REPRODUCTIVE, BIOCHEMICAL, AND HORMONAL TRAITS OF LOCAL QUAIL IN RESPONSE TO DIETARY SUPPLEMENTATION OF DRIED GARLIC POWDER

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ABSTRACT

The study was conducted to find out the effect of dried garlic (*Allium sativum*) powder at different levels on the productive and reproductive performance of local quail. About ninety female local quail were used. The quails were divided into six groups (control, standard diet + 3% lipid, standard diet + 2% powder garlic, standard diet + 2% powder garlic + 3% lipid, standard diet + 4% powder garlic, and standard diet + 4% powder garlic + 3% lipid). A higher significance (p≤0.05) in egg weight (11.69 g/egg), feed intake (2977.13 g/week), hen day egg production (92.48 %), and egg mass (10.62) was recorded of quail eating (4% powder garlic). The results show the significant (p≤0.05) superiority of quails fed 4% of garlic powder in the internal egg characteristics such as egg albumen weight, yolk height, Haugh unit, and egg hardness. A significant (p≤0.05) improvement in the blood lipid profile in favor of quail birds fed on rations containing dried garlic powder, as the highest value for total cholesterol, triglycerides, LDL, and VLDL found in the treatment of birds fed on high lipids, while the highest values of HDL were in the treatments of fed different levels of garlic powder. The highest levels of Ghrelin, T4, and LH, hormones were recorded for quail birds fed with 2% garlic powder. Birds fed on high lipid diet showed higher concentrations of leptin and growth hormone, while the higher value of FSH was seen in a 4% garlic supplemented diet. We conclude from the above that birds fed 4% dried garlic powder were superior in most productive and reproductive traits, compared to other treated birds.

KEYWORD: Local Quail, Reproductive, Lipid profile, Hormonal levels, Garlic. Egg production.

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الصفات التناسلية والبيوكيميائية والهرمونية للسمان المحلي استجابةً لأظافة مسحوق الثوم المجفف للعليقة

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المستخلص

أجريت هذه الدراسة لمعرفة تأثير أضافة مسحوق الثوم المجفف إلى عليقة السمان في الخصائص الإنتاجية والتناسلية والبيوكيميائية والهرمونية لإناث السمان. قسمت الطيور (90) الى ستة مجاميع بواقع (15) طيرا مرقما لكل معاملة. أظهرت النتائج وجود تفوق معنوي لطيور المعاملة المغذاة على 4% من مسحوق الثوم المجفف في كل من وزن البيضة (11.69 غم/بيضة) و كمية العلف المستهلك (2977.13 غم/أسبوع) والنسبة المئوية لأنتاج البيض (92.48%) وكتلة البيض (10.62). كما وتفوقت طيور نفس المعاملة (4% مسحوق الثوم المجفف) في صفات البيض الداخلية المتمثلة في وزن بياض البيض وأرتفاع الصفار ووحدة هاو وصلابة قشرة البيضة. سجلت فروقات معنوية في مستوى الدهنيات أذ كانت أعلى القيم لكوليسترول الكلي والدهون الثلاثية والكوليسترول المنخفض الكثافة لمجموعة الطيور المغذاة على (3%) من اللبيدات الحيوانية في حين سجلت أعلى قيم لكوليسترول المفيد أو عالي الكثافة لطيور المجاميع المغذاة على نسب مختلفة من مسحوق الثوم المجفف.كذلك أظهرت النتائج وجود فروقات معنوية بين الطيور المعاملات الستة في مستوى هرمونات الدم حيث تم تسجيل أعلى مستوى من (Ghrelin) و (T4) و (LH) لطيور المغذاة على 2% من مسحوق الثوم المجفف. في حين سجلت أعلى القيم لكل من (Leptin) و (GH) لطيور المغذاة على 3% من اللبيدات، أما طيور المغذاة على 4% من مسحوق الثوم المجفف تفوقت في تركيز هرمون (FSH) على المجاميع الأخرى. نستنتج مما سبق أن الطيور التي تغذت على 4٪ مسحوق الثوم المجفف كانت متفوقة في معظم الصفات الإنتاجية والتناسلية، مقارنة بالطيور المعاملات الأخرى.

كلمات مفتاحية: السمان ، هرمون نمو الحويصلات، هرمون الأباضة، الجيرلين، أنتاج البيض.

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INTRODUCTION

Quail (*Coturnix coturnix*) is one of the poultry species, which has been used in various biological experiments including meat and egg production. Quail is a popular bird model in numerous fields of research because of its small body size, short generation interval (3-4 generations per year), resistance to many common avian diseases, and high egg production it has been considered as an excellent laboratory experimental bird, less feed and easy maintenance (4). The great nutritional value of quail eggs and meat makes them valued (41). Quail eggs are high in nutrients that are beneficial to human health. Quail eggs are consumed by a large number of people, particularly in Asian countries. Despite their small size, quail eggs have three to four times the nutritious value of chicken eggs and are rich in vitamins and minerals. Consumption of quail eggs regularly aids in the prevention of various diseases and strengthens the immune system. Quail eggs have considerably better nutritional benefits than other eggs, and they are rich providers of antioxidants, minerals, and vitamins, as well as providing us with more nourishment than other foods (25). Today's consumers are concerned about their health and the quality of their meals. Food safety is not a privilege reserved for the wealthy, but rather a human right. Unfortunately, some inexperienced or dishonest chicken farmers are failing to observe the antibiotic withdrawal time in their broiler feed, putting human health at risk. Farmers have been employing antibiotics in animal feed regularly since the 1950s to achieve a faster rate of growth (21). According to much research, using medicinal herbs and plants as feed supplements for ruminants is a recent trend based on availability and cost, but using them as a pharmaceutical tool with monogastric species and birds is possible. Garlic or onion, for example, has been increasingly important as an additive in farm animal nutrition and protection in recent years, owing to a wide range of helpful characteristics. Their efficacy was demonstrated by a decrease in the number of dangerous microbes in the chicken digestive tract, leading to faster growth, more efficient digestion, and improved immunity and health (33). Given the importance of quail productivity and being a laboratory bird and to increase its production efficiency and to know the effect of dried garlic powder as a food additive on the egg production, lipid profile, liver function, kidney function, and levels of blood hormones that related to the growth and productive efficiency of domestic female's quail.

MATERIALS AND METHOD

Birds and treatments

The study was carried out at the Animal House unit of the college of science, Salahaddin University-Erbil. Ninety 35-day old female local quail were used in the study. The quails were divided randomly to six groups (Control, 3% lipid, 2% power garlic, 2% powder garlic + 3% lipid, 4% powder garlic and 4% powder garlic + 3% lipid). The birds were housed in 6 cages and each cage content 15 numbered quail as experimental unit/ treatment. The dimension for the cages was 100cm × 45cm × 25 cm (length, width, height). Feed and water were supplied ad libitum. The experimental diet contained 22% protein and 2700 Kcal – ME / Kg (The energy level of the groups to which lipid was added was 2950 Kcal-ME/Kg) from 35 days of age to the end of experimental and light was provided for 12 hours. The quail were fed the brooder/grower diets for 5 weeks and after that, the birds were fed with six different diets in terms of additives, the 1st group was fed on the same upper diet without additives, the 2nd group was fed with a percentage of which 3% of lipid was added, the 3rd group was added to their diet 2% of dried garlic powder, the 4th group was added 2% of dried garlic powder with 3% lipids, the 5th group fed a ration, 4% of dried garlic powder was added and the 6th group, 4% dried garlic powder with 3% lipids to the end of experimental.

Egg production

From the first day of sexual maturity, the egg weight (g) and egg number (collected eggs) were recorded every day (5% of birds laid eggs) and continued up to the end of the experiment, the egg for each quail hens was taken using a sensitive electronic scale. The Hen-Day Egg Production HDEP % and egg number /bird were calculated according to the following equations: HDEP %= (Total number

of eggs produced on a day/Total number of hens present on that day) *100 (16). The feed intake (FI.) and feed conversion ratio (FCR) were both determined. About 80 eggs were retrieved from each treatment group at the end of the experiment to analyze egg quality parameters such as egg weight (g), yolk height (mm), and Haug unit. The shell weight with membranes was measured after the eggs were broken, and the shell was dried to measure the shell thickness (mm) in three points and the average was found.FCR (feed g/egg) = Feed intake (g / bird) / [(Egg production (egg weight)]

Haugh Unit = 100 Log (H + 7.57 – 1.7 $^{w\ 0.37}$)

As: H = albumin height (mm), w = egg weight (g) (31).

After 7th week of age when 3 eggs per each replicate were taken to determine the egg quality that composed of those characteristics of an egg that affects its acceptability as egg [weight (gm), length (mm), width (mm)], shell quality include [weight (gm), thickness (mm), and strength (Kg/cm3)]; yolk [weight (gm), diameter (mm), height (mm), color, and Haugh unit]. A sensitive digital scale was used to weigh the eggs. With an electronic digital Vernier caliper sensitivity, the length, width, and yolk diameter of the eggs were measured. After obtaining external measurements of egg size and shell strength, interior measurements were taken by carefully cutting an aperture around the sharp end of the egg large enough to allow both the albumen and the yolk to pass through without mingling their contents. After that, carefully separate the yolk from the albumen and weigh it. Simultaneously, the associated albumen is also weighed. An electronic caliper was used to measure the egg's yolk and albumen height. By carefully inserting the opening component in the shell and weighing it on an electronic scale, the shell weight with the membrane was determined. Using an electronic digital vernier caliper, the shell thickness (mm) with intact membranes was measured at three distinct sites, and the average of the broad, sharp, and central regions of the egg was produced (39).

Biochemical and hormonal analysis

Five quail were randomly selected after the trial ended for the blood sample of each treatment. Each bird's jugular vein was sampled in sterile tubes and sent to the laboratory for further processing (total = 30). The obtained blood sera were separated by centrifugation at 3,000 rpm for 10 minutes, then put into aseptic vials and stored at -20°C in a deep freezer for subsequent analysis. The serum glucose concentrations, urea, serum lipid profile (total cholesterol, high-density lipoproteins HDL, high-density lipoproteins HDL, and triglycerides), creatinine, bilirubin, uric acid, and liver enzymes such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were determined according to (10) using available commercial diagnostic kits by used COBAS INTEGRA® 400 plus (Switzerland). However, hormones such as tri-iodothyronine (T3), thyroxin (T4), estrogen, growth hormone (GH), Follicle-stimulating hormone (FSH), Luteinizing Hormone (LH), leptin, and ghrelin were analyzed by ELX800 Absorbance Microplate reader, 400 to 750 nm, 96 well (BioTek Instruments, USA).

Statistical Analysis

To analyze the data for quail's traits, the PROC GLM (General Linear Model) procedure SAS, (37) was utilized with the following model:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

Where: Y ij= Study traits of i th treatments (I, i=1, Control, i=2, High lipids 3% , i=3, 2% powder garlic, i=4, 2% powder garlic + 3% lipid, i=5, 4% powder garlic and i=6, 4% powder garlic + 3% lipid, μ = Population mean; ε_{ij} = random error. It was assumed to be independently and normally distributed with mean zero and variance $\delta^2 e$.

Duncan's Post-Hoc test was used for the comparison of all studied parameters between different groups. The level of ≤ 0.05 is considered significant.

Ethical approval

All birds and procedures were used according to the animal care guidelines of the local institutional research ethics committee (Ref. No.: 4S/498), Date of issue: October 12, 2021).

RESULTS AND DISCUSSION

Egg quality and production

The results shown in both Tables 1 and 2 observed a significant superiority of quail birds fed a ration supplemented with 4% of dried garlic powder in most of the studied egg production and quality traits. As shown in Table 1, the significant highest egg production (84.33 number/week), egg weight rate (11.69 g/egg), feed intake (2977.13 g/week), HDP (92.48%), and egg mass (10.62 g) were observed in the quail's group taken 4% of garlic in their diets in comparison with the control and other groups. The results of the study also show the significant ($p \leq 0.05$) superiority of quails fed 4% of garlic powder in the internal egg characteristics such as albumen weight (6.05 g) and yolk height (9.21 g). Also, an insignificant increase in the yolk and albumen weight together, and albumen height were observed in quails feed on 4% garlic powder, Table 2. Quails feed on 2% garlic showed a significantly higher ($p \leq 0.01$) yolk weight (4.24 g) compared with the control and other groups. Moreover, no differences were observed in shell weight, shell thickness, hardness, Haugh unit, and yolk color among the groups. These results indicate the efficacy and positive effect of garlic powder in improving and increasing the reproductive efficiency and productivity of quail eggs, in addition to reducing the damage caused by eating lipids in reducing the productive performance of birds. The present results are in agreement with the findings of (33 and 42) who observed a significant increase in egg production of birds fed a ration supplemented with garlic powder. The recorded results about egg weight, HDP, egg mass, albumen weight, and yolk height in the present study are in contrast with the results of (8) who found that the addition of garlic with the concentration of 1%, 2%, and 3% to the diets does not significantly affect them in White Leghorn chickens, but the same line with our results regarding yolk weight, FCR, albumen height, shell weight, Haugh unit, and shell thickness. There was no statistical difference in feed intake and FCR in broiler chicken feeding on the diet containing 5g/kg garlic (9). The HDP result in our study was higher than reported by (2 and 3) in local quail. The recorded data are in agreement with the results of (33) who observed a significant improvement in the percentage of egg production, the number of eggs/hen, egg mass/hen, and feed conversion, but in contrast with them in which they found no significant influence of adding garlic to the diet on average egg weight or consumption /hen /day. Also, The result of the current study was consistent with the significant increase in the internal traits of eggs studied by (12 and 32) in birds fed different levels of garlic powder. Moreover (28) found a significant increase in egg weight and albumen weight in laying hen supplemented with garlic powder with concentration 4% until 8%, and these results are in the same line with our results in local quail. The egg weight is strongly affected by the protein and amino acid contents of the diet (26). The increase in the egg weight is due to the amino acids contents in the garlic (28).

Table 1. Effect of different levels of garlic on feed intake and egg production traits in local quail

Traits	Treatments (Mean ± SE)					
	Control	High lipids	Garlic 2%	High lipids + Garlic 2%	Garlic 4%	High lipids + Garlic 4%
Egg number/week	83.07 ± 1.37 ab	81.07 ± 0.66 ab	71.47 ± 0.89 c	79.47 ± 1.28 b	84.33 ± 1.68 a***	81.27 ± 0.66 ab
Egg weight (g)	11.12 ± 0.12 ab	11.14 ± 0.09 ab	11.45 ± 0.14 ab	11.02 ± 0.11 b	11.69 ± 0.12 a*	11.45 ± 0.13 ab
Feed intake/week (g)	2936.4 ± 21.6 ab	2649.33 ± 84.4 bc	2526.87 ± 97.4 c	2686.27 ± 89.6 abc	2977.13 ± 100.6 a**	2590.53 ± 87.8 c
FCR (Feed g/egg)	3.21 ± 0.09 a*	2.93 ± 0.08 ab	3.10 ± 0.13 ab	3.09 ± 0.12 ab	3.10 ± 0.13 ab	2.79 ± 0.09 b
Hen day egg production (%)	90.38 ± 1.21 bc	89.08 ± 0.73 abc	85.08 ± 1.06 c	86.52 ± 1.31 bc	92.48 ± 1.33 a**	85.25 ± 1.63 c
Egg mass (g)	9.98 ± 0.22 ab	9.94 ± 0.13 ab	9.67 ± 0.21 b	9.55 ± 0.18 b	10.62 ± 0.13 a*	10.01 ± 0.26 ab

The different letters in the same row indicate significant differences * Significant at p≤0.05 ** Significant at p≤0.01 * Significant at p≤0.001 SE= Standard error**

Biochemical traits

The results of the study shown in Table 3 showed a significant ($p \leq 0.05$) improvement in the blood lipid profile in favor of quail birds fed on rations containing dried garlic powder, as the highest value for total cholesterol, triglycerides, LDL and VLDL found in the treatment of birds fed on high lipids, while the highest values of HDL were in the treatments of birds fed different levels of garlic powder. As shows in Table 3 and regarding serum parameters related to liver function, the results found a significantly higher concentration of the AST (249.40 IU/L) and ALT (2.80 IU/L) enzymes in a group of birds fed with a high lipid diet in comparison with control and other groups. While birds feed with added garlic 2% and 4% attenuated the AST (garlic 2%, 183.00 IU/L and garlic 4%, 177.00 IU/L) and ALT (garlic 2% and 4%, 1.20 IU/L) enzymes to the lower value and near to the control (AST 178.40 and ALT 1.50 IU/L) group. Also, the lower value of the alkaline phosphatase was observed in quail groups fed with 2% (348.80 IU/L) and 4% (463.22 IU/L) garlic supplemented with the diet.

Table 2. Effect of different levels of garlic on egg quality in local quail

Egg quality Traits	Treatments (Mean ± SE)					
	Control	High lipids	Garlic 2%	High lipids + Garlic 2%	Garlic 4%	High lipids + Garlic 4%
Albumin weight (g)	5.48 ± 0.10 b	5.82 ± 0.16 ab	5.72 ± 0.21 ab	5.89 ± 0.15 ab	6.05 ± 0.11 a*	5.81 ± 0.10 ab
Yolk weight (g)	3.91 ± 0.11 ab	3.82 ± 0.12 b	4.24 ± 0.14 a**	3.65 ± 0.08 b	3.97 ± 0.07 ab	3.66 ± 0.11 b
Yolk and Albumin weight (g)	9.39 ± 0.18 a	9.64 ± 0.25 a	9.96 ± 0.33 a	9.54 ± 0.20 a	10.02 ± 0.15 a	9.47 ± 0.16 a
Albumin height (mm)	1.48 ± 0.16 a	1.54 ± 0.12 a	1.48 ± 0.13 a	1.67 ± 0.13 a	1.73 ± 0.14 a	1.68 ± 0.12 a
Shell weight (g)	2.19 ± 0.12 a	2.04 ± 0.10 a	2.16 ± 0.11 a	1.88 ± 0.07 a	2.18 ± 0.11 a	1.86 ± 0.09 a
Shell thickness (mm)	0.199 ± 0.0003 a	0.200 ± 0.0004 a	0.187 ± 0.0005 a	0.188 ± 0.0006 a	0.196 ± 0.0004 a	0.200 ± 0.007 a
Hardness (g/mm^2)	552.94 ± 42.06 a	588.55 ± 32.2 a	556.72 ± 31.2 a	529.72 ± 27.4 a	581.72 ± 34.6 a	503.17 ± 20.6 a
Haugh unit	68.49 ± 1.46 a	69.38 ± 1.21 a	68.14 ± 1.33 a	70.43 ± 1.25 a	70.21 ± 1.11 a	70.84 ± 1.05 a
Yolk color	4.33 ± 0.09 a	4.28 ± 0.11 a	4.39 ± 0.12 a	4.39 ± 0.10 a	4.33 ± 0.09 a	4.39 ± 0.12 a

The same letters in the same row indicate no significant differences * Significant at $p \leq 0.05$ SE= Standard error

No significant differences in serum bilirubin was found among the studied groups. These results indicate a significant improvement in the liver function of the quail feeding on diet supplemented with dried garlic powder. Regarding the serum biochemical parameters related to kidney function which are illustrated in Table 4, the group of birds feeds with high lipid diet+2% garlic and high lipid diet+4% garlic showed a significantly ($p \leq 0.05$) lower value of uric acids (5.42 mg/dL and 5.96 mg/dL respectively) in comparison with the control (8.26 mg/dL) and other groups. No significant differences in the creatinine, urea, and blood urea nitrogen were observed among the groups. Also, no significant differences in blood sugar were obtained among the groups. Hyperlipidemia is a medical disorder marked by an increase in any or all of the blood's lipid profile or lipoproteins. Although high levels of LDL are regarded to be the greatest indicator of atherosclerosis risk, dyslipidemia can also refer to high total cholesterol or triglycerides, as well as low levels of HDL (5). The findings of the study are following the results of (11) who found that garlic supplemented (1% and 1.5%) in the broilers group had considerably ($p \leq 0.05$) lower cholesterol and triglyceride concentration than the control group. The same results were observed in laying hens according to the study (33). A chicken feed with a diet containing 0.25, 0.50, and 0.75 g/kg garlic significantly ($p \leq 0.01$) observed a lower level of total cholesterol, LDL, and VLDL, and the highest values of HDL compared with the control group, while triglycerides not significantly affected with the garlic (19). The results of other investigations observed significant health improvement in lipid profile when using different levels of garlic powder (1, 7 and 21). The mechanism by which garlic lowers plasma cholesterol

levels is unclear. Garlic, according to some researchers, inhibited the lipogenic and cholesterrogenic activities of liver enzymes as fatty acid synthase, 3-hyydroxymethylglutaryl-CoA (HMG-CoA) reductase, and glucose-6 phosphate dehydrogenase (12 and 22). When multiple studies evaluated cholesterol-clearing enzymes, they found that this idea was correct. For instance (23) found that feeding 3 percent commercial garlic powder lowered HMG-CoA reductase and cholesterol 7-hydroxylase activities by 40%. Allicin is thought to be the key ingredient in garlic that helps with health and hypercholesterolemia (27) and It is thought to inhibit cholesterol synthesis and platelet aggregation, as well as prevent thrombosis (12). These obtained results in the present study may have a direct effect on reducing the deposition of fat around the ovaries and oviducts of quail birds, in addition to improving the health status of the birds, which in turn had a significant effect on increasing the productivity and reproductive capacity of birds fed on diets containing garlic powder. The recorded results are consistent with the findings of (33) who observed a significant decrease in the AST and an insignificant decrease in the ALT enzymes in laying hens added 1% garlic to the basal diet. The same results were obtained by (24) who found a decrease in AST in broiler chicken fed diets supplemented with *Allium sativum* when compared with control and different treatment groups. But in contrast with them who observed no significant effects of garlic feeding on alkaline phosphatase enzyme. Garlic supplementation reduced AST levels considerably, but had no significant effect on ALT levels, according to the findings of the meta-analysis done by (35). Also (6) reported a significant ($p \leq 0.05$) decrease in AST and no change in ALT enzymes and total bilirubin in broiler chicken feeding on the diet supplemented with 5g/kg garlic. According to (17), one of garlic's key preventive actions, according to is to reduce oxidative damage in the liver. Garlic aids the liver's regular function by increasing the cell's regeneration ability. As shown in the study of (33), the addition of 0.5% and 1% of garlic to the diet had no significant effect on the serum creatinine but the addition of the 0.5% garlic + 1% onion significantly increase the creatinine. While 1% garlic + 1% onion in the diet does not affect the serum creatinine significantly. The recorded results are in agreement with the results of (9) who observed no significant effect of garlic on serum creatinine. The decrease of the uric acid in the present study is in contrast with the results of (9) who recorded no significant changes in the serum uric acid in the group of chicken feed on 5g/kg garlic. The present results are in the line with results of (13) who found a significant ($p \leq 0.001$) decrease in uric acid and no change in the creatinine in the serum of broiler chicks fed on a diet provided with a 2% garlic. In contrast with our results (34) found a significant increase in the uric acid of broiler chicken fed with a diet containing 0.5%, 1%and 1.5% powder garlic in comparison with the control group., but agree with our results in which they observed no significant effect of garlic on serum creatinine. Also, no significant differences in blood sugar were obtained among the groups in the present study. This result is in differ from the findings of (24) who observed a significant decrease in the blood glucose in the broiler chicken fed diets supplemented with garlic when compared with the control group. The addition of 0.25, 0.5, and 0.75% of garlic powder to the basal diet in the broiler results in the decrease of the blood sugar significantly (21). The finding of (9) is in the line with our results who found no significant effects of garlic on blood sugar in broiler chicken feeding on the diet containing 5g/kg garlic. According to our review, very little study was applied about the effect of garlic on the hormones in the birds. Leptin and ghrelin, which act on the central nervous system and target reproductive organs, play significant roles in body weight management, eating behavior, and reproduction. These hormones may work on the central nervous system as a signal of adequate dietary storage, triggering puberty and maintaining normal reproductive function. The fact that leptin and ghrelin have a significant negative connection shows that these two hormones may be antagonistic. Increased ghrelin levels are linked to lower levels of HDL cholesterol and higher levels of LDL cholesterol in the blood (38). The obtained results are in agreement

with the findings of (36) who observed a positive correlation between total fat intake and the types of dietary fat with serum leptin levels and adversely correlated with serum ghrelin levels. When compared to the control group, rats fed a high-fat diet had a considerable rise in total body weight. Hyperleptinemia and hypoghrelinemia were produced by a high-fat diet consumed over time (18). The addition of 5% garlic powder significantly decreased body weight gain, serum triglyceride, total cholesterol, and hyperleptinemia in rats fed a high-fat diet (20). The recorded results from Table 4 are in agreement with these results. The increase in the leptin hormone is strongly related to the increase in serum cholesterol, while the increasing the concentration of the ghrelin hormone is related to the decrease in cholesterol. Due to that garlic supplementation in the diet lowered the cholesterol, so that the level of the leptin decrees and ghrelin hormone increased.

Hormonal level

The effect of garlic supplemented to the diet on the reproductive hormones and growth-related hormones are presented in Table 4. Quail fed on the higher lipid diet showed a significantly ($p\leq0.001$) higher concentration in leptin hormone (1.493 ng/ml) in comparison with control (0.71 ng/ml) and other groups and the lowest value of them were observed in the groups of taken 2% garlic (0.65 ng/ml) and high lipids+4% garlic (0.56 ng/ml). While ghrelin showed a significantly ($p\leq0.001$) higher concentration in quail fed on the diet supplied with 2% garlic. Regarding thyroid, growth hormone, and reproductive steroid hormones, the quail receiving garlic powder in their diet showed significantly ($p\leq0.05$) higher concentrations of T4 and LH hormones particularly in the bird's group with 2% garlic. While the higher significant ($p\leq0.05$) concentration of the FSH was observed in the group supplemented with 4% garlic in comparison with other groups. No significant changes in T3 are found among the groups. The highest concentration of the estradiol hormone was seen in the control quail group in comparison with the other groups. While the quail fed on high lipid diet and 2% significantly ($p\leq0.05$) showed the highest level of growth hormone in comparison with the control and other groups. The results obtained by (43) observed a significant increase in serum T4 ($p\leq0.01$) and T3 ($p\leq0.05$) hormones in broiler chicken fed on the diet supplemented with 4mg/kg of garlic powder. On the other hand (40) found no significant effects of garlic on serum T4 and T3. Thyroid hormones are required for the development and reproduction of birds. They promote growth, assist in the maturation of numerous tissues, and aid in the effective hatching of eggs. Inhibiting thyroid activity in chicken hens, reduced hatching success (29). The study of (14) found that rats treated with cyclophosphamide induce the eduction of the serum LH and FSH, while the garlic supplemented to the diet in the cyclophosphamide treated rats significantly ($p\leq0.05$) ameliorated and improved the concentration of these two hormones. The same results were obtained with (14 and 15). LH levels increased in groups of mice receiving 400 and 800 mg/kg doses of garlic extract. FSH levels rose significantly in groups given dosages of 200, 400, and 800 mg/kg (30). Significant difference in FSH and LH among quail groups date on palm pollen in japanes quail was reported by (6).These results are in agreement with our results improved that garlic enhances the improvement of gonadotropins from the pituitary glands and stimulates the production of the eggs in the quail.

CONCLUSIONS

A significant superiority of quail birds fed a ration supplemented with 4% of dried garlic powder in most of the studied egg production and quality traits including egg weight rate, feed intake, HDP, egg mass, albumen weight, and yolk height. Also, a significant improvement in the blood lipid profile in favor of quail birds fed on rations containing dried garlic powder with the highest values of HDL was seen in the treatments of birds fed different levels of garlic powder. The quail receiving garlic powder in their diet showed higher concentrations of ghrelin, T4, and LH hormones particularly in the bird's group with 2% garlic. While a higher concentration of the FSH was observed in the group supplemented with 4% garlic.

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Table 3. Effect of different levels of garlic on serum biochemical parameters in local quail.

Serum biochemical parameters	Treatments (Mean ± SE)					
	Control	High lipids	Garlic 2%	High lipids + Garlic 2%	Garlic 4%	High lipids + Garlic 4%
Total cholesterol (mg/dL)	264.60 ± 31.13 ab	347.00 ± 68.30 a*	196.20 ± 20.11 b	284.80 ± 18.54 ab	266.40 ± 46.87 ab	239.20 ± 25.44 ab
Triglyceride (mg/dL)	2855.60 ± 51.2 b	5090.60 ± 101 a*	2380.40 ± 52.4 b	3553.60 ± 69.20 ab	3235.80 ±84.80 ab	2249.80 ± 64.80 b
HDL (mg/dL)	6.04 ± 0.57 c	3.10 ± 0.10 c	12.84 ± 0.82 b	12.80 ± 0.93 b	14.50 ± 1.01 b	21.08 ± 2.40 a*

Table 4. Effect of different levels of garlic on serum hormones related to growth and reproductive in local quail.

	Treatments (Mean ± SE)					
	Control	High lipids	Garlic 2%	High lipids + Garlic 2%	Garlic 4%	High lipids + Garlic 4%
Ghrelin (pg/ml)	63.21 ± 1.33 b	64.48 ± 1.68 b	70.60 ± 2.8 a***	66.12 ± 3.57 b	55.74 ± 0.80 c	53.82 ± 1.21 c
Leptin (ng/ml)	0.71 ± 0.35 bc	1.49 ± 0.29 a*	0.65 ± 0.25 C	0.95 ± 0.63 b	0.97 ± 0.29 b	0.56 ± 0. 09 c
T3 (ng/ml)	2.96 ± 0.005 a	2.97 ± 0.0001 a	2.96 ± 0.004 A	2.96 ± 0.004 a	2.96 ± 0.005 a	2.96 ± 0.005 a
T4 (ng/ml)	79.30 ± 1.31 b	87.11 ± 1.86 b	100.73 ± 1.95 a*	96.97 ± 1.87 a	97.425 ± 1.94 a	85.95 ± 1.02 b
FSH (pg/ml)	228.29 ± 10.27 b	225.25 ± 12.45 b	227.56 ± 8.54 B	234.35 ± 10.67 b	267.32 ± 12.37 a*	211.52 ± 7.61 b
LH (pg/ml)	1638.48 ± 96.4 b	1667 ± 98.91 b	1935.40 ± 52.34 a*	1850.40 ± 85.33 ab	1731.2 ± 85.77 b	1746.4 ± 29.33 b
Estradiol (pg/ml)	75.13 ± 1.95 a*	65.60 ± 1.86 b	63.84 ± 1.56 B	69.82 ± 1.77 ab	62.03 ± 1.28 b	61.96 ± 1.24 b
Growth hormone (pg/ml)	1358.09 ± 97.32 b	1622.13 ± 43.79 a*	1539.38 ± 33.03 A	1507.006 ± 74.1 a	1433.70 ± 34.82 ab	1474.57 ± 29.91 ab

REFERENCES

1.Adebiyi F, A Ologhobo,and I Adejumo .2018. Raw Allium sativum as performance enhancer and hypocholesterolemic agent in laying hens. Asian J. Anim. Vet. Adv 13: 210-217.

2. Ahmed L. S. and Y.M.S. Al-Barzinji. 2020. Comparative study of hatchability and fertility rate among local quails. Iraqi Journal of Agricultural Sciences –2020:51(3):744-751.

3. Ahmed L. S. and Y.M.S. Al-Barzinji. 2020. Three candidate genes and its association with quantitative variation of egg production traits of local quail by using PCR-RFLP. Iraqi Journal of Agricultural Sciences:51(Special Issue):124-131.

4. Akpa G, J Kaye, I Adeyinka, and M Kabir .2008. The relationships between laying age and repeatability of egg quality traits in Japanese quails (Coturnix coturnix japonica). International Journal of Poultry Science 7: 555-559.

5. Alam MK, M. Nyeem, and M. A Samad .2018. Effects of garlic on hyperlipidemia: A review. Journal of Medicinal Plants 6: 44-48.

6. Al-Salhie K.Ch.K, T.F. Shawket and B.A.M. Lehmood. 2017. Effect of supplementation date palm pollen on some physiological and reproductive traits of japanese quail birds (Coturnix coturnix japonica). The Iraqi Journal of Agricultural Sciences 6) 48: 1334-1343.

7. Ao X, J Yoo, J Lee, H Jang, J Wang, T Zhou and I Kim .2010. Effects of fermented garlic powder on production performance, egg quality, blood profiles and fatty acids composition of egg yolk in laying hens. Asian-Australasian Journal of Animal Sciences 23: 786-791.

8. Asrat M, T Zeryehun, N Amha, and M Urge .2018. Effects of supplementation of different levels of garlic (Allium sativum) on egg production, egg quality and hatchability of White Leghorn chicken. Livestock Research for Rural Development 30: 37.

9. Aydogan I, E Yildirim, A Kurum, D Bolat, M Cinar, M Basalan and A Yigit .2020. The

effect of dietary garlic (Allium sativum), black cumin (Nigella sativa) and their combination on performance, intestine morphometry, serum biochemistry and antioxidant status of broiler chickens. Brazilian Journal of Poultry Science 22: 1-10.

10. Borges LP, V.C Borges, A.V Moro, C.W Nogueira, J.B.T Rocha and G Zeni. 2005. Protective effect of diphenyl diselenide on acute liver damage induced by 2-nitropropane in rats. Toxicology 210: 1-8.

11. Borgohain B, J.D Mahanta, D Sapcota, B Handique and R Islam .2019. Effect of Feeding Garlic (Allium sativum) on Haematological, Serum Biochemical Profile and Carcass Characteristics in Broiler Chicken. Int. J. Curr. Microbiol. App. Sci 8: 492-500.

12. Canogullari S, M Baylan, Z Erdogan, V Duzguner and A Kucukgul .2010. The effects of dietary garlic powder on performance, egg yolk and serum cholesterol concentrations in laying quails. Czech Journal of Animal Science 55: 286-293.

13. Darwish H, A Abd Al-Hamid, M Osman,and S Hassan .2021. Effect of dietary ginger and garlic supplementations on growth performance, carcass characteristics and blood biochemical of broiler chicks. J. Agric. & Env. Sci. 20: 1-32.

14. Ekeleme-Egedigwe CA, A.C Famurewa, E.E David, C.O Eleazu and U.O Egedigwe .2019. Antioxidant potential of garlic oil supplementation prevents cyclophosphamide-induced oxidative testicular damage and endocrine depletion in rats. Journal of Nutrition & Intermediary Metabolism 18: 100109.

15. El-Akabawy G and N.M El-Sherif .2016. Protective role of garlic oil against oxidative damage induced by furan exposure from weaning through adulthood in adult rat testis. Acta histochemica 118: 456-463.

16. El-Sheikh TM .2016. Evaluation of productive and reproductive performance of Japanese quails in floor pens and conventional cages with different stocking densities. Egyptian Poultry Science Journal 36: 669-683.

17. Gedik N, L Kabasakal, Ö Şehirli, F Ercan, S Sirvancı, M Keyer-Uysal and G Şener .2005. Long-term administration of aqueous garlic extract (AGE) alleviates liver fibrosis and oxidative damage induced by biliary obstruction in rats. Life sciences 76: 2593-2606.

18. Handjieva-Darlenska T and N Boyadjieva .2009. The effect of high-fat diet on plasma ghrelin and leptin levels in rats. Journal of physiology and biochemistry 65: 157-164.

19. Ismail I, Alagawany M, A Taha, N Puvača, V Laudadio and V Tufarelli .2021. Effect of dietary supplementation of garlic powder and phenyl acetic acid on productive performance, blood haematology, immunity and antioxidant status of broiler chickens. Animal Bioscience 34: 363-370.

20. Kang S-A, H-J Shin, K-H Jang, S-E Choi, K-A Yoon, J-S Kim, H-K Chun and Y-H Lim .2006. Effect of garlic on serum lipids profiles and leptin in rats fed high fat diet. Preventive Nutrition and Food Science 11: 48-53.

21. Karim M, M Hossain, M Ali and A Hossain .2017. Effect of garlic powder (Allium sativum) on growth, dressing parameters, serum biochemical contents and profitability of broiler. Bangladesh Journal of Animal Science 46: 215-224.

22. Khan R, Z Nikousefat, V Tufarelli, S Naz, M Javdani and V Laudadio .2012. Garlic (*Allium sativum*) supplementation in poultry diets: Effect on production and physiology. World's Poultry Science Journal 68: 417-424.

23. Konjufca V, G Pesti and R Bakalli .1997. Modulation of cholesterol levels in broiler meat by dietary garlic and copper. Poultry science 76: 1264-1271.

24. Kumar S, A Kumar and A Ch .2013. Alteration in serum biochemical parameters due to garlic (Allium sativum) supplementation in broilers diets. African Journal of Biotechnology 12: 4691-4698.

25. Lalwani P. 2012. Quail egg nutrition. https://nutrineat.com/quail-egg-nutrition.

26. Latifa R .2007. The increasing of afkir duck's egg quality with pregnant mare's serum gonadotropin (Pmsg) hormones. Jurnal Protein 14: 21-30.

27. Lawson L.D .1998. Garlic: a review of its medicinal effects and indicated active compounds. Blood 179: 176-209.

28. Leke J.R, E Wantasen, F Sompie, F.H Elly and R Siahan .2020. The Characteristics and Quality of Egg from Commercial Laying Hens Fed with Garlic (Allium Sativum) Supplemented Ration. ANIMAL PRODUCTION 21: 98-103.

29. Mcnabb F.A .2007. The hypothalamic-pituitary-thyroid (HPT) axis in birds and its role in bird development and reproduction. Critical reviews in toxicology 37: 163-193.

30. Modaresi M and M Mohajer .2015. The Effect of Garlic Extract on Spermatogenesis and Sexual Hormones in Heat-Stressed Male Mice. J Adv Med Biomed Res 23: 88-97.

31. Mustafa A.A .2013. The Effect of Dietary Peppermint on Productive Performance and Physiological Traits in Japanese quail. Master Thesis. College of Agriculture, Salahaddin University-Erbil.

32. Olobatoke R and S Mulugeta. 2011. Effect of dietary garlic powder on layer performance, fecal bacterial load, and egg quality. Poultry science 90: 665-670.

33. Omer H.A, S.M Ahmed, S.S Abdel-Magid, G.M El-Mallah, A.A Bakr and M.M.A Fattah .2019. Nutritional impact of inclusion of garlic (Allium sativum) and/or onion (Allium cepa L.) powder in laying hens' diets on their performance, egg quality, and some blood constituents. Bulletin of the National Research Centre 43: 1-9.

34. Onunkwo D, J Nathaniel, J Ezike, W Amaduruonye and G Daniel-Igwe .2019. Effect of garlic rhizome (Allium sativum) powder supplemented diets on the haematology and serum biochemistry of broiler chickens at starter and finisher phases. Nigerian Journal of Animal Production 46: 149-156.

35. Panjeshahin A, M Mollahosseini, M Panbehkar-Jouybari, M Kaviani, F Mirzavandi and M Hosseinzadeh .2020. Effects of garlic supplementation on liver enzymes: A systematic review and meta-analysis of randomized controlled trials. Phytotherapy Research 34: 1947-1955.

36. Polak A.M, A Krentowska, A Łebkowska, A Buczyńska, M Adamski, E Adamska-Patruno, J Fiedorczuk, A.J Krętowski, I Kowalska and A Adamska. 2020. The association of serum levels of leptin and ghrelin with the dietary fat content in non-obese women with polycystic ovary syndrome. Nutrients 12: 2-15.

37. SAS, Statistical analyses system. 2002: SAS/STAT User's Guide, Version 8. First Ed. – Cary, NC.

38. Slama F.B, N Jridi, M.C.B Rayana, A Trimeche, M Hsairi and O Belhadj .2015. Plasma levels of leptin and ghrelin and their correlation with BMI, and circulating lipids and glucose in obese Tunisian women. Asian biomedicine 9: 161-168.

39. Tabeekh M .2011. Evaluation of some external and internal egg quality traits of quails reared in Basrah City. Basra J. Vet. Res 10: 78-84.

40. Varmaghany S, MaK Torshizi, S Rahimi, H Lotfollahian and M Hassanzadeh. 2015. The effects of increasing levels of dietary garlic bulb on growth performance, systolic blood pressure, hematology, and ascites syndrome in broiler chickens. Poultry science 94: 1812-1820.

41. Wen Z, Y Du, M Xie, X Li, J Wang and P Yang . 2017. Effects of low-protein diets on growth performance and carcass yields of growing French meat quails (France coturnix coturnix). Poultry Science 96: 1364-1369.

42. Yalcın S, E.E Onbaşılar, Z Reisli and S Yalcın .2006. Effect of garlic powder on the performance, egg traits and blood parameters of laying hens. Journal of the Science of Food and Agriculture 86: 1336-1339.

43. Zamil S, K Al-Shammari and E Mohammed .2020. Influence of Selected Dietary Plant Extracts on Productive, Physiological, and Viral Immunological Response of Broilers. Tropical Animal Science Journal 43: 205-210.