EFFECT OF DIETARY GINGER AND GARLIC SUPPLEMENTATIONS ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND BLOOD BIOCHEMICALS OF BROILER CHICKS

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ABSTRACT

The present study was carried out to investigate the impact of garlic or ginger supplementation in the diets of broiler chicks and assessing growth efficiency, carcass characteristics, and blood biochemicals of broiler chicks. A total of 150 unsexed 7-day-old Arbor Acres broiler chicks were randomly assigned to five dietary treatments; each with five replicates of six chicks per replicate (n=30). Five experimental diets were formulated so that the control diet contained neither ginger nor garlic. While, birds in the 2nd and 3rd groups were fed on diets containing 1 and 2% ginger powder while the 4th and 5th groups were fed on diets containing 1 and 2% garlic powder, respectively. Garlic and ginger inclusion had a strong impact on growth performance characteristics. The low level of ginger powder (1%) had significant effects on enhancing final body weight (BW) and body weight gain (BWG) by 7.12 and 8.10%, respectively compared to the control group only. However, feed consumption was lower significantly (P≤0.05) in the chicks fed a high level of each ginger or garlic (2%) compared with control and chicks fed on a diet that contained ginger (1%). The supplementation of ginger or garlic in the diet of birds significantly (p≤0.05) improved feed conversion ratio (FCR) and European Production Efficiency Factor (EPEF) compared to the control.
Arbor Acres chicks fed garlic 2% supplementation had a significantly higher total protein compared to the control group, diets supplemented with 2% ginger significantly increased globulin compared with the control and garlic levels at 1% and 2%. Ginger supplementation at 1% significantly enhanced α-globulin concentrations compared with the control group and 1% garlic diet. Chicks fed the basal diet containing 2% ginger or 2% garlic showed a lower triglyceride than those in the other groups. The total cholesterol level decreased significantly in 2% garlic diet compared with the control and 1% ginger diets. The lowest ALT was observed in 1% garlic, 1% and 2% ginger, respectively. Each of low levels of ginger or garlic significantly decreased AST compared with the control and 2% ginger groups. Chicks fed the basal diet supplemented with the each levels of ginger or garlic at 2% had a significantly lower uric acid and uric acid to creatinine ratio than the control and low level of garlic (1%) groups. It was concluded from the present study that ginger and garlic could be used as good natural alternatives for growth promoters.

Keywords: ginger; garlic; performance; carcass; blood; broiler

INTRODUCTION

In the past, antibiotics were the most used feed additives as growth promoters in animal nutrition (Nasir and Grashorn, 2010). However, since the prohibition of the use of antibiotics in animals feed, their use has been declining leading to increasing diseases, mortality, and morbidity (Khan et al., 2012; Attia et al., 2017). The introduction of feed additives will enhance feed utilization, quality improvement, and animal welfare (Attia and Al-Harthi, 2015).

Recently, phytogenic plants have abundant benefits of being primary nutrients and pro-nutrient secondary plants. These plants have been shown to have growth-promoting effects that increase growth and health status, and are rich in secondary metabolites (Grashorn, 2010). Plant phytochemicals are known as secondary plant metabolites and are
suggested as animal growth promoters (Attia et al., 2017). Phytogenic plants consist of mixtures of compounds that have many effects as antimicrobial, stimulating the digestive system, antioxidants, anticoccidial, increase the development of digestive enzymes, and enhance the utilization of digestive products by enhancing liver functions (Ziarlarimi et al., 2011).

Ginger (Zingiber officinale) is a herb containing a variety of active compounds, including gingerdiol, gingerol, gingerdione, and shogaols (Zhao et al., 2011). It has antibacterial and anti-inflammatory actions, and ginger rhizome was known to reduce cholesterol levels in the blood (Saeid et al., 2010; Rehman et al., 2011). Ginger is consumed as a delicacy, medicine, condiment, or spice (Khan et al., 2012; Ahmed et al., 2014). Ginger has been shown to have anti-oxidant and anti-diabetes properties (Morakinyo et al., 2011), also it works as an immune booster and enhancer to the digestive functions (Al-Shuwaili et al., 2015). In addition, Ginger was found to have a positive impact on weight gain, feed conversion ratio, and survival rate (Oleforuh-Okoleh et al., 2014). Rivlin (2001) also showed that gingerols enhanced gastrointestinal motility and to have antibacterial properties in laboratory animals.

Garlic (Allium sativum) has been used as a spice and as a native medicine. It has many beneficial effects on both humans and animals with antibacterial and antiviral properties (Weber et al., 1992), antifungal (Ankri and Mirelman, 1999), antiparasitic, antioxidant, anticholesteremic, anti-cancerous, and vasodilator characteristics (Hanich et al., 2010). In addition to its beneficial effects on digestion in birds due to its very rich aromatic essential content, garlic supplementation for broiler chicks have been recognized for their strong stimulating effect on the immune system (Demir et al., 2005). Garlic has biologically active compounds such as compounds containing sulfur (Alliin, Allicin, ajoene, Allylpropyl disulphide, Diallyl trisulphide and sallilcisteine) (Mansoub, 2011). They work against many viruses, bacteria, fungi, and parasites and it works as antioxidant, anti-
thrombotic, and vasodilator properties as antimicrobial. Allicin, rapidly decomposes several volatile organosulphur compounds with bioactivities (Chang and Cheong, 2008). Promoting weight gain, feed efficiency, reduced mortality, and increased livability in broiler chicks (Oleforuh-Okoleh et al., 2014; Karangiya et al., 2016).

As natural growth promoters, garlic and ginger may be possible alternatives for traditional artificial growth promoters such as antibiotics (Karangiya et al., 2016). Ginger and garlic supplementation have been recognized in broiler chicken diets for their powerful stimulating effect on birds’ immune and digestive systems (Al-Shuwaili et al., 2015).

Thus, the objective of this study was to evaluate the impact of ginger and garlic powder supplementation on growth efficiency, carcass characteristics, and blood biochemicals of broiler chicks.

**MATERIALS AND METHODS**

The study was carried out at the Poultry Research Unit at Al-Bostan Station, Department of Animal and Poultry Production, Faculty of Agriculture, Damanhour University from October to November 2018.

All treatments and bird care procedures were approved by the Institutional Animal Care and Use Committee in AU-IACUC, Damanhour University, Egypt. Authors declare that the procedures imposed on the birds were carried out to meet the Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals and birds used for scientific purposes.

**Broiler and experimental design**

A total of 150 unsexed seven days old of broiler chicks (Arbor Acres) were acquired from a commercial hatchery (Cairo Poultry Company), wing banded and randomly divided keeping similar initial body weight with a mean body weight of 172.8±1.23g, were used in the
current study. Broiler chicks were divided into 5 experimental groups (treatments) in a straight run experimental design in 25 cages (55×50×35 cm length-width-height) with 5 replicates of 6 birds in each for a 28-day feeding trial (from 7 to 35 days of age). Birds of the first group served as the control group and were fed the basal diet without any additives, while the 2nd and 3rd groups were fed diets containing 1 and 2% ginger powder, respectively, the 4th and 5th groups were fed diets containing 1 and 2% garlic powder, respectively. All diets were formulated to meet or exceed NRC (1994) nutrient recommendations of chickens for starter (7-21 days), finisher (21-35 days) periods (Table 1).

Table (1): Composition and calculated analyses of the experimental diets.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Starter diet, 1-21 d of age</th>
<th>Grower diet, 22-35 d of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow corn, kg</td>
<td>490</td>
<td>550</td>
</tr>
<tr>
<td>Soybean meal 48% CP, kg</td>
<td>420</td>
<td>358</td>
</tr>
<tr>
<td>Di-calcium phosphate, kg</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Limestone, kg</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td>NaCl, kg</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Vitamin+ mineral premix1, kg</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>DL-Methionine, kg</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>L-Lysine, kg</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Vegetable oil2, kg</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>ME</td>
<td>3035</td>
<td>3135</td>
</tr>
<tr>
<td>CP</td>
<td>229</td>
<td>208</td>
</tr>
<tr>
<td>Ca</td>
<td>9.5</td>
<td>9.1</td>
</tr>
<tr>
<td>Available P</td>
<td>5.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Methionine</td>
<td>6.0</td>
<td>5.6</td>
</tr>
<tr>
<td>TSAA</td>
<td>9.6</td>
<td>9.1</td>
</tr>
<tr>
<td>Lysine</td>
<td>13.7</td>
<td>12.6</td>
</tr>
<tr>
<td>Ether extract</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>Ash</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>Dry matter</td>
<td>901</td>
<td>912</td>
</tr>
</tbody>
</table>

1Vit+Min mixture provides per kg of the diet: vitamin A (retinyl acetate) 24 mg, vitamin E (dl-α-tocopheryl acetate) 20 mg, menadione 2.3 mg, Vitamin D3 (cholecalciferol) 0.05 mg, riboflavin 5.5 mg, calcium pantothenate 12 mg, nicotinic acid 50 mg, choline chloride 600 mg, vitamin B12 10 μg, vitamin B6 3 mg, thiamine 3 mg, folic acid 1 mg, d-biotin 0.50 mg. Trace
mineral (mg per kg of diet): Mn 80 Zn 60, Fe 35, Cu 8, Se 0.60. A mixture of soybean oil, cotton seed oil and sunflower at 33.33% of each. ME, metabolic energy; CP, crude protein; Ca, calcium; TSAA, total sulfur amino acids

Ginger and garlic were purchased as a dry powder from the local commercial market at Damanhour City, Egypt. This experimental diet was destined weekly and stored in airtight containers.

Birds management

All chicks were housed in battery brooders, a gas heater was utilized to supply the chickens with the heat needed for brooding which took place in a semi-opened room and the birds remained under the same managerial, hygienic, and environmental conditions. Birds of all experimental groups were vaccinated against Newcastle via drinking water at 7, 18, and 28 days of age. They were also vaccinated against Gumboro at 12 days of age. Ambient temperatures were at 30-32°C during the 1st week and weekly decreased by 3°C throughout the following three weeks. During the 4th and 5th weeks, the temperature was maintained at 22-24°C. A similar light schedule to the commercial condition was used; 23 h light from one day old until the 7th day, pursued by 20 h light from the 8th day to the end of the experiment (35 days of age). All birds were fed ad libitum the experimental diets and given free access to water. Ingredients and chemical composition of the basal diets (% as fed basis) fed during the two phases are offered in Table (1). The average minimum, maximum temperature degrees were as °C and relative humidity as % during 21-35 days of age were 28.6 and 35.2°C and 53.2 and 64.5%, respectively.

Data collection for Productive performance

During the trial period, chicks were individually weighed (g) at 7 and 35 d of age, and body weight gain (g/chick) was calculated. The feed intake (FI, g/chick) was recorded for each pen and calculated for the 28 days of the experimental period. Feed conversion ratio (FCR, g feed/ g gain) was calculated as the average feed consumption per unit of body weight gain during the same periods. Broiler performance was
evaluated using the European production efficiency factor (EPEF) according to **Hubbard broiler management guide (1999)**.

**Carcass characteristics**

At 35 days of age, five broiler chicks from each treatment (1 per each replicate) were randomly selected for slaughtering with body weight similar to each treatment mean, the assigned chicks were slaughtered to determine carcass characteristics. Dressing percentage included relative weights of carcass and giblets (liver, gizzard, and heart) were estimated as a percentage of live body weight. Liver, gizzard, heart, spleen, pancreas, intestinal, proventriculus, thymus, and bursa of Fabricius were separated individually weighed, and expressed as absolute weight and as a percentage of live body weight.

**Blood samples collection and analysis**

At the end of the experimental period (35 days), five chicks from each treatment (n=5/treatment) were randomly selected and slaughtered. About 3 ml of blood were collected from the wing vein into vacationer tubes without containing K₃-EDTA (1 mg/ml). Coagulated blood samples were centrifuged at 4000 rpm for 15 minutes and the clear serum was separated and stored in a deep freezer at -20°C until biochemical analysis. All blood biochemical variables were determined calorimetrically using commercials kits.

Serum total protein (g/dl) was measured using special kits delivered from Diamond diagnostics using a spectrophotometer (Beckman DU-530, Germany) according to guidelines of **(Armstrong and Carr, 1964)**. Serum albumin (g/dl) was determined using special kits delivered from Diamond diagnostics according to the method of **Doumas et al. (1977)**. Serum globulin level (g/dl) was calculated by the difference between total protein and albumin since the fibrinogen usually comprises a negligible fraction **(Sturkie, 1986)**. Albumin to globulin ratio (A/G) was also calculated by dividing the total level of albumin by the total level of globulin. The serum protein fractions were
separated by zone electrophoresis on an agarose gel using an automated electrophoresis system and commercial diagnostic kits Diamond diagnostics.

Serum total lipid, triglyceride concentrations (mg/dl) were determined using special kits delivered from Diamond diagnostics (Fringes et al., 1972). Serum total cholesterol (mg/dl) was determined using the specific kits according to (Bogin and Keller, 1987). Serum samples were analyzed for high-density lipoprotein (HDL, mg/dl) and low-density lipoprotein (LDL, mg/dl).

Serum Creatinine level (mg/dl) was estimated according to (Husdan and Rapoport, 1968), while serum uric acid level (mg/dl) was measured according to the method explained by (Patton and Crouch, 1977). The uric acid to creatinine ratio was also calculated.

The transaminase enzymes activities of serum aspartate aminotransferase (AST) and serum alanine aminotransferase (ALT), as U/L were determined by colorimetric method of (Reitman and Frankel, 1957). Alkaline phosphatase (ALP, U/L) concentration was determined according to the method of (John and Bauer, 1982).

Statistical analysis
Statistical analysis was done using the GLM procedure of statistical analysis software of SAS Institute (SAS, 2009) using one-way analysis of variance according to the following formula: \( y_{ij} = \mu + \tau_j + \epsilon_{ij} \), where \( \mu \) = general mean, \( \tau_j \) = treatment effect, and \( \epsilon \) = experimental random error. Before analyses, arcsine transformed was done to normalize data distribution. Mean difference at \( p \leq 0.05 \) was tested using Tukey’s HSD test. The replicate was the experimental unit.

RESULTS AND DISCUSSION

Productive performance
Table (2) shows the effect of dietary supplementation of ginger and garlic on the productive performance of broiler chickens (Arbor
Acres) during 7-35 days of age. Garlic and ginger inclusion into feed had a strong impact on the growth performance characteristics. While the initial body weight of the birds did not show significant differences (P≤0.05), the feeding of the test ingredients (ginger or garlic) significantly (P≤0.05) affected the final body weight (BW), body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR) and European production efficiency factor (EPEF) of the birds. Ginger powder at 1% and 2% and garlic powder at 1% had significant effects on enhancing final BW and BWG compared to the control group only. However, BW and BWG in treatments fed on diets supplemented with ginger or garlic were similar and did not differ significantly. It was found that feed consumption was lower significantly (P≤0.05) in the chicks fed a high level of each ginger or garlic (2%) compared with control and chicks fed contained ginger (1%), the highest feed consumption was observed in chicks fed on the basal diet without any supplementations. The supplementation of ginger or garlic in the diet of birds significantly (P≤0.05) improved FCR and EPEF compared to the control group. No mortality was detected in all treatment groups throughout the study period.

Table 2: Effect of dietary supplementation of ginger and garlic on growth performance of broiler chicks during 7-35 days

<table>
<thead>
<tr>
<th>Traits</th>
<th>Control</th>
<th>Ginger 1%</th>
<th>Ginger 2%</th>
<th>Garlic 1%</th>
<th>Garlic 2%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW, 7d</td>
<td>172.8±3.17</td>
<td>172±4.14</td>
<td>172±4.39</td>
<td>172.9±3.56</td>
<td>172.7±3.65</td>
<td>1.000</td>
</tr>
<tr>
<td>BW, 35d</td>
<td>1913.1±37.7</td>
<td>2053.5±32.0</td>
<td>2024.9±30.9</td>
<td>2040.0±44.4</td>
<td>1983.1±43.0</td>
<td>0.069</td>
</tr>
<tr>
<td>BWG, 7-35d</td>
<td>1740.3±38.1</td>
<td>1881.5±31.7</td>
<td>1852.8±31.5</td>
<td>1867.1±44.2</td>
<td>1810.4±42.3</td>
<td>0.066</td>
</tr>
<tr>
<td>FI, 7-35d</td>
<td>3007.0±17.8</td>
<td>2883.4±20.8</td>
<td>2769.6±15.8</td>
<td>2783.8±12.3</td>
<td>2711.8±18.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>FCR, 7-35d</td>
<td>1.75±0.041</td>
<td>1.54±0.029</td>
<td>1.52±0.027</td>
<td>1.51±0.037</td>
<td>1.52±0.035</td>
<td>0.0001</td>
</tr>
<tr>
<td>EPEF</td>
<td>316.4±5.12</td>
<td>383.0±7.15</td>
<td>388.7±9.71</td>
<td>392.4±22.9</td>
<td>378.7±18.1</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Means within the same rows with different superscript letters are significantly different at (p≤0.05). BW= body weight; BWG= body weight gain; FI= feed intake; FCR= feed conversion ratio; EPEF= European production efficiency factor.

Similarly, some researchers have observed a significant increase in BW and BWG of birds fed ginger and garlic that confirmed the
findings of (Ademola et al., 2005; Javendel et al., 2008) who fed ginger and garlic as growth promoters in broiler diets observed a pronounced improvement in their BWG and FCR. These findings may be due to the birds' good health status, which may be caused by the addition of garlic, and may also be due to garlic's chemical composition (Reuter, 1995). Windisch et al. (2008) mentioned proven effects of phytobiotic feed additives on various species of poultry showed decreased FI and improved FCR. Pourali et al. (2010) suggested that allicin in garlic promotes the efficiency of the intestinal flora thus, improving digestion and enhancing the utilization of energy, leading to improved growth.

The present results were in line with those obtained by Sadeghi and Moghaddam (2018) and Gaikwad et al. (2019) they concluded that the final BW and BWG of birds were significantly higher (P≤0.05) in all supplemented groups with ginger in comparison to the control. These results were in line with the finding of Farinu et al. (2004) also reported that ginger supplementation improved growth of broilers at levels of 5, 10, or 15 g/kg of feed. In addition, Herawati (2010) reported that Hubbard strain broilers fed on a diet with additional red ginger had a significantly higher final BW than those fed on the control diet without any supplementation.

The current FI findings were in agreement with those reported by Saleh et al. (2014) who recorded that FI was decreased in birds fed ginger supplemented diets. Ginger powder supplementation with 1, 2, and 3% had a significantly less (2.0%) of FI (Gaikwad et al., 2019). Arshad et al. (2012), who concluded that adding ginger extract to the poultry diets decreased FI. Also, Barazesh et al. (2013) reported that the effect of ginger powder on increasing levels of dietary ginger powder caused a significant reduction in feed consumption. According to Moorthy et al. (2009), Herawati (2010), and Sadeghi and
Moghaddam (2018), the FCR of broiler with ginger supplementation was better.

On the other hand, Onibi et al. (2009) and Fadlalla et al. (2010) observed that garlic powder had no major impact on birds' BWG and FCR. Some researchers have found that garlic supplementation has a non-significant impact on FI in broilers (Onu, 2010; Aji et al., 2011; Rahimi et al., 2011). In addition, Ahmed et al. (2014) and Hassan et al., (2019) did not find any significant improvements in BW and BWG of broilers fed on a diet containing ginger powder as compared to the control group.

Our results disagree with the results found by Valiollahi et al. (2014) who reported that ginger supplementation had a positive effect on feed consumption in broiler diets with regard to the control one. Zomrawi et al. (2012) indicated that ginger adversely affected the BWG of broiler diets. Saleh et al. (2014) found that, compared to the control, dietary ginger inclusion increased FCR value.

The reduction in FI due to the higher ginger level could be attributed to the adverse effect of ginger taste on the palatability of feed in broiler chickens' diets. In this research, the insignificant improvement in FCR might be attributed to the ability of ginger to increase the digestive and absorptive potential of the small intestine of commercial broilers by increasing the depth of the crypt (Karangiya et al., 2016). The findings of FCR were in line with the findings reported by Moorthy et al. (2009). In addition, the maximum BW of broiler birds fed on ginger may be due to ginger's active components, which increase digestive enzyme secretion and improve the process of digestion and absorption. Similarly, garlic contains 17 compounds including amino acids, minerals, enzymes, and sulphur. S-allylcysteine sulphoneoxide, S-methyl-cystein sulphoxide, diallydisulphide, S-allylcystein, dialkyl polysulphides, ajoene, and allicin; are the main alkaloids in ginger (Khan et al., 2012). Garlic contains compounds such as allicin and...
Oregano sulfur compounds which are responsible for inhibiting pathogenic bacteria and fungi, resulting in an improved gut environment, enhancing and regenerating the physiological structure of the intestinal epithelium layer, enhancing crypt depth and villus height, ultimately supporting digestive capacity and improve nutrient absorption and assimilation (Adibmoradi et al., 2006). The fact that ginger stimulates lactic acid bacteria and reduces pathogenic bacteria such as mesophilic aerobic, coliform, and E. coli, and thus improves nutrient absorption to improve the bird's weight gain (Tekeli et al., 2011).

**Carcass characteristics**

The results of carcass characteristics of broiler chickens under the effect of different dietary levels of ginger and garlic are summarized in Table (3). Different treatments had statistically no significant effects on carcass characteristics and inner organs of chicks at 35 days of age except for the spleen and bursa of Fabricius. Broilers fed a high level of garlic (2%) had a significantly higher spleen percentage compared with the group fed diet contained ginger at 1%. A significantly higher bursa of Fabricius percentage was found with the level of ginger (2%) and garlic; each level (1 and 2%) over only the control group. In this study, different levels of ginger or garlic, as a powder, had no marked effect on the relative weight of the dressing, proventriculus, gizzard, liver, heart, pancreas, thymus, and intestinal tract.

The dietary addition of ginger and garlic in the current study did not have a marked effect on the dressing percentage and relative weight of most internal organs. In line with our results, Dieumou et al. (2009) and Pourali et al. (2010) who reported that carcass parts were not affected by ginger and garlic, it was, however, in consonance with Raeesi et al. (2010) who reported a significant effect on the carcass parts of broilers fed with garlic.
Table 3: Effects of dietary supplementation of ginger and garlic on carcass traits of broiler chicks at 35 days

<table>
<thead>
<tr>
<th>Traits</th>
<th>Control</th>
<th>Ginger 1%</th>
<th>Ginger 2%</th>
<th>Garlic 1%</th>
<th>Garlic 2%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressing, %</td>
<td>70.06±1.76</td>
<td>74.23±0.819</td>
<td>72.53±1.42</td>
<td>71.21±0.254</td>
<td>72.35±0.449</td>
<td>0.169</td>
</tr>
<tr>
<td>Heart, %</td>
<td>0.616±0.039</td>
<td>0.606±0.008</td>
<td>0.683±0.060</td>
<td>0.591±0.0314</td>
<td>0.663±0.054</td>
<td>0.531</td>
</tr>
<tr>
<td>Liver, %</td>
<td>2.68±0.051</td>
<td>2.76±0.048</td>
<td>2.82±0.093</td>
<td>2.95±0.150</td>
<td>3.14±0.18</td>
<td>0.130</td>
</tr>
<tr>
<td>Proventriculus, %</td>
<td>0.414±0.031</td>
<td>0.525±0.089</td>
<td>0.598±0.140</td>
<td>0.549±0.025</td>
<td>0.603±0.023</td>
<td>0.455</td>
</tr>
<tr>
<td>Gizzard, %</td>
<td>1.47±0.333</td>
<td>1.08±0.077</td>
<td>1.29±0.238</td>
<td>1.34±0.146</td>
<td>1.54±0.161</td>
<td>0.603</td>
</tr>
<tr>
<td>Pancreas, %</td>
<td>0.336±0.013</td>
<td>0.295±0.027</td>
<td>0.296±0.022</td>
<td>0.328±0.025</td>
<td>0.244±0.017</td>
<td>0.080</td>
</tr>
<tr>
<td>Intestine, %</td>
<td>9.39±0.967</td>
<td>8.16±0.434</td>
<td>9.83±0.441</td>
<td>9.38±0.529</td>
<td>8.87±0.67</td>
<td>0.457</td>
</tr>
<tr>
<td>Abdominal Fat, %</td>
<td>1.65±0.344</td>
<td>1.24±0.174</td>
<td>1.16±0.088</td>
<td>1.21±0.126</td>
<td>1.14±0.085</td>
<td>0.346</td>
</tr>
<tr>
<td>Spleen, %</td>
<td>0.149±0.018&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.136±0.004&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.154±0.014&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.191±0.011&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.211±0.023&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.029</td>
</tr>
<tr>
<td>Bursa, %</td>
<td>0.095±0.043&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.186±0.016&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.257±0.034&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.244±0.020&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.266±0.020&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.009</td>
</tr>
<tr>
<td>Thymus, %</td>
<td>0.471±0.068</td>
<td>0.579±0.013</td>
<td>0.653±0.047</td>
<td>0.575±0.016</td>
<td>0.566±0.145</td>
<td>0.583</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Means within the same rows with different superscript letters are significantly different at (p≤0.05)
Rahimi et al. (2011) and Habibi et al. (2014) noted that the addition of ginger in feed or drinking water for broilers chicken had no significant effect on the dressing percentage and the relative weight of liver, heart, and gizzard. Shewita and Taha (2018) observed that there were non-significant variations among the groups obtaining various amounts of ginger powder in the slaughter characteristics, including the dressing percentage, relative liver, heart, spleen, proventriculus, and gizzard weight. However, the relative weight of the bursa increased in both groups supplemented with ginger compared to the control (Mohanad et al., 2019). Furthermore, El-Deek et al. (2002) found that the weight of the carcass did not differ significantly between the control and the broilers treated with ginger. Also, Qorbanpour et al. (2018) and Hassan et al. (2019) revealed that there were no significant differences among different ginger treated groups in live weight, dressing weight, and percentage and relative weights of liver, heart, gizzard, spleen, bursa of Fabricius and thymus.

Aji et al. (2011) and Sangilimadan et al. (2019) revealed non-significant (P>0.05) discrepancies in blood loss, feather loss, liver, heart and gizzard weights, and eviscerated and ready-to-cook variations between various dietary garlic categories. Makwana et al. (2015) reported no significant effect on shrinkage loss, blood loss, feather loss, eviscerated yield, relative heart weights, liver, gizzard, and giblets due to 0.1 and 0.5% garlic supplementation. In contrast to the present findings, but he reported significant (P<0.05) improvement in dressing percentage as for garlic supplementation in broilers.

Serum biochemical parameters

Table 4 indicates the influence of ginger and garlic supplementation on total proteins profile and immunoglobulins constituents of broilers at 35 days of age. Garlic level at 2% supplementation had a significantly higher total protein compared to the control group, but garlic levels at 1% and 2% and control groups had a
significantly increased albumin compared with ginger level at 2%. Diets supplemented with 2% ginger significantly increased globulin compared with the control and garlic levels at 1% and 2%. In addition, garlic supplementation at 1% and 2% and control groups significantly increased albumin to globulin ratio compared with the high level of ginger. Ginger supplementation at 1% significantly enhanced α-globulin concentrations compared with the control group and 1% garlic diet. γ-globulin was significantly higher in broiler chickens fed diets supplemented with 2% ginger than that of each levels supplementation of garlic.

The effect of ginger on total protein content of plasma in broilers is controversial. These results are partially in agreement with Al-Homidan (2005) who found that dietary supplementation of ginger at 60g/kg decreased broilers’ total protein content, but on the other hand the positive effect of ginger at 5g/kg of diet on blood total protein was reported by (Zhang et al., 2009). A non-significant effect of dietary ginger on blood total protein and albumin in broilers was also previously reported (Mohamed et al., 2012) and Hassan et al. (2019).

This discrepancy may be due to the various levels of administration. Findings of our study showed that supplementing diets with garlic powder increased total protein and albumin, this results are in agreement with Rafiee et al. (2013) who reported that the addition of ginger in broiler diets helped enhancing protein, albumin, and globulin serum concentration. The significant improvement in total albumen concentration of blood serum of birds feed garlic may be due to whole factors that lead to the improvement in total protein with the albumen as the main part of blood protein, which transports food nutrients and thyroxine in blood. On the other hand, On the contrary, it was reported that there were no differences in serum biochemical parameters (total protein, albumin and globulin) of broilers fed diet enriched with garlic Khan et al. (2012).
Table 4: Effect of dietary supplementation of ginger and garlic on total proteins profile and immunoglobulins of broiler chicks at 35 days

<table>
<thead>
<tr>
<th>Traits</th>
<th>Control</th>
<th>Ginger 1%</th>
<th>Ginger 2%</th>
<th>Garlic 1%</th>
<th>Garlic 2%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein, g/dl</td>
<td>6.20±0.036&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.43±0.076&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>6.10±0.159&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.10±0.036&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.57±0.021&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.001</td>
</tr>
<tr>
<td>Albumin, g/dl</td>
<td>3.43±0.056&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.20±0.190&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.70±0.290&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.43±0.138&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.67±0.076&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.007</td>
</tr>
<tr>
<td>Globulin, g/dl</td>
<td>2.77±0.084&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.23±0.117&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.40±0.132&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.67±0.138&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.90±0.097&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>0.000</td>
</tr>
<tr>
<td>A/G ratio</td>
<td>1.25±0.060&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.01±0.090&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.82±0.123&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.32±0.110&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.27±0.071&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.003</td>
</tr>
<tr>
<td>α-globulin, g/dl</td>
<td>1.30±0.036&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.50±0.036&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.43±0.021&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.30±0.036&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.40±0.036&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.001</td>
</tr>
<tr>
<td>B-globulin, g/dl</td>
<td>1.17±0.055</td>
<td>1.17±0.042</td>
<td>1.17±0.0558</td>
<td>1.16±0.042</td>
<td>1.13±0.021</td>
<td>0.384</td>
</tr>
<tr>
<td>γ-globulin, g/dl</td>
<td>0.40±0.097&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.567±0.112&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.900±0.167&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.300±0.126&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.367±0.112&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.017</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup> Means within the same rows with different superscript letters are significantly different at (p ≤ 0.05). A/G ratio = Albumin to globulin ratio
Table 5: Effect of dietary supplementation of ginger and garlic on Lipid profiles of broiler chicks at 35 days

<table>
<thead>
<tr>
<th>Traits</th>
<th>Control</th>
<th>Ginger 1%</th>
<th>Ginger 2%</th>
<th>Garlic 1%</th>
<th>Garlic 2%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lipids, mg/dl</td>
<td>43.33±0.760</td>
<td>43.00±0.730</td>
<td>45.00±0.365</td>
<td>45.33±0.760</td>
<td>44.67±0.422</td>
<td>0.054</td>
</tr>
<tr>
<td>Triglycerides, mg/l</td>
<td>189.3±1.52a</td>
<td>180.3±2.23b</td>
<td>173.0±0.966c</td>
<td>176.7±0.760bc</td>
<td>173.0±0.966c</td>
<td>0.0001</td>
</tr>
<tr>
<td>Cholesterol, mg/dl</td>
<td>211.0±1.83a</td>
<td>206.0±1.67ab</td>
<td>202.0±0.632bc</td>
<td>204.7±1.17bc</td>
<td>200.7±0.211c</td>
<td>0.0001</td>
</tr>
<tr>
<td>HDL, mg/dl</td>
<td>42.67±0.558ab</td>
<td>42.00±0.365b</td>
<td>42.67±0.558ab</td>
<td>44.33±0.558a</td>
<td>41.33±0.211b</td>
<td>0.002</td>
</tr>
<tr>
<td>LDL, mg/dl</td>
<td>130.5±2.51a</td>
<td>127.9±1.14ab</td>
<td>124.7±0.402b</td>
<td>125.0±1.27ab</td>
<td>124.7±0.329b</td>
<td>0.022</td>
</tr>
</tbody>
</table>

abcde Means within the same rows with different superscript letters are significantly different at (p≤0.05)

HDL= High-density lipoprotein; LDL= Low-density lipoprotein
Changes in the pattern of serum lipid profile in broiler at 35 days of age are shown in Table 5. Chicks fed the basal diet containing 2% ginger or 2% garlic showed lower triglyceride than those in the other groups (control and 1% ginger, respectively). The total cholesterol level decreased significantly in 2% garlic diet compared with the control and 1% ginger diets. Feeding on a diet with 1% garlic significantly increased HDL compared with the ginger or garlic at 2% groups. LDL level decreased significantly in 2% each of ginger or garlic diet compared to the control group.

Our results were similar to that found by Shewita and Taha (2018) which showed that ginger significantly ($P \leq 0.05$) decreased cholesterol, HDL, and triglyceride levels compared to the control group. Ginger rhizome is known to decrease blood cholesterol levels (Bhandari et al., 1998; Akhani et al., 2004; Saeid et al., 2010; Rehman et al., 2011; Oleforuh-Okoleh et al., 2015). Although, Zhang et al. (2009) concluded that the addition of ginger in the diet at 5g/kg diet reduced cholesterol levels in broiler serum. In ginger-supplemented groups, lipid profile parameters including total cholesterol, total triglycerides, HDL, LDL, and VLDL were decreased, indicating ginger's hypolipidemic impact. This result was consistent with that of Ademola et al. (2009) found that serum cholesterol and triglyceride levels in broilers were significantly reduced by the dietary supplementation of ginger. In addition, overall cholesterol and serum LDL levels decreased significantly in the ginger-supplemented group (Shanoon et al., 2012). By inhibiting hydroxymethyl-glutaryl-coenzyme-A reductase (HMG-CoA) or by increasing the excretion of bile acid and fecal cholesterol, the use of dietary ginger will decrease overall serum cholesterol (Malekizadeh et al., 2012). Alizadeh-Navaei et al. (2008) observed that ginger powder supplementation significantly lowered triglyceride levels, total cholesterol, LDL, and very low lipoprotein density levels (VLDL).
The results of present study are in agreement with Stanacev et al. (2011) who reported that garlic manifested hypocholesterolemic effects on chickens through inhibition of the most important enzymes that participate in the synthesis of cholesterol and lipids. Also, Mansoub (2011) who reported reductions in total cholesterol when broilers were supplemented with 1g/kg garlic. In addition, Konjufca et al. (1997) reported that garlic reduced plasma cholesterol by decreasing the activity of 3-hydroxy-3-methylglutaryl reductase. Allicin has been proposed as the active compound in garlic responsible for health promotion and hypocholesterolaemic benefits (Lawson, 1998).

The results in Table (6) showed the effect of dietary supplementation of ginger and garlic on the liver and renal functions of broiler chicks at 35 days. Chicks fed the basal diet supplemented with 1% garlic had a significantly lower alkaline phosphatase than the other groups. The lowest ALT was observed in 1% garlic, 1% and 2% ginger, respectively. The results indicate that each of low levels of ginger or garlic significantly decreased AST compared with the control and 2% ginger groups. Serum AST/ALT ratio was significantly lower in the groups of 1% ginger, 1% and 2% garlic than 2% ginger group. Chicks fed the basal diet supplemented with the each levels of ginger or garlic at 2% had a significantly lower uric acid and uric acid to creatinine ratio than the control and low level of garlic (1%) groups.

Results of this study showed that the broiler groups fed on diets supplemented with either ginger or garlic, showed a significant decrease in serum ALT and AST activity. Similar to those found by Shewita and Taha (2018), our findings revealed that significant differences in serum ALT activities were not observed among the experimental groups fed diets with different levels with ginger or garlic powder. Moreover, Metwally (2009) observed that groups fed on diets containing garlic showed a significant decrease in the activity of ALP, ALT, and AST compared to the control group.
Table 6: Effect of dietary supplementation of ginger and garlic on liver and renal functions of broiler chicks at 35 days

<table>
<thead>
<tr>
<th>Traits</th>
<th>Control</th>
<th>Ginger 1%</th>
<th>Ginger 2%</th>
<th>Garlic 1%</th>
<th>Garlic 2%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>liver functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIL (U/L)</td>
<td>11.00±0.365</td>
<td>11.00±0.00</td>
<td>11.33±0.422</td>
<td>9.00±0.00</td>
<td>11.33±0.558</td>
<td>0.0001</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>66.0±0.365</td>
<td>63.3±0.760</td>
<td>63.3±0.211</td>
<td>62.7±0.558</td>
<td>64.0±0.632</td>
<td>0.002</td>
</tr>
<tr>
<td>AST (U/L)</td>
<td>58.0±0.632</td>
<td>54.7±0.760</td>
<td>59.3±0.422</td>
<td>54.3±0.919</td>
<td>55.0±0.966</td>
<td>0.0001</td>
</tr>
<tr>
<td>AST/ALT Ratio</td>
<td>0.879±0.011</td>
<td>0.863±0.011</td>
<td>0.937±0.009</td>
<td>0.867±0.013</td>
<td>0.860±0.022</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>renal function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uric acid (g/dl)</td>
<td>4.00±0.000</td>
<td>2.667±0.422</td>
<td>2.00±0.00</td>
<td>3.667±0.211</td>
<td>2.00±0.00</td>
<td>0.0001</td>
</tr>
<tr>
<td>Creatinine (g/dl)</td>
<td>1.10±0.036</td>
<td>1.17±0.056</td>
<td>1.10±0.00</td>
<td>1.13±0.056</td>
<td>1.17±0.042</td>
<td>0.669</td>
</tr>
<tr>
<td>Uric acid/Creatinine Ratio</td>
<td>3.66±0.122</td>
<td>2.29±0.340</td>
<td>1.82±0.00</td>
<td>3.24±0.127</td>
<td>1.72±0.059</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

*ab,c,d Means within the same rows with different superscript letters are significantly different at (p≤0.05)
ALP= Alkaline Phosphatase; ALT= alanine aminotransferase; AST= aspartate aminotransferase; AST/ALT Ratio= aspartate aminotransferase to alanine aminotransferase ratio
The serum AST and ALT were markedly decreased with 100 or 150µl/kg BW of ginger when considered with control data (Herve et al., 2019). Ginger or garlic activate the stabilized cell membrane and protect the liver from harmful agents and oxidative damage to the liver cells caused by free radicals. This was expressed in liver enzyme reduction. By accelerating the regenerative ability of its cells, garlic allows the liver to retain its normal function. Treatment with allicin tends to improve the impact of antibody activation (Colorni et al., 1998).

CONCLUSIONS

It is concluded from the present study that ginger or garlic at the level of 1% show an improved production performance, enhance proteins profile, ginger or garlic supplemented at 2% improved lipid profile, renal function, and liver function in broilers. Thus, ginger and garlic are considered safe due to having no acute toxic side effects as reported through the experimental period. According to our results, ginger or garlic could be used as good natural alternatives for growth promoters.

REFERENCES


Shanoon, A. K.; Jassim, M. S.; Amin, Q. H. and Ezaddin, I. N. 2012. Effects of ginger (Zingiberofficinale) oil on growth performance and


تأثير الزنجبيل والثوم على الآداء الإنتاجي وخصائص الذبيحة وصفات الدم البيوكيميائية لدجاج اللحم

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2 قسم إنتاج الدواجن، كلية الزراعة، جامعة الأسكندرية، الأسكندرية، مصر

اجريت الدراسات الحديثة لمعرفة تأثير إضافة الثوم والزنجبيل في علاقي كتاكيت التسمين وتقييم كفاءة النمو وخصائص الذبيحة وصفات الدم لكتاكيت التسمين. تم استخدام 150 كتكوتاً من كتاكيت التسمين عمر 7 أيام من سلالة الأربورايز على خمسة معاملات غذائية بكل معاملة خمسة مكررات مع كل مكررة ستة طيور، وتم تغذية الطيور على علاقي متساوية في الطاقة والبروتين. وكانت المعاملة الأولى (الكنترول)، المعاملتين الثانية والثالثة إضافة الزنجبيل (في صورة مسحوق) بمعدل 1% و2% على الترتيب، والمعاملتين الرابعة والخامسة إضافة الثوم (في صورة مسحوق) بمعدل 1% و2% على الترتيب. وكان استخدام الزنجبيل والثوم تأثير قوي على خصائص أداء النمو وكان للمستوى المنخفض من الزنجبيل (1%) تأثيرات معنوية قوية على وزن الجسم النهائي (12%) والزيادة في وزن الجسم (8.1%).

قيمة البكترول CBD ارتفعت على التوالي مع زيادة من إضافة الزنجبيل والثوم مع معاملات الزنجبيل والثوم بمعدل 2%، وأدت إضافة الزنجبيل والثوم إلى تحسين معدل التحويل الغذائي وكذلك معدل الإنتاج الأوروبي. وأدت إضافة الزنجبيل والثوم بمعدل 2% إلى زيادة مستوى البروتين الكلي. وأدت إضافة الزنجبيل بمعدل 1% إلى زيادة مستوى الألفا جلوبيولين وزيادة الكوليسترول بما يعادل 2%، وزيادة مادة الـ ALT. وازدادت نسبة حمض اليوريك وعاؤ حمض اليوريك كنسبة حمض الكرياتينين باضافة الزنجبيل بمستويه 1% والثوم بمعدل 2%، إضافة الزنجبيل بمعدل 1% و2% من الزنجبيل. ومن خلال هذه الدراسة يتضح أنه يمكن استخدام الزنجبيل والثوم كمنشطات نمو طبيعية لداري التسمين.

الكلمات الدالة: الزنجبيل، الثوم، الآداء الإنتاجي، الذبيحة، الدم، بداري التسمين