 and 2013) observed that there was an increase in feed intake for bird fed 1.0 and 1.5 percent gingerroot powder and that there was no significant difference in feed conversion ratio (2.18, 2.19, 2.15 and 2.24)among all dietary treatment; however, at 1.5 and 2.0 percent significantly (P<0.05) decreased feed intake as compared to the control group. Elmakki *et al.* (2013) evaluated the effect of ground ginger root (*Zingiber officinale*) to the diet of broiler birds at 0, 0.25, 0.50 and 0.75 percent level and reported that feed intake and FCR was significantly (P<0.05) lower in the six week with increased levels. Fakhim *et al.* (2013) observed that supplementation of aqueous extract of ginger (*Zingiber officinale*) at 0, 0.25, 0.50, 0.75 and 1 percent level had no significant difference in feed intake(4332.5, 4344.5, 4351.0, 4331.5 and 4341.0 g) and feed conversion ratio among the treatment groups. George *et al.* (2013) observed that increased ginger level (0, 2, 4and 6 g/kg diet) significantly (P<0.05) increased feed intake (4070.0, 4175.0, 4196.0 and 4270.0 g) while feed conversion ratio was better with increased level of ginger (2.12, 2.04, 1.94, and 1.84) of broiler birds. Ahmed *et al.* (2014) reported ginger supplementation at the rate 0, 0.50, 0.75 and 1.00 percent level in broiler diet was 2266.10, 2432.67, 2396.30 and 2443.65 g feed intake while FCE was 2.5, 2.2, 2.2 and 2.2, respectively.

The values either of feed intake and FCEwere significantly (P<0.05) positive in treatmentgroups as compared to control group. Ebrahimnezhad *et al.* (2014) reported that supplementation of ginger at 0, 5, 10, 15, 20 and 25 g/kg feed showed significant (P<0.05) difference in feed intake (4770.30, 4537.30, 4537.10, 5015.00, 4557.90, 4749.70 and 4664.30g/bird) and feed conversion efficiency (1.88, 1.72, 1.91,1.85, 1.80 and 1.81) among the treatment groups. Habibi *et al.* (2014) reported that there was no significant difference in feed intake of broiler on ginger supplementation as a powder or essential oils. Rebh *et al.* (2014) observed that supplementation of ginger powder at the rate 0, 0.75, 1.25, 1.75, 2.25 g/kg feed in broiler showed no significant difference in feed intake (806.68, 782.46, 882, 768.26 and 766.93 g) and FCR (1.27, 1.04, 1.40, 1.09 and 1.22) among the treatment groups.

Adeyemo *et al.* (2016) observed that bird fed with ginger at the rate 0, 1, 1.5 and 2 percent level had significant (P<0.05) difference in FCR (2.43, 2.55, 2.63and 2.51) of broiler birds; however feed intake was similar. Karangiya *et al.* (2016) revealed that feed intake of experimental birds in ginger (3367.77 g) and mixture of garlic and ginger (3395.61 g) supplemented group have significantly (P<0.05) higher feed intake as compared to control (3270.56 g) group. Attia *et al.* (2017) reported that 0.5 per cent ginger supplemented continuously had no effect on feed intake of broiler chicken during 7-42 days of age. Shinde *et al.* (2017) reported that average total feed intake of experimental bird in control group was significantly (P<0.05) higher as compared to cardamom and ginger supplemented group. Al-Khalifa *et al.* (2018) observed that feed consumption was not affected in broiler birds when fed diet supplemented with ginger powder at 0, 5, 10 and15 g/kg diet. Rio *et al.* (2019) reported that total feed intake during the entire period of the experiment of 6thweeks was 4.614, 4.612, 4.608 and 4.585 kg/bird on diet supplemented with ginger powder at the rate of zero (T1), 2.5 (T2), 5.0 (T3) and 7.5 (T4) g/kg feed, respectively. The corresponding value for mean feed intake was 0.769, 0.769, 0.768 and 0.764 kg/bird/week. The overall feed intake was non-significant between treatment groups. Further, they also reported that the average feed conversion efficiency (FCE) of broiler birds in different group was 1.82, 1.83, 1.73 and 1.70 for T1, T2, T3 and T4 groups, respectively.

Feed conversion efficiency was significantly (P<0.05) better in T4 group followed by T3, T1 and the least in T2group; however, there was non-significant difference between T1 and T2 groups and between T3 and T4groups.

Carcass Traits and Organ Weight

El-Deek *et al.* (2002) reported that supplementation of anise; ginger and fennel at 0.05 percent level respectively had no significant difference in dressing percentage 78.0, 77.7, 77.9 and 76.4 percent of broiler birds, respectively. Ademole *et al.* (2009) evaluated the effect of garlic and ginger powder

and their mixture on carcass and organs of broiler and showed significant (P<0.01) difference in the carcass part and organ development of the broiler birds. Moorthy *et al.* (2009) showed that no effect of ginger supplementation on relative weight of abdominal fat and liver in broilers. Zhang *et al.* (2009) found that ginger significantly (P<0.05) increased carcass yield compared to the control group, but the abdominal fat was slightly lower.

Shanoon *et al.* (2012) studied on the effect of ginger oil on organ weight of broiler birds. Result showed that all organ weight and carcass characteristics were not affected irrespective of the treatments; however, relative weight of head and the gizzard decreased (P<0.05) as compared to the control. Zomrawi *et al.* (2012) reported that supplementation of ginger root powder at 0, 0.5, 1.0 and 1.5 percent level increased pre-slaughter weight (g/bird) in 1.0 percent and 1.5 percent level in broiler diet. There was no significant difference in dressing percentage (75.88,75.91, 76.26 and 75.15 %) among the treatment groups, respectively. Barazesh *et al.* (2013) suggested that inclusion of ginger powder at 0, 0.50, 1.00 and 1.50percent level in broiler diets had no significant change in the weight of liver (3.62, 3.45, 3.02 and 3.12 %),gizzard (3.52, 3.17, 2.84 and 3.59) and spleen (0.18,0.17, 0.17 and 0.21 %) as percentage of live weight, respectively among the four treatments. Elmakki *et al.* (2013) reported that carcass weight was higher for birds fed with 0.25 percent level ginger (1591 g) in comparison to control (1562 g). Fakhim *et al.* (2013) showed that the different concentration of ginger extract in drinking water of broiler influenced the carcass yield significantly (P<0.05) as compared to control. Rafiee *et al.* (2013) reported that liver of broiler significantly (P<0.05) decreased when fed with thymus and ginger; however, there was no significant difference in heart percentage between treatment groups. Zomwari *et al.* (2013) evaluated the effect of ginger powder as natural feed additives on carcass trait of broiler chicks. Four graded level of ginger root powder 0, 1, 1.5 and 2 percent were used. Result showed significant (P<0.05) decrease in pre-slaughter weight for bird fed 2 percent ginger root powder and lower dressing percentage was recorded for control as well as 2 percent ginger root powder diet. Habibi *et al.* (2014) observed that ginger powder at 0.75 and 1.5 percent or given essential oils 0.075 and 0.15 mg/kg diet had no significant effect on spleen and bursa off abricus. Attia *et al.* (2017) showed that 0.5 percent ginger could replace mannano-ligosaccharide as aprebiotic without negative effects on productive performance, carcass traits, meat quality, blood constituent and immune response as compared with the control. Kidane *et al.* (2017) conducted an experiment on effect of different mixture level of oyster mushroom, garlic and ginger powder as substitutes for antibiotics growth promoter on carcass traits of broiler.

The treatment were T1 = negative control, T2 = positive control (T1 + 0.30 gm/kg oxytetracycline), T3 = T1 + 0.5per cent oyster mushroom powder + 1 percent garlic powder, T4 = T1 + 0.5 percent oyster mushroom powder + 1 percent ginger powder, T5 = T1 + 1 percent garlic powder + 1 percent ginger powder and T6 = T1 +0.33 percent oyster mushroom powder + 0.66 percent garlic powder + 0.66 percent ginger powder and showed that bird kept on T2 and T4 diet had highest (2112 gm) and lowest (1893 gm) slaughter weight, respectively (P>0.05). The lowest and share of dressed carcass, eviscerated carcass and breast cut was recorded for T6. Rio *et al*. (2019) observed that the values for dressing percentage and carcass yield were comparatively higher in ginger supplemented diet at the rate of 7.5 (T4) g/kg feed group as compared to either 5.0 (T3) g/kg feed or 2.5 (T2) g/kg feed or zero (T1)g/kg feed groups, respectively. The weight of the gizzard, spleen and gallbladder were high in T3 group than the other groups; whereas, the weight of heart and liver was high in T2 and T4 groups, respectively.

Blood Parameters

Ademole *et al.* (2009) showed that ginger supplementation to broiler diet at 0, 1.0, 1.5 and 2percent level had no significant difference on Packed Cell Volume (25.41, 26.41 25.27 and 27.07 %) and haemoglobin concentration (8.46, 8.79, 8.50 and 9.10g/dl). Dieumou *et al.* (2009) evaluated the effect of ginger and garlic essential oil on some blood parameters and observed no significant difference in the activities of the serum transaminases and blood creatinine level including that none of the essential oil given to the bird was toxic. Zhang *et al.* (2009) observed that supplementation of ginger increased (P<0.001) activities of total superoxide dismutase and glutathione peroxidise but reduce (P<0.01) concentrations of malondialdehyde and cholesterol in serum of broiler at 21and 42 days of age. Concentration of total protein in serum of ginger supplemented broiler tended (P=0.092) to be

higher at 21 d and was higher (P=0.002) at 42 d of age compared with that control broilers. Supplementation of ginger at the level of 5g/kg improved antioxidant status of the broilers and the efficacy was enhanced as the particle size was reduced from 300 to 37 µm. Kehinde *et al*. (2011) reported that ginger supplementation at 0, 1.5, 3.0 and 4.5 percent had no adverse effect on haemoglobin percent, white blood cell and lymphocyte count. Packed Cell Volume (PCV) and Red Blood Cell count was significantly varied (P<0.05). Inclusion of ginger at 1.5 and 3.0percent had no adverse effect on blood constituent of cockerel chick.

Bamidele and Adejumo (2012) showed that dietary supplementation of garlic and ginger mixture at 0.50 garlic + 0.50 ginger, 1.00 garlic + 1.00ginger, 1.5 garlic + 0.75 ginger and 2.00 garlic + 0.75ginger per cent level had significantly (P<0.001) higher packed cell volume (18.00 24.00 27.50 26.67 26.25 %)and haemoglobin concentration (5.98, 7.98, 9.22, 8.86and 8.72 g/dl) of broiler bird as compared to control group. Mohamed *et al.* (2012) showed that supplementation of ginger at the rate 0.1 and 0.2percent to the diet significantly (P<0.05) decreased the serum cholesterol, triglyceride and glucose; however, it had no effect on total protein.

Zomrawi *et al.* (2012) reported that inclusion of ginger root powder at 0, 0.5,1 and 1.5 percent in the diet had no significant effect on Hb (58.06, 55.94, 56.92 and 59.06 %) and Packed Cell Volume (30, 25.75, 26 and 26.75 %) of broiler birds. Zomrawi *et al.* (2013) found that supplementation of ginger root powder at 0, 1, 1.5 and 2 percent level in the diet had no significant (P>0.05) difference in Hb (7.9, 8.65, 8.8 and 7.4 %) and Packed Cell Volume(27.75, 26, 26.25 and 25.25 %) of broiler birds. George *et al*. (2015) observed that inclusion of ginger at 0, 2, 4and 6 g/kg of feed had no significant (P>0.05) effect on Packed Cell Volume (27.00, 30.00, 30.67 and 32.33 %) and Hb (9.00, 10.00, 10.02 and 10.08 g/dl) of broiler birds. Zidan *et al.* (2016) observed that ginger supplemented at 5 g/kg diet improved antioxidant status of broiler birds.

Talukdar *et al.* (2017) reported that supplementation of ginger powder at 0, 1and 2 percent level in broiler diet had no significant difference on Packed Cell Volume (21, 23, 33 and27.00%) and Hb (7.00, 7.00 and 7.33%) among the treatment group. Al-Khalifa *et al.* (2018) evaluated the effect of ginger powder supplemented at 0, 5, 10 and 15g/kg diet on haematological parameters in broiler and found no significant difference in haemoglobin concentration (13.2, 13.3 12.26 and 12.7 %). Rio *et al*.(2019) observed that dietary supplementation of ginger powder had no significant effect on haemoglobin concentration (Hb) and packed cell volume (PCV) irrespective of treatment groups.

Economics of Production

Minh *et al.* (2010) reported that supplementation of dried ginger to broiler diets led to improved performance and reduced feed cost. Mohammed and Yusuf (2011) carried out a study on eighty four, day old Anak strain broiler chicks to evaluate the effect of inclusion of ginger (*Zingiber officinale*) as a feed additive in broiler diets on cost of feeding. The birds were fed on various level of supplemental ginger in addition to a control diet (G1) without ginger. The treatment diets were G2, G3 and G4 and had 250, 500 and 750 g supplemental ginger per 100 kg, respectively. They founded that supplementation of dried ginger to broiler diets led to improved performance and reduced feed cost. Elmakki *et al.* (2013) evaluated the effect of ground ginger root (*Zingiber officinale*) at 0, 0.25, 0.50 and 0.75 percent level in broiler ration and found that return/bird (SDG)was 9.48, 9.7, 8.08, 9.0 and concluded that bird fed with 0.25 percent ground ginger root showed increase in carcass yield and return.

Karangiya *et al.* (2016) showed that the supplementation of ginger at 1 percent in ration of broiler, on the basis of performance efficiency index was found to be more economical as compared with control bird. Shinde *et al.* (2017) observed that supplementation of ginger (*Zingiber officinale*) powder at 0, 1, 2 and 3 percent level in broiler ration was more economical in term of net profit per bird and per kg live weight, respectively. Rio *et al*. (2019) observed that the total cost of production per broiler on diet supplemented with ginger powder at the rate of zero (T1), 2.5 (T2), 5.0 (T3) and 7.5 (T4) g/kg feed was lowest in T1 followed by T2, T4 and highest, in T3 groups; however, the cost of production per kg live weight of broiler was comparable in all groups. The net profit per kg live weight of broiler was highest in T4 as compared to other treatment groups.

Conclusion

It was concluded that inclusion of ginger powder at various level had significant effect on the

performance in terms of body weight, body weight gain and feed conversion efficiency (FCE). The overall performance index, carcass characteristics as well as net profit per birds. Dietary inclusion of ginger powder had no effect on the live ability, feed consumption and blood constituents (Hb and PCV) of broiler chicken.

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