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IMPACT OF GINSENG (*PANAX GINSENG*) ON GROWTH PERFORMANCE, BLOOD BIOCHEMICAL PARAMETERS AND ANTIOXIDATIVE STATUS OF JAPANESE QUAIL

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ABSTRACT: The effect of dietary inclusion of varying levels of ginseng powder as a natural antioxidant on the productive performance, hematological and blood biochemical parameters of blood, and antioxidative status of Japanese quails. A total of 300 unsexed Japanese quails, aged one week were randomly divided into five experimental groups. The experiment lasted five weeks. The first group fed the basal diet (control); while the 2nd, 3rd, 4th, and 5th groups were fed the basal diet supplemented with 0.5, 1.0, 1.5, and 2.0 g ginseng/ Kg of diet, respectively. The results showed that quails fed the basal diet supplemented with different levels of ginseng (treated groups) had significantly better live body weight, body weight gain, feed conversion ratio, economic efficiency, and production index compared with the control group. In comparison to the control group, supplementation of various ginseng lowered serum levels of cholesterol and low-density lipoprotein (LDL), while RBCs count, hemoglobin, PCV, glucose, globulin, and antioxidant enzymes activity were significantly increased. Additionally, ginseng supplementation increased *lactobacillus* sp. while total bacterial count (*E. coli, and proteus*) decreased compared with the control group. In conclusion, supplementing Japanese quails with ginseng improved their growth performance, physiological characteristics, and antioxidative status.

Key words: Ginseng, Quail, Productive performance, Bacterial count, Antioxidative status

INTRODUCTION

Recently, throughout the world, including in Egypt, the Japanese quail (Coturnix japonica) as an alternative part to chicken as a source of eggs and meat is considered of great economic importance (El-Daly *et al*., 2014). Quail is one of the smallest types of birds farmed for meat and eggs, and it is also of scientific importance as a laboratory animal (Vali *et al*., 2005). The production of quail in Egypt is increasing commercially very quickly, due to the interest in selecting new breeds that have a high body weight and rapid growth and require a small space for growth and maintenance with very low funding compared to other species of poultry (Abd El-Azeem *et al*., 2019). Quail meat is considered the best for patients with high blood pressure, as it is characterized by low fat content, very delicious, and healthy (Elnaggar, *et al*.,, 2021).The major challenge in the long-term sustainability of quail production remains the cost of dietary protein and the supply of essential amino acids (Wickramasuriya *et al*., 2015; Rezaeipour *et al*., 2016).

Due to their plant-derived (phyto-additive) characteristics and growth-promoting benefits, several therapeutic herbs have become increasingly popular in recent decades as an alternative to antibiotics (Abd El-Hack et al., 2020; Alagawany *et al.,* 2020; Ebrahim *et al*., 2020). Many herbs and plant extracts possess antimicrobial activities and antioxidant properties that make them useful as natural animal feed additives (Kim *et al*., 2010; Huang *et al*., 2012).

Ginseng is a highly valued and popular medicinal plant that belongs to the Araliaceae family and belongs to the genus Panax (Helms, 2004). Microorganism fermentation of medicinal herbs such as red ginseng improved their pharmacological efficacy and neuroprotective activity by modifying the components of medicinal herbs (Zhao *et al.*, 2016). For a long time, ginseng has been utilized as one of the most well-known herbal treatments (Kiefer and Pantuso, 2003). Ginseng saponins (GS), also known as ginsenosides, are thought to be one of the main active ingredients in the root (Zhang *et al.,* 2008), with a wide range of pharmacological activities such as anti-inflammatory (Wang *et al.,* 2013), antioxidant (Lee *et al.,* 2012), and immunomodulatory properties. Ginseng plays role in regulating blood lipid and decreasing blood sugar levels, cancer prevention, liver, kidney, heart protection, and immunostimulatory effects (Sohn *et al*., 2008). To date, animal experiments study has shown that ginseng reduced blood pressure and improve cardiovascular dysfunction (Kang *et al*., 1995) and had a relaxing effect on vascular smooth muscle and anti-inflammatory properties as well as anti-stress effect (Peng *et al*., 1995). Therefore, the objectives of the present study were to study the feeding effect of ginseng supplementation in Japanese quail diets on productive performance, physiological characteristics, and antioxidative status.

MATERIAL AND METHODS

The current experiment was conducted at the Animal and Poultry Research Centre (El-Bostan Farm), which is part of the Animal and Poultry Production Department, Faculty of Agriculture, Damanhour University. All treatments and birds care procedures were approved by the Institutional Animal Care and Use Committee in 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.

Experimental design

A total number of 300 one week unsexed Japanese quail chicks, aged one week and averaged 41.3 g body weight (BW) were randomly divided into five experimental groups (60 chicks each). Each group was subdivided into 6 replicates (10 chicks each). The first treatment was fed the basal diet without any supplementation (control), while the 2^{nd}, 3^{rd}, 4^{th} and 5^{th} treatments were supplied with different levels of ginseng 0.5, 1.0, 1.5, and 2.0 g/ Kg diet, respectively. The ginseng material used in the experiment was obtained in powder form a commercial source (local market) in Damanhour City, Beheira Governorate, and analyzed in the laboratory, the most important major compounds are shown in Table (1). The experimental diets were formulated according to NRC (1994). During the starter (7-21 d) and grower stages (22-42d), chicks were fed a basal diet comprising (22.9 and 21.4%) of crude protein and (3042 and 3103 kcal/kg) of metabolizable energy, respectively.

Housing and management

The birds were kept under the same environmental and managerial conditions. All birds were wing banded and housed in wire cages (40×50×40 cm). The birds were reared under variable temperatures, the initial temperature in the farm was maintained at 35°C for the first 2 days and then reduced linearly by 0.5°C per day from the third to the sixth day of age. From the 7^{th} day until 42 days of age, the temperature was slowly reduced until reaching the comfort temperature (24°C). The light regime used was 20 L: 4D/ day (artificial light). Chicks were fed the experimental diets *ad libtium* and clean fresh water was available. The experiment lasted five weeks after 1st week at 42 days of age.

Collected performance data

Productive performance including individual live body weight (LBW, g), body weight gain (BWG, g), and feed consumption (FC, g) were recorded throughout the trial period (1-6 wk of age). For each replicate within treatment groups, feed conversion ratio (feed/gain ratio, FCR) was calculated according to the formula:

FCR = FC (g) /BWG (g).

Also, the survival rate was calculated. The economic efficiency of experimental diets was estimated by (Zeweil, 1996) as the ratio between income and total feed cost during the experimental growth period. The price of the diets and ginseng supplements was calculated according to the local market price at the same time as the experiment in 2020 by the Egyptian pound (L.E.).

Economic efficiency = (Net revenue/ Total feed cost) * 100

Net revenue = Total revenue - Total feed cost.

Total revenue: the selling price of the obtained live weight. The production index value was calculated throughout the experimental period (7-42 d) of age according to Hubbard broiler management guide 1999

$\mathrm{EPEI} = \frac{\mathrm{BW\ (kg)\ x\ SR}}{\mathrm{PP\ x\ FCR}} \mathrm{x}\ 100$Where:

EPEI = European Production Efficiency Index.

BW = Body weight (kg)

SR = Survival rate (100% - mortality) PP = Production Period (days)

FCR = Feed conversion ratio (kg feed / kg gain).

Blood collection and hemato-biochemical parameters

At the age of 6 weeks, blood samples (approximately 2 ml) were fasted and collected between 8.00 and 9.00 a.m. from the brachial vein of arandom sample of 6 quails /group into heparinized and un-heparinized under vacuum tubes. Coagulated blood samples were centrifuged at 4,000 rpm for 15 min, and the clear serum was separated (isolated) and stored (stocked) frozen at −20°C until biochemical analysis. Non-coagulated blood, a part of each sample was used to assess the hematological parameters including red blood cells count (RBCs), hemoglobin (Hb), the percentage of packed cell volume (PCV) were also measured according to (Feldman *et al*. 2000). Plasma samples were separated from blood by centrifugation at 4,000 rpm for 15 min and stored at −20°C.

Plasma total proteins, albumin, were measured by using special kits delivered from sentinel CH. Milano, Italy by means of spectrophotometer according to guidelines and recommendation of (Armstrong and Carr 1965; Doumas *et al*. 1971). Plasma globulin level was calculated by subtracting the total protein and albumin since the fibrinogen usually comprises a negligible fraction (Sturkie, 1986). Albumin to globulin ratio was also calculated according to (Fossati and Prencipe 1982), plasma glucose concentration was measured by the method of (Trinder 1969). The activity of serum alanine aminotransferase (ALT), were estimated according to Reitman and (Frankle 1957). The creatinine level was measured according to the method explained by (Husdan and Rapoport 1968). Serum triglycerides concentrations were tested using specific kits from CAL-TECH Diagnostics, INC, (CAL) Chino, California, U.S.A. According to the recommendations of (Bogin and Keller 1987), serum total cholesterol was estimated using the specific kits, high-density lipoprotein (HDL) was measured according to the method outlined by (Lopes-Virella *et al.* 1977), and low-density lipoprotein (LDL) was calculated by the formula of (Raya *et al*. 2014). The activity of malondialdehyde (MDA) in the blood was measured using the method reported by (Placer *et al*. 1966). The calorimetric method of (Koracevic *et al*. 2001) was used to assess blood total antioxidant capacity (TAC). Serum glutathione peroxidase activity (GPX) was determined according to the colorimetric method of (Bauer 1982). Serum glutathione activity (GSH) was determined according to (Ellman 1959). (Misra and Fridovich 1972) method for measuring serum superoxide dismutase (SOD) was used.

Slaughter traits

At the end of the experimental period (42 d of age), six quails from each group were randomly taken, fasted for 12 hours, individually weighed, and slaughtered to complete bleeding. Abdominal fat was removed from the gizzard and abdominal region and individually weighed for each carcass. Edible giblets (liver, heart, and gizzard) were individually separated and weighed. Pancreas, spleen and gland bursa of fabricius were individually separated and weighed, and relative weight to live (pre-slaughtered) and calculated for each organ relative to pre-slaughtered weight. The length of the small intestine was also measured. Dressing percentages were calculated as follows:

Dressing % = (dressing weight/ pre-slaughter live body weight) * 100

Where: Dressing weight = weight of empty carcass without head + edible giblets part.

Bacterial count

During slaughtering procedures, six birds from each treatment were taken randomly for the collection of cecal content samples. Then, samples were subjected to analyzed for total bacterial count (TBC, cfu x 10^6), *Lactobacillus Spp.* (cfu x 10^3). *Escherichia coli* as colony-forming unit (cfu x 10^3), and proteus (cfu x 10^3) using modified methods described by (Baurhoo *et al*. 2007), which differed only in used agars

Statistical analysis

The analysis of variance for completely randomized design experiments using general linear models procedure of SAS (2006) examined the effects of dietary treatments. The model used was:

Yij = μ + Ti + eij

Where Yij = is the dependent variable; μ= the general mean; T= the fixed effect of treatment and eij = random error. The significance of differences among means were determined using Duncan's new multiple range test (Duncan, 1955) at P≤0.05.

RESULTS AND DISCUSSION

Productive performance traits

Effects of dietary inclusion with different levels of ginseng on growth performance of Japanese quail were shown in Table (2). Varying levels of ginseng supplementationresulted in a significant (P=0.001) increase in live body weight (LBW) at 3 and 6 weeks of age. Overall, ginseng treatments raised BW at 3 weeks of age by 6.9, 14.6, 19.3, and 14.5 % of the control value with the 0.5, 1.0, 1.5, and 2.0 % treatments, respectively. Also, ginseng , treatments raised BW at 6 weeks of age by 15.7, 23.0, 23.5, and 20.5 %, respectively, with the best BW being at the levels of 1.0 and 1.5 %. BWG was increased in a level-dependent way (P=0.001) from 1st to 3rd week and a similar trend was seen with LBW, which reached 109.8, 121.9, 130.3, and 121.3 % of the control group, respectively. During the second period from 3th to to 6th week BWG was increased in a level-dependent way (P=0.003), and a similar trend was seen with BW, which reached 115.5, 120.4, 115.2, and 115.1 % of the control group, respectively. During the total period from 1st to 6th week, BWG was increased in a level-dependent way (P=0.001), and a similar trend was seen with BW, which reached 112.7, 121.2, 122.1, and 117.9 % of the control group, respectively.

At the time periods indicated above, it is clear from the data analysis of variance that different levels of ginseng, overall quail chick feed consumption was lowered not significantly. The improvement in weight gain associated with the reduction in feed consumption resulted in a significantly (P=0.007, 0.003, and 0.001) improved FCR (Table 2), during the first period the 0.5, 1.0, 1.5, and 2.0 % treatments enhanced FCR by 17.1, 19.9, 23.5, and 18.8%, respectively. During the second period improved FCR by 18.1, 21.7, 17.4, and 14.8%, respectively. During the third period improved FCR by 18.1, 21.7, 17.4, and 14.8%, respectively, compared to the control group, with the best FCR observed at the 1.0 and 1.5 g/kg levels. Data from Table (3) shows the survival rate (%), where it is noted that when compared to the control group, SR (%) were improved significantly (P=0.004) with ginseng treatments, reaching 103.2, 103.1, 101.3, and 103.2 %, respectively.

The results obtained in this study corresponded with the results of (Muwalla and Abuirmeileh 1990) showed that supplementation of 0.25% of powder Panax ginseng increased body weight gain. Also, Yan *et a*l. 2010 noticed that body weight gain was improved with the dietary treatment of powder ginseng adventitious root meal at 0.1% in broiler chickens. Saha *et al*. 2011 studied that the positive effect of ginseng on the growth performance of treated groups could be attributed to natural plant extracts containing a variety of bioactive ingredients that have intrinsic abilities to improve digestion and stimulate enzyme activity. Chung and Choi 2016 also found that mortality and weight gain were most enhanced in the groups fed diets supplemented with 1% fermented red ginseng powder combined with red koji. Additionally, the presence of ginsenoside in the Panax ginseng complex contributed to improving the parameters evaluated by its antimicrobial and antioxidant potential, as well as, assist the absorption of nutrients by increasing the permeability of the small intestinal mucosa as confirmed by Zhang *et al*. (2008) & Kim *et al*. (2010). Therefore, using ginseng powder is considered a key strategy to support gut health and to optimize digestive functions, thereby improving growth performance. While, Özcan (2016) found that supplementing Japanese quails with 5 and 10 mg/kg ginseng root extract had no effect on body weight. The use of 5% Panax ginseng reduced feed consumption but had no effect on feed conversion ratio (Sohn *et al*., 2008). Kim *et al*. (2014) reported that supplementing with 3% red ginseng marc markedly decreased mortality of broiler.

Hematological characteristics

Hematological parameters of ginseng-treated quails were shown in Table (3). All hematological indices were within the range of reference values. Red blood cells (RBCs) counts increased (P=0.001) gradually as ginseng levels increased. The increases of RBCs were 32.4, 33.2, 32.4, and 31.8 % compared with the control. It is noted that when compared to the control group, Hb concentration (g/dl) was significantly increased(P=0.002) with ginseng treatments, reaching reaching 129.2, 126.0, 135.7, and 135.9 %, respectively. Also, the PCV % value was increased significantly (P=0.003) with ginseng treatments, reaching 107.3, 123.3, 112.7, and 124.4 %, respectively.

The improvement in the number of RBCs may be due to the role of ginseng in stimulating the bone marrow to synthesis erythropoietin (Jensen *et al*., 2000; Karadeniz and Altintas, 2008). Panax ginseng administration significantly enhanced haemoglobin concentrations, RBCs, WBCs count, and lymphocyte numbers in rats, according to Simsek *et al*. (2007). Xi *et al*. (2017) showed that adding different types of ginseng to poultry diets may enhance the hematological parameters in poultry. While Yan *et al*. (2010) indicated that ginseng supplementation did not affect RBCs and WBCs counts and increased lymphocyte levels. Also, in the study with laying hens (Kim *et al*., 2015), WBCs, hemoglobin levels and hematocrit were not affected and RBCs count was improved with ginseng supplementation. Yener *et al*. (2021) found that ginseng plant supplementation did not affect erythrocytes, hematocrit, lymphocytes, and increased hemoglobin, leukocytes.

Protein profile

Protein profiles (total protein, and globulin) as shown in Table (3) were significantly increased (P=0.001) by the ginseng treatments of quails. The percentages of those increases in total protein compared with control were 12.3, 13.5, 8.2, and 12.2 %, respectively. Likewise, the percentages of those increases in globulin compared with control were 23.3, 33.3, 22.2, and 30.4 %, respectively. Data from the same table showed the differences in the serum albumin and albumin/globulin ratio concentration were not statistically significant with ginseng treatments compared to the control group.

Some blood biochemical parameters

Data from Table (3) shows the quail's blood analysis, where it is noted that when compared to the control group, plasma glucose levels were increased significantly (P=0.001) with ginseng treatments, reaching 35.5, 30.4, 26.8, and 28.8 %, respectively. With ginseng treatment, the alanine aminotransferase (ALT) level decreased not significantly with the four ginseng levels. The normal values recorded here for ALT (which reflect insignificant differences compared with control values) were indicative of the normal functioning of the livers of the experimental quails. Different levels of ginseng inclusion in the diets appeared to considerably significantly reduced serum concentrations of creatinine, reaching 78.9, 79.7, 74.8, and 71.5 % of control quails, respectively.

Panax ginseng powder extract supplementation raised total protein, ALT, and AST levels in Japanese quails (Osfor, 1995), but had no effect on urea or creatinine levels in serum. Saponin enhanced the active component serum production, according to Ruda Kewich and Benishin (2001). Ginseng plant supplementation enhanced AST, ALT, and GGT levels in rats (Karakus *et al*., 2011), but had no effect on AST and ALT levels in laying hens (Kang *et al*., 2016). According to Sohn *et al*. (2008), supplementing with 0.5 and 1 percent Sibirya ginseng leaf had no effect on AST, ALT, albumin, total protein, and increased glucose in blood serum. Song *et al*. (2004) found that supplementing with ginseng, a polysaccharide derived from the root of Panax ginseng C.A. Meyer, had no effect on serum AST and ALT activity or albumin levels, similar to the current study.

Lipid profile

In respect of serum triglycerides concentration, the present results showed a lower non-significant of quails supplemented by different ginseng levels compared with the control group. However, serum total cholesterol and low-density lipoprotein (LDL) showed significantly decreased (P=0.001 and 0.004) differences in ginseng treatments compared with the control group. They were reduced by 87.4, 88.2, 88.8, and 89.0 % and by 91.8, 92.8, 95.6, and 92.9 %, respectively. On the other hand, ginseng therapies had a substantial (P=0.002) effect on blood HDL levels. When compared to the control group with the four levels of ginseng, blood high-density lipoprotein was raised by 14.9, 14.9, 11.3, and 17.2 %, respectively.

In our study, dietary ginseng significantly decreased total cholesterol and it had no effect on serum triglyceride levels in quails, according to several studies (Hassan *et al*., 2012; Yıldırım *et al*., 2013), ginseng root powder had no effect on serum triglyceride and cholesterol levels. However, several researchers (Muwalla and Abuirmeileh, 1990) found that dietary ginseng supplementation lowered serum total cholesterol and LDL cholesterol levels in avian species via impairing hepatic cholesterogenesis. When compared to a diet without ginseng, Qureshi *et al*. (1983) found that ginseng supplementation reduced hydroxyl methylglutaryl-CoA (HMG-CoA) reductase activity and cholesterol 7-hydroxyylase activity, and that ginsenoside (saponins) are the bioactive agents for the suppression of cholesterogenesis and lipogenesis. The ginseng plant also reduced serum triglyceride and cholesterol levels, according to several researchers (Jang *et al*., 2007; Yan *et al*., 2010; Kim *et al*., 2015; Özcan, 2016). According to Kim *et al*. (1985), ginseng saponin can partially restore LDL biosynthesis in fowl fed a high cholesterol diet. The saponin's solubilizing activity may aid in the elimination of fats from the circulation.

Antioxidant status

Table (3) shows the effect of ginseng supplements on antioxidant levels in the blood serum of treated quails. Ginseng treatments enhanced (P=0.001) blood total antioxidant capacity (TAC) by 2.9, 3.5, 4.2, and 3.4 % with the four levels, respectively compared with the control group. Glutathione activity (GSH), Glutathione peroxidase activity (GPx), and superoxide dismutase (SOD) showed significantly increased (P=0.001, P=0.002, and 0.003, respectively by 11.7, 17.1, 3.0, and 5.1 %, and by 0.87, 0.52, 0.95, and 1.43 %, and by 8.4, 7.3, 8.0, and 4.2 % compared with the control group with the four levels of ginseng, respectively. On the other hand, ginseng therapies had a substantial effect (P=0.001) on blood malondialdehyde (MDA) levels. When compared to the control group with the four levels of ginseng, blood MDA was reduced by 26.7, 32.7, 30.9, and 32.6 %, respectively. The results in the current study are similar to the results reported previously for ginseng extract and demonstrate the antioxidant evidenced by its free radical scavenging. Zhang *et al*. (2008) found that ginseng saponins (GS), i.e., ginsenosides, are believed to be one of the major active ingredients in the root. The antioxidant capacity of ginseng extract may have the potential to be used as an effective dietary antioxidant to prevent oxidative stress-related diseases suggested by Oh *et al*. (2010). The improvement of growth performance may be to the total phenolic content and antioxidant activity of ginseng (Chen *et al*., 2010; Deng *et al*., 2013). Ginseng possesses a variety of pharmacological activities, including anti-inflammatory, antioxidant, and immune-modulatory activities (Wang *et al*., 2013; Lee *et al*., 2012).

Carcass characteristics

Table (4) shows the quail's carcass characteristics measurements. Dressing (%) were increased significantly (P=0.001) with ginseng treatments, reaching 106.4, 104.2, 103.5, and 104.6 %, respectively. On the other hand, ginseng therapies had a substantial (P=0.001) effect on abdominal fat (%), that reduced by 30.0, 26.7, 33.3, and 23.3 %, compared with control, respectively. On the other hand, liver, heart, gizzard, pancreas, spleen, and bursa of Fabricius weight percentages were not significantly different among experimental groups. Table (4) summarizes the effects of ginseng treatments on intestine length (cm) in quails. Ginseng treatments enhanced the intestine length; hence, this leads to increase its inner surface and thus increasing the absorption of digested nutrients that are transported to all cells of the body through the blood. This improvement in the relative weight of the bursa of Fabricius may be due to the increase in the number of lymphocytes due to the ginseng containing effective compounds such as saponins and polysaccharide acidic sugars, which have a positive effect on immune functions and strengthen the immune system in the body of the live bird (Ilsley *et al*., 2005; Dong *et al*., 2007). Kim *et al*. (2002) indicated that 5% Panax ginseng leaves had no effect on carcass yield. Sohn *et al*. (2008) reported that 0.5 and 1% ginseng increased bursa Fabricius weight but did not affect the liver and spleen weight. Ginseng supplementation had important role in the meat palatability because it affects the first impressions of the meat by consumers. In the study of Yener *et al.* (2021) found that carcass and the relative weight percentages of heart , liver, bursa Fabricius, and abdominal fat were not affected by supplementation of ginseng plant. However, the relative weight percentages of the gizzard and spleen were increased in the doses of powder red ginseng root.

Bacterial count

Data for the cecal bacterial count are shown in Table (5). All the supplemented ginseng treatments had significantly increased (P=0.002) *Lactobacillus sp.* compared with the control group; either in terms of TBC or the pathogenic bacteria species (*E. coli* and proteus). Our results showed a significant reduction in the number of pathogenic bacteria, indicating the role of ginseng as a good source to relieve bacterial disorders in the digestive tract of quails. *Lactobacillus spp.* is an indicator microorganism for flora that mediates excellent digestive system functioning in chicken. These bacteria make short-chain fatty acids, which create an acidic environment that prevents the growth of bacteria that produce odor. Lactobacillus species are also hypothesized to prevent *E. coli* from producing poisonous amins by secreting antienterotoxins. The antibacterial properties of ginseng have been attributed to a number of ginseng components (Tan and Vanitha, 2004). The beneficial effects of ginseng on the growth performance of rabbits were mainly attributed to the alteration of the intestinal microbial, increased enzyme secretion, improved immune response, reducing biological stress, increasing antioxidant activity, and consequently improving health status (Brugalli, 2003, Fascina *et al*., 2012). Park *et al*. (2009) and Yan *et al*. (2011) found that a significant reduction in the number of pathogenic bacteria. It is well known that the beneficial bacterial community in the digestive tract could enhance and maintain the structural and functional integrity of the epithelial lining mucosa, and affect the immune system. Furthermore, many studies have shown that ginseng's immunomodulatory properties may be related to the actions of its ginseng polysaccharides (Xi *et al*., 2017). Many plants have a favorable effect on bacteria by stimulating their selective development and metabolic activity in the caecum, as well as decrease the number of potentially harmful species like E. coli. For example, maternal sea weed derived polysaccharide supplementation reduced the number of E. coli and salmonella in weaned pigs' colon and caecum (Leonard et al., 2011).

Economic efficiency and production index

Results of economic efficiency in Table (6) shows the total revenue, net revenue (NR), economic efficiency, relative economic efficiency (%), and European production efficiency index (EPEI) that were used to assess the economic nutritional programs altered net revenue, which is represented by the equation NR = total revenue - total feed cost, indicating that net revenue increased as dietary nutrient levels increased by supplementing with ginseng. The best economic efficiency and relative economic efficiency (%) were obtained present study, the broiler was evaluated in terms of EPEF, which combines body weight and livability, according to Yener *et al*. (2021). In terms of livability and EPEF, dietary red ginseng root powder supplementation had no significant impacts. In laying hens, a similar result was achieved (Yildirim *et al*., 2013).

CONCLUSION

Based on the results of the present study, it could be concluded that all ginseng viability of various levels of ginseng. Supplementing with ginseng in the

with 2.0 g /kg diets than the other treatments. Therefore, it is advised to include these ingredients in the poultry diet to improve performance and health status, which will benefit the owners of commercial farms to raise the economic value. Contrary to the results of the

treatments enhanced productive performance, physiological traits, antioxidant status, bacterial count, carcass characteristics as well as economic efficiency and production index of Japanese quails. In spite of the favorable results of all dietary ginseng supplementation at the middle levels (1.0, and 1.5 g/ kg diet), seems to be better than the low and high levels.

Table (1): The most important major compounds of powder ginseng

Proximate analysis of ginseng	**%**
Moisture	9.6
Ash	5.1
Crude protein	11.6
Lipids	5.5
Crude fiber	7.8
Carbohydrate	55.0
Oils	5.4
Fatty acid content of ginseng	
Meristic	11.7
Palmitic	26.1
Stearic	3.8
Oleic	30.3
Linoleic	23.9
Linolenic	3.7

Table (2): Effect of dietary inclusion with different levels of ginseng on growth performance of Japanese quail

Dietary supplementations	Ginseng levels (g/kg diet)						
	Control	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	***p value***
Items	**Body weight (g)**						
1 wk	41.3	40.9	41.6	40.9	42.1	1.89	0.085
3 wk	117.9^{c}	126.0^{b}	135.1^{a}	140.7^{a}	135.0^{a}	2.90	0.001
6 wk	199.1^{c}	230.3^{a}	244.9^{a}	245.8^{a}	240.0^{a}	8.00	0.001
	Body weight gain (g)						
1-3 wk	76.6^{c}	84.1^{b}	93.4^{a}	99.8^{a}	92.9^{a}	6.77	0.001
3-6 wk	91.2^{b}	105.3^{a}	109.8^{a}	105.1^{a}	105.0^{a}	9.11	0.003
1-6 wk	167.8^{c}	189.1^{b}	203.3^{a}	204.9^{a}	197.9^{a}	10.00	0.001
	Feed consumption (g feed / bird/ period)						
1-3 wk	212.0	200.0	210.0	212.0	209.0	3.00	0.098
3-6 wk	530.0	500.0	500.0	505.0	520.0	2.90	0.978
1-6 wk	742.0	700.0	710.0	717.0	729.0	11.09	0.190
	Feed conversion ratio (g feed/ g body weight gain)						
1-3 wk	2.77^{a}	2.38^{b}	2.22^{b}	2.12^{b}	2.25^{b}	0.980	0.007
3-6 wk	5.81^{a}	4.76^{b}	4.55^{b}	4.80^{b}	4.95^{b}	0.876	0.003
1-6 wk	4.42^{a}	3.70^{b}	3.49^{c}	3.50^{c}	3.68^{b}	0.065	0.001
Survival rate (%)	95.9^{b}	99.0^{a}	98.9^{a}	97.1^{a}	99.0^{a}	2.77	0.004

^{a,b,c} Means in the same row followed by different superscripts are significantly different at (p≤ 0.05).SEM, Standard error of means; BW, body weight; BWG, weight gain; FC, Feed consumption; FCR, Feed conversion ratio.

Table (3): Effect of dietary inclusion with different levels of ginseng on hemato-biochemical parameters of Japanese quail

Dietary supplementations	**Ginseng levels (g/kg diet)**						
	Control	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	***p value***
Items	**Hematological traits**						
RBCs (10^6/cmm^3)	3.40^{b}	4.50^{a}	4.53^{a}	4.50^{a}	4.48^{a}	0.811	0.001
Hb (g/dl)	10.30^{b}	13.31^{a}	12.98^{a}	13.98^{a}	14.00^{a}	0.909	0.002
PCV (%)	31.32^{c}	33.60^{b}	38.62^{a}	35.31^{b}	38.95^{a}	1.990	0.003
Blood biochemical constituents							
T. protein (g/dl)	5.7^{b}	6.4^{a}	6.5^{a}	6.2^{a}	6.4^{a}	2.88	0.001
Albumin(g/dl)	3.0	3.1	2.9	2.9	2.9	1.09	0.065
Globulin(g/dl)	2.7^{b}	3.3^{a}	3.6^{a}	3.3^{a}	3.5^{a}	0.998	0.001
A/G ratio	1.11	0.92	0.80	0.87	0.82	0.087	0.060
Glucose (mg/dl)	140.3^{b}	190.1^{a}	183.0^{a}	177.9^{a}	180.7^{a}	8.98	0.001
ALT (IU/L)	64.0	59.7	59.7	60.0	61.2	9.98	0.083
Creatinine (mg/dl)	1.23^{a}	0.97^{b}	0.98^{b}	0.92^{b}	0.88^{b}	0.098	0.002
Triglycerides (mg/dl)	138.3	101.0	102.0	107.7	104.9	18.91	0.082
Cholesterol (mg/dl)	213.6^{a}	186.7^{b}	188.3^{b}	189.7^{b}	190.1^{b}	23.91	0.001
HDL (mg/dl)	47.0^{c}	54.0^{a}	54.0^{a}	50.3^{b}	55.1^{a}	8.99	0.002
LDL (mg/dl)	138.9^{a}	127.5^{b}	128.9^{b}	132.8^{b}	129.0^{b}	11.9	0.004
Indicators of antioxidative status							
MDA (ɱg/ml)	118.7^{a}	87.0^{b}	79.9^{b}	82.0^{b}	80.1^{b}	0.065	0.001
TAC (nmol/L)	406.6^{c}	418.3^{b}	419.0^{b}	423.7^{a}	420.5^{a}	29.9	0.001
GPX (mmol/L)	877.7^{b}	885.3^{a}	882.3^{a}	886.0^{a}	890.3^{a}	12.90	0.002
GSH (U/Ml)	59.1^{b}	66.0^{a}	69.2^{a}	68.0^{a}	62.1^{a}	0.098	0.001
SOD (U/ml)	245.7^{b}	266.3^{a}	263.7^{a}	265.3^{a}	255.9^{a}	8.99	0.003

^{a,b,c} Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$).
SEM, standard error of means; RBCs, red blood cell; PCV, packed cell volume; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MDA, malondialdehyde; TAC, total antioxidant capacity; GPx, glutathione peroxidase; GSH, glutathione; SOD, superoxide dismutase.

Table (4): Effect of dietary inclusion with different levels of ginseng on carcass characteristics of Japanese quail

Dietary supplementations	Ginseng levels (g/kg diet)						
	Control	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	***p value***
Items	**Carcass characteristics**						
Dressing (%)	69.21^{b}	73.62^{a}	72.55^{a}	71.62^{a}	72.42^{a}	9.87	0.001
Liver (%)	1.63	1.72	1.70	1.77	1.67	0.89	0.098
Heart (%)	0.92	0.89	0.87	0.84	0.87	0.07	0. 341
Gizzard (%)	1.64	1.67	1.69	1.71	1.69	0.34	0.187
Abdominal fat (%)	0.30^{a}	0.21^{b}	0.22^{b}	0.20^{b}	0.23^{b}	0.05	0.001
Pancreas (%)	0.53	0.45	0.41	0.48	0.44	0.09	0.082
Spleen (%)	0.041	0.042	0.040	0.041	0.039	0.01	0.198
Bursa of Fabricius(%)	0.07	0.07	0.06	0.08	0.08	0.01	0.098
Intestine length (cm)	66.6	71.6	76.3	80.0	66.6	1.91	0.230

[a,b,] Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$)
SEM, standard error of means.

Table (5): Effect of dietary inclusion with different levels of ginseng on bacterial counts in cecal contents of Japanese quail

Dietary supplementations	Ginseng levels (g/kg diet)						
	Control	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	***p value***
Items	**Bacterial counts**						
TBC (cfu x 10^{6})	4.91^{a}	3.73^{b}	3.77^{b}	3.83^{b}	3.61^{b}	0.891	0.001
Lactobacillus (cfu x 10^{3})	1.11^{b}	1.55^{a}	1.77^{a}	1.70^{a}	1.92^{a}	0.993	0.002
E. Coli (cfu x 10^{3})	1.40^{a}	0.87^{b}	0.73^{b}	0.77^{b}	0.80^{b}	0.911	0.001
Proteus (cfu x 10^{3})	0.88^{a}	0.47^{b}	0.53^{b}	0.43^{b}	0.51^{b}	0.068	0.003

[a,b,] Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$)
SEM, standard error of means; TBC, total bacterial count.

Table (6): Effect of dietary inclusion with different levels of ginseng on economic efficiency and production index of Japanese quail

Dietary supplementations	Ginseng levels (g/kg diet)						
	Control	0.5	1.0	1.5	2.0	SEM	*p value*
Items	**Carcass characteristics**						
Birds price (7 d) (LE)	1.45	1.45	1.45	1.45	1.45	--	--
FC (kg/chick)	0.742	0.700	0.71	0.717	0.729	11.09	0.190
Price/ Bird (L.E)	7.5	7.5	7.5	7.5	7.5	--	--
Feed cost L.E/Kg+ feed additive	5.57	5.25	5.33	5.38	5.47	--	--
Body weight gain (g/ bird)	167.8[c]	189.1[b]	203.3[a]	204.9[a]	197.9[a]	10.00	0.001
Total cost	8.67[a]	8.35[b]	8.00[c]	7.94[c]	7.84[c]	0.987	0.001
Total Revenue (LE)	12.0	12.0	12.0	12.0	12.0	--	--
Net Revenue (LE)	3.33c	3.65b	4.00a	4.06a	4.16a	0.890	0.001
Economic efficiency	0.38[c]	0.44[b]	0.50[a]	0.51[a]	0.53[a]	0.065	0.001
Relative economic efficiency (%)	100.0	113.8	130.2	133.1	138.2	--	--
Production index	8.43[c]	11.80[b]	15.26[a]	15.02[a]	15.97[a]	2.90	0.001

[a,b,c] Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM, standard error of means.

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الملخص العربى

تأثير إستخدام نبات الجينسنج علي الاداء الانتاجي ،خصائص الدم البيوكيمياوية وخصائص الاكسدة علي السمان الياباني

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أجريت هذه الدراسة في وحدة بحوث الدواجن بمزرعه البستان، قسم الانتاج الحيواني والداجني، كلية الزراعة - جامعة دمنهور وكان الهدف منها دراسة التأثيرات الناتجة عن إضافة مستويات مختلفة من نبات الجينسنج علي الصفات الانتاجيه والكفاءة الاقتصادية ومعامل الانتاج الاوربي والصفات الفسيولوجية وانزيمات الاكسدة لكتاكيت السمان الياباني النامي تم استخدام ٣٠٠ كتكوت من كتاكيت السمان الياباني عشوائيا بداية من عمر أسبوع إلى خمسه معاملات تجريبيه بكل معاملة ٦٠ طائر في سته مكررات بكل منها ١٠ كتاكيت علي النحو التالي: المجموعة الاولى هى المقارنه (الكنترول) وكانت تغذت علي العليقة بدون إضافات ؛ والمعاملات الاربعه الاخري تغذت على العليقه الأساسيه مع اضافه الجينسنج بمستويات ٠، ٥- ١,٠٠- ١,٥٠ – ٢,٠٠جم /كجم علف علي التوالي. أظهرت النتائج حدوث زيادة معنوية في وزن الجسم الحي ومعدل الزيادة في وزن الجسم مع تحسن في الكفاءة الغذائية والكفاءة الاقتصادية في المجموعات التي غذيت علي المستويات المختلفة من الجينسنج بالمقارنة بمجموعة الكنترول..لوحظ أيضا وجود زيادة في مستوي تركيز انزيمات الاكسدة في سيرم الدم في المجموعات المغذاة علي الجينسنج بالمستويات المختلفة مقارنة بالكنترول.

وقد خلصت نتائج الدراسة إلي أن إضافة المستويات المختلفة من الجينسنج كان لها تأثير ايجابي ومعنوي على الأداء الإنتاجي وقياسات الدم ,وانزيمات الاكسدة في كتاكيت السمان وكانت افضل معامله هي ١,٠٠- ١,٥٠ جم / كجم علف افضل نسبة اضافة من الناحية الاقتصادية.