Effect of Dietary Garlic Powder Supplementation on Productive Performance and Physiological Traits of Laying Hens Affected by Fatty Liver Syndrome

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Abstract

The present study aimed at assessing the effect of garlic powder supplementation in the present study aimed at assessing the effect of garlic powder supplementation in the diet on productive performance, egg quality parameters, lipid profile and liver function tests of ISA Brown laying hens suffering from fatty liver syndrome. In four treatments, 24 birds were randomly distributed, three replicates of 8 birds were randomly distributed and a total of 96 laying hens (80 weeks) were distributed. The experimental diet consisted of diet without garlic supplementation (T1) and the diet supplemented with 2.5 g/kg (T2), 5.0 g/kg (T3) and 7.5 g/kg (T4) of garlic powder. The experiment was carried out for 56 days.The garlic supplementation was found to significantly improve a number of productive and physiological traits. Egg production percentage results indicated that there are significant differences among the birds fed with garlic powder with the highest egg production percentage recorded in T3 and T4. The egg weight of T2 and T3 group is significantly better as compared to the control group. The relative shell weight, shell thickness, albumin height and yolk height were also favorably correlated with garlic supplementation. Besides, garlic in the diet reduced serum cholesterol and triglyceride concentrations, substantially more than the control treatment. The activities of the liver enzymes (ALT and AST) were significantly decreased in the groups treated with garlic as compared to the control group of untreated hens, indicating a reduced liver stress and damage. The health-promoting properties of garlic can be attributed to its bioactive components such as organosulfur compounds and antioxidants which play a key role in improving lipid metabolism, liver functions, and reducing oxidative stress. The supplementation with 5 g garlic powder/kg diet was the most consistent treatment that resulted in improvement in productive performance and physiological parameters. The results indicate that garlic powder is a good natural feed supplement to maintain health status and production performance in laying hens with fatty liver syndrome. The inconsistent egg quality parameters obtained from laying hens fed with high fat diets supplemented with garlic powder may result from different effects on hens. The variability of egg quality parameters among high fat diets supplied to laying hens with and without garlic powder might be related to several effects on the birds.

Keywords: Garlic powder, laying hens, fatty liver syndrome, egg quality, productive performance, lipid profile.

Introduction

Laying hens need a constant source of energy and nutrients to support egg production and physiological functions. Lipids are critical for these functions, but the quantity of fat supplied as feed to laying hens is normally not adequate for the requirements of both egg production and maintenance of the body. As a result, the liver is the main site of lipid synthesis in birds, which make this organ very

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antimicrobial, antioxidant, antiviral, and antifungal properties [7] Previous studies have shown the inhibitory effect of garlic and its derivatives against a wide variety of Gram-positive and Gram-negative bacteria, including enteric pathogens which negatively impact animal health.

Organosulfur compounds have been credited with the biological activity of garlic, its ability to modulate immune responses and enhance physiological functions. Garlic's compounds have been demonstrated to increase the release of nitric oxide and prostaglandin E2 in activated macrophages which leads to improved antimicrobial activity and immune regulation in birds [8] Moreover, garlic supplementation has been associated with better lipid metabolism, decreased oxidative stress and improved overall performance in poultry species.

In light of these advantageous effects, garlic powder could be a nutritional approach to reduce the negative impacts of fatty liver syndrome in laying hens. Hence, the present study was carried out to assess the effects of various dietary levels of garlic powder on productive performance, egg quality traits, lipid profile and some physiological parameters in the ISA brown laying hens suffering from fatty liver syndrome.

Materials and Methods

The experiment was carried out in a commercial laying hen farm in Al-Kifl District, Babylon Governorate, Iraq, from 1st September to 30th October, 2023. The number of ISA Brown laying hens used in the study was 96, which are at 80 weeks of age. Twenty-four hens were placed in each of the four experimental treatments. The treatments were then replicated three times with eight hens per replicate.

sensitive to metabolic disturbances caused by excessive accumulation of lipid [1]

Fatty Liver Hemorrhagic Syndrome (FLHS) is a metabolic disorder that occurs in commercial laying hens and is one of the most common ones. This is a disorder in which fat accumulates in abnormal amounts in the liver and in the abdominal cavity which causes the liver to become enlarged, fragile and fatty. In severe cases, the rupture of the liver may occur and cause internal hemorrhage, resulting in sudden death. The disease is particularly common in caged laying hens and can result in significant economic losses from reduced productivity, poor health and higher mortality rates [2،3]

Post mortem lesions found in affected birds usually include enlarged, fatty, yellowish livers, with a tendency to bleed. The exact cause of FLHS remains to be fully determined, but a number of risk factors have been suggested. These include nutritional imbalance, high energy levels in the diet, exposure to mycotoxins, genetic susceptibility, environmental stress, suboptimal housing conditions and high ambient temperatures. The effect of these factors on disease development is thought to be additive [4]

As FLHS is a multifactorial condition, many efforts have been made to understand the nutritional interventions that can help to reduce hepatic lipid accumulation and oxidative damage. Medicinal plants and phytogenic feed additives are becoming more and more popular as natural alternatives for enhancing poultry health and production in recent years. Numerous biologically active compounds have been found in these plants, such as flavonoids, alkaloids, sulfur containing compounds, and dietary fiber; many of which have antioxidant, anti-inflammatory, and lipid-modulating properties [5،6]

Garlic (Allium sativum) is one of the most widely studied medicinal plants for use in animal nutrition. It exhibits several bioactive components like allicin, flavonoids, polyphenolic compounds, tannins, terpenoids, anthocyanins, and saponins which have

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samples. The biochemical measurements were done based on the methods reported by [11،12،13]

Data collected were analyzed statistically with SAS software (Version 9.4, SAS Institute, 2012). The Duncan Multiple Range Test (Duncan, 1955) [14،15]was used for comparing the treatment means and differences were considered significant at $P \leq 0.05$.

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Results and Discussion

The effect of the study on the productive performance of laying hens is shown in Table 1. There was a marked rise in percentage of egg production for treatment T4 over treatment T1 and T2, H.D. In terms of egg weight, the weight of eggs of treatments T2 and T3 were significantly higher than the other treatments T1 and T4. The shell's relative weight with treatment T4 was found to have significant increase when compared to treatments T1 and T2. All addition treatments resulted in significant differences from the control treatment in shell thickness.

The basal diet was formulated on the basis of the nutritional guidelines of the ISA Brown Management Guide and all birds were fed the diet at about 2850 kcal/kg ME and 16% CP. The following treatments were used in the experiments:

T2: Basal diet that includes garlic powder supplement.
T2: Basal diet with 2.5g of garlic powder per kg of diet.
T3: Basal diet + 5.0 g of garlic powder/kg diet.
T4: Garlic powder (7,5 g / kg diet).

The productive performance parameters were measured weekly during the 56-day experimental period. The treatment means were calculated using measurements from each replicate as described by [9،10]

At the end of the experiment, blood samples were taken from all replicates, with two birds from each replicate. After isolating the blood serum, the samples were sent for laboratory testing, physiological and biochemical assessments were made at the end of the experiment (day 56). Three hens were sampled per replicate for laboratory analysis of blood

Table 1: Effect of Dietary Garlic Powder Supplementation on productive of laying hens

Treatments	H.D %	Egg weight (g)	Relative egg shell weight %	Egg shell thickness
T1	54.35^{c}	52.13^{c}	5.21^{b}	0.24^{b}
T2	57.26^{b}	55.21^{a}	5.52^{b}	0.29^{a}
T3	60.15^{a}	54.92^{b}	5.48^{ab}	0.30^{a}
T4	59.30^{ab}	52.73c	5.31^{a}	0.28^{a}
SEM	*0.55*	*0.31*	*0.04*	*0.01*
P-Value	*0.05*	*0.05*	*0.05*	*0.05*

were significantly higher compared to the control treatment. The relative weight of the albumin and yolk was not significantly different among the treatments.

Some qualitative characteristics of produced eggs were studied in Table 2 and the albumen of eggs produced under treatment T4 was found to be significantly greater than T1 and T3. As for yolk height, all addition treatments

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Table 2: Effect of Dietary Garlic Powder Supplementation on egg quality of laying hens

Treatments	Albumin height (m)	Yolk height (m)	Relative albumin weight %	Relative yolk weight %
T1	3.27[b]	0.71[c]	30.23	15.11
T2	4.01[ab]	0.92[b]	32.01	16.01
T3	3.94[b]	1.00[a]	31.85	15.92
T4	4.10[a]	0.87[b]	30.57	15.29
SEM	*0.03*	*0.02*	*2.11*	*4.12*
P-Value	*0.05*	*0.05*	*NS*	*NS*

supplementations. As seen in Table 4, the liver enzymes AST and ALT of the control group (T1) have been significantly higher than the other treatments with the inclusion of garlic in the laying hen ration.

The results, presented in Table 3, do not support any significant difference between the total protein but cholesterol and triglycerides were significantly higher in the control group (T1) than the other treatments, which included feeding the laying hens with garlic

Table 3: Effect of Dietary Garlic Powder Supplementation on Total protein and lipid profile of laying hens

Treatments	Total protein	Cholesterol	Triglyceride
T1	3.76	289.20[a]	172.10[a]
T2	3.49	213.41[b]	161.12[b]
T3	3.64	198.63[d]	136.22[c]
T4	3.67	184.31[c]	137.40[c]
SEM	*5.14*	*1.22*	*6.27*
P-Value	*NS*	*0.05*	*0.05*

Table 4: Effect of Dietary Garlic Powder Supplementation on liver enzyme of laying hens

Treatments	ALT (U/L)	AST (U/L)
T1	121.16[a]	8.12[a]
T2	94.21[b]	5.33[bc]
T3	91.13[b]	4.21[c]
T4	89.53[b]	6.25[b]
SEM	*6.74*	*0.75*
P-Value	*0.05*	*0.05*

performance, egg quality, lipid metabolism and liver function of the laying hens of ISA Brown that were affected by fatty liver syndrome. The egg production, egg quality

Discussion

In the present investigation, it was revealed that the garlic powder in the diet was a beneficial factor on the productive

levels of circulating lipids [20] Moreover, garlic might be able to modulate the expression of genes associated with fatty acid biosynthesis such as fatty acid synthase (FAS), acetyl-CoA carboxylase (ACC), and sterol regulatory element-binding protein-1c (SREBP-1c) that help control triglyceride deposition in the liver. The other significant result was the decrease in activities of liver enzymes (ALT and AST) in garlic groups of birds. Increased levels of these enzymes usually mean liver damage or leakage of the enzymes into the bloodstream due to liver failure. The liver integrity of the supplemented groups is better, with lower enzyme activities, suggesting less liver stress. It may be associated with the antioxidant activity of garlic which enhances the activity of natural antioxidant enzymes (superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), total antioxidant capacity (TAC) and reduces the concentration of lipid peroxidation products (LPO products) malondialdehyde (MDA) [21] Another possibility is that garlic can also be a stimulator of the activation of PPAR-α and an upregulatory of CPT-1, reducing the deposition of fat in the liver and increasing the use of fatty acids as fuel. This means that less triglyceride and very-low-density lipoprotein (VLDL) is likely to build up in the liver, helping to stop fatty liver syndrome from getting worse or to help your metabolism be healthier [22] the overall findings of the data presented here indicate a few of the beneficial effects of garlic supplementation due to its antimicrobial, antioxidant, anti-inflammatory and lipid-lowering properties. As a consequence of these actions, liver functions are improved, laying hen's metabolic status is improved and their productive performance is increased in laying hens with FSH. The results showed that garlic powder is a natural remedy that can be used as a dietary strategy to increase the health and production of the poultry under the hepatic metabolic disorders condition.

Conclusion

characteristics, biochemical parameters significantly improved in garlic treated group when compared to control group, suggesting beneficial effect of garlic in reducing the negative impact of Hepatic lipid accumulation. Fatty liver syndrome (FLS) is established as a metabolic syndrome which causes abnormalities in liver function and adversely influences productive efficiency of laying hens. As the liver is involved in lipid synthesis and yolk precursor production, fat deposition can cause a decrease in metabolic activity, a decrease in nutrient utilization and a decrease in egg production. Furthermore, oxidative stress from fatty liver syndrome is linked to cellular damage, hormonal imbalances and reduced reproductive ability [16،17] The improvement in egg production and egg quality seen after garlic supplementation could be due to the wide range of biological activities of garlic compounds. The sulfur compounds found in garlic, such as allicin, diallyl sulfide, diallyl disulfide, diallyl trisulfide and diallyl tetrasulfide, have potent antimicrobial and antioxidant properties. These compounds may help create a balance of the gut microbiota, break down feed, and increase utilization of feed, leading to better productive performance [18،19] The quality of shell and internal egg characteristics was also enhanced by garlic supplementation. The improvements could be due to better utilization of nutrients and/or less oxidative damage, so there is more of the minerals and nutrients needed for eggshell formation and albumen development. As in the previous studies with phytogenic feed additives for poultry, the results of this study are comparable. The marked decrease in serum cholesterol and triglyceride level in the garlic treated groups indicate a hypolipidemic effect of garlic. Organosulfur compounds are said to block the action of the important enzyme responsible for cholesterol biosynthesis – 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase. An inhibitor of this enzyme reduces the amount of cholesterol produced by the liver, and thus leads to lower

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From this study it was concluded that feeding of garlic powder was beneficial to the productive performance and physiological condition of ISA Brown laying hens suffering from fatty liver syndrome. Garlic supplementation improved egg production, egg quality and lowered serum cholesterol, triglycerides and liver enzyme activities (ALT, AST). The positive effects are probably connected to the antioxidant and anti-lipid effect of garlic. The optimal overall garlic powder level was 5 g/kg diet as tested. Thus, garlic powder has potential as a natural feed supplement to enhance liver health and productivity in laying hens suffering from fatty liver syndrome.

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