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EFFECT OF DIETARY GINGER AND GARLIC SUPPLEMENTATIONS ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND BLOOD BIOCHEMICAL 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 ($P \leq 0.05$) 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 ($p \leq 0.05$) improved feed conversion ratio (FCR) and European Production Efficiency Factor (EPEF) compared to the control

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group. 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

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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 **(Hanieh *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-

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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

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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.

Ingredients	**Starter diet, 1-21 d of age**	**Grower diet, 22-35 d of age**
Yellow corn, kg	490	550
Soybean meal 48% CP, kg	420	358
Di-calcium phosphate, kg	20	15
Limestone, kg	10	12.5
NaCl, kg	3	3
Vitamin+ mineral premix[1], kg	3	3
Dl-Methionine, kg	2.5	2.5
L- Lysine, kg	1.5	2.0
Vegetable oil[2], kg	50	54
Total	1000	1000
ME	3035	3135
CP	229	208
Ca	9.5	9.1
Available P	5.2	4.2
Methionine	6.0	5.6
TSAA	9.6	9.1
Lysine	13.7	12.6
Ether extract	47	48
Crude fiber	33	38
Ash	55	52
Dry matter	901	912

[1]Vit+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 D_3 (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

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mineral (mg per kg of diet): Mn 80 Zn 60, Fe 35, Cu 8, Se 0.60. [2] 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 30-32ºC during the 1^{st} week and weekly decreased by 3ºC throughout the following three weeks. During the 4^{th} and 5^{th} weeks, the temperature was maintained at 22-24ºC. A similar light schedule to the commercial condition was used; 23 h light from one day old until the 7^{th} day, pursued by 20 h light from the 8^{th} day to the end of the experiment (35 days of age). All birds were fed *ad libtum* 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

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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 K_3-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 -20ºC 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

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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: $y_{ij} = \mu + \tau_j + \varepsilon_{ij}$, where μ=general mean, τ= treatment effect, and ε= 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

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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 ($P \leq 0.05$), the feeding of the test ingredients (ginger or garlic) significantly ($P \leq 0.05$) 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 ($P \leq 0.05$) 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 ($P \leq 0.05$) 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

Traits	Control	Ginger		Garlic		P value
		1%	2%	1%	2%	
BW, 7d	172.8±3.17	172±4.14	172.8±4.39	172.9 ±3.56	172. 7±3.65	1.000
BW, 35d	1913.1±37.7	2053.5±32.0	2024.9±30.9	2040.0±44.4	1983.1±43.0	0.069
BWG, 7-35d	1740.3±38.1	1881.5±31.7	1852.8±31.5	1867.1±44.2	1810.4±42.3	0.066
FI, 7-35d	3007.0±17.8	2883.4±20.8	2769.6±15.8	2783.8±12.3	2711.8±18.6	0.0001
FCR, 7-35d	1.75±0.041	1.54±0.029	1.52±0.027	1.51±0.037	1.52±0.035	0.0001
EPEF	316.4±5.12	383.08±7.15	388. 7±9.71	392.4±22.9	378.7±18.1	0.007

[a,b,c]Means within the same rows with different superscript letters are significantly different at ($p \leq 0.05$). 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

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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 ($P \leq 0.05$) 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

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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 BWG 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-allylcystein sulphoxide, S-methyl-cystein sulphoxide, diallydisulphide, S-allylcystein, diakyl polysulphides, ajoene, and allicin; are the main alkaloids in ginger **(Khan *et al.,* 2012)**. Garlic contains compounds such as allicin and

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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.

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Table 3: Effects of dietary supplementation of ginger and garlic on carcass traits of broiler chicks at 35 days

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

^{a,b} Means within the same rows with different superscript letters are significantly different at ($p \leq 0.05$)

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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

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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 suplementation 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)**.

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Table 4: Effect of dietary supplementation of ginger and garlic on total proteins profile and immunoglobulins of broiler chicks at 35 days

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

[a,b,c] Means within the same rows with different superscript letters are significantly different at ($p \leq 0.05$). A/G ratio = Albumin to globulin ratio

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Table 5: Effect of dietary supplementation of ginger and garlic on Lipid profiles of broiler chicks at 35 days

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

^{a,b,c,d} Means within the same rows with different superscript letters are significantly different at ($p \leq 0.05$)
HDL= High-density lipoprotein; LDL= Low-density lipoprotein

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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 hydroxylmethyl-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).

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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-methlyglutaryl 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.

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Table 6: Effect of dietary supplementation of ginger and garlic on liver and renal functions of broiler chicks at 35 days

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

[a,b,c,d] Means within the same rows with different superscript letters are significantly different at ($p \leq 0.05$)
ALP= Alkaline Phosphatase; ALT= alanine aminotransferase; AST= aspartate aminotransferase; AST/ALT Ratio= aspartate aminotransferase to alanine aminotransferase ratio

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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.

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الملخص العربي

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

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أجريت الدراسات الحديثة لمعرفة تأثير إضافة الثوم والزنجبيل في علائق كتاكيت التسمين وتقييم كفاءة النمو وخصائص الذبيحة وصفات الدم لكتاكيت التسمين. تم اسخدام 150 كتكوتاً من كتاكيت التسمين عمر 7 أيام من سلالة الأربورايكرز على خمسة معاملات غذائية بكل معاملة خمسة مكررات وبكل مكررة ستة طيور، وتم تغذية الطيور على علائق متساوية في الطاقة والبروتين وكانت المعاملة الأولى (الكنترول)، المعاملتين الثانية والثالثة اضافة الزنجبيل (في صورة مسحوق) بمعدل 1% و2%على الترتيب، والمعاملتين الرابعة والخامسة إضافة الثوم (في صورة مسحوق) بمعدل 1% و2% على الترتيب. وكان لاستخدام الزنجبيل والثوم تأثير قوي على خصائص أداء النمو وكان للمستوى المنخفض من الزنجبيل (1%) تاثيرات معنوية قوية على وزن الجسم النهائي (7.12%) والزياده في وزن الجسم (8.10%) على التوالي مقارنة بمجموعة الكنترول، وانخفض استهلاك العلف باضافة الزنجبيل أو الثوم بمعدل (2%) مقارنة بالكنترول والكتاكيت المغذاة على الزنجبيل بمعدل 2%، وأدت اضافة الزنجبيل والثوم إلى تحسين معدل التحويل الغذائي وكذلك معامل الإنتاج الأوروبي وأدت اضافة الثوم بمعدل 2% إلى زيادة البروتين الكلي مقارنة بالكنترول، وأدت إضافة الزنجبيل بمعدل 2% إلى زيادة مستوى الجلوبيولين مقارنة بالكنترول والثوم 1% و2%. وأدى استخدام الزنجبيل بمعدل 1% إلى زيادة الألفا جلوبيولين مقارنة بالكنترول و1% من الثوم، وأدت إضافة الزنجبيل أو الثوم بمعدل 2% إلى انخفاض الدهون الثلاثية، بينما انخفض الكوليسترول مع الثوم بمعدل 2% مقارنة بالكنترول والزنجبيل بمعدل 1%. وانخفض مستوى انزيم الكبد الـ ALT بإضافة الثوم بمعدل 1% والزنجبيل 1% و2%. وانخفض انزيم الـ AST مع كل المعاملات مقارنة بالكنترول و2% زنجبيل، وانخفض مستوى حمض اليوريك ونسبة حمض اليوريك للكرياتينين باضافة الزنجبيل بمستوييه والثوم بمعدل 2% مقارنة بالكنترول والمستوى المنخفض من الثوم. ومن خلال هذه الدراسة يتضح أنه يمكن استخدام الزنجبيل والثوم كمنشطات نمو طبيعية لبدارى التسمين.

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