Egypt. Poult. Sci. Vol. (42) (I): (17-38)(2022) (2112-1190)

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

THE IMPACT OF STOCKING DENSITY AND LICORICE POWDER SPPLEMENTATION ON THE PRODUCTIVE STATE AND SOME PHYSIOLOGICAL TRAITS OF LAYING HENS

Maysa,M.Hanafy[1]; Fouad A., Tawfik[1] ; Ebtsam E.E.Iraqi[1] and M.E., Farag[2]

[1]Dep. of Poult. Breeding Res. Anim. Prod. Res. Inst., Agric. Res. Center, Egypt

[2] Dep. of Poult. Nutr. Res. Anim. Prod. Res. Inst., Agric. Res. Center, Egypt

Corresponding author: Maysa,M.Hanafy Email: maysam_hanafy@yahoo.com

Received: 08/12/2021 Accepted: 30 /01/2022

ABSTRACT: The current work was conducted to reduce the negative effects of increasing stocking density by adding licorice powder to laying hen diets. Also, evaluate the impact of these treatments on productive and physiological performance of Inshas laying hens. A 3x3 factorial design experiment was performed including three stocking densities (6, 9 or 12 birds/m^2) with three dietary levels of licorice (0, 0.5 and 1.0 %). A total number of 216 hens of Inshas local strain at 44 weeks of age were randomly distributed into 9 treatment groups with two replicates and housed during the experimental period 44 -56 weeks of age in floor pens with dimensions of 2 × 2 m. The results indicated that increasing stock density to 12 birds/m^2 caused a significant reduction in most of productive performance, fertility and hatchability percentages and blood parameters. Meanwhile, reducing stock density to 6 and 9 birds /m^2 participated in avoiding the negative effect. However, the best results for the previous parameters were exhibited by stocking density at 9 birds / m^2.

Regardless stock density, addition of licorice significantly increased egg production, egg number, egg weight, egg mass and improved feed conversion but feed consumption was not affected. Also, there was significant improvement in fertility and hatchability percentages, egg quality traits (egg shell thickness, Haugh unit score and egg yolk color) and most of blood parameters due to licorice supplementation. The best results were obtained by adding licorice at level of 0.5 %.

With regard to the interaction between stock density and licorice addition. It could be observed that, the highest egg production, egg weight, economic efficiency, the best feed conversion and the lowest feed consumption were recorded for hens received 0.5% licorice in their diet with stocking density of 9 birds / m^2. In addition, the best blood parameter values and the lowest plasma total lipids and LDL concentrations were achieved by the same treatment (0.5% licorice with stocking density of 9 birds/m^2).

In conclusion, from this study, it can be concluded that adding 0.5% licorice to laying hen diets with stocking density to 9 birds /m^2 was more efficient in improving the performance and economic efficiency increasing of Inshas laying hens.

Key words: stocking density, licorice, Laying hens, Performance, Blood constituents.

INTRODUCTION

The ultimate goal of poultry producers worldwide is to raise large numbers of birds in a small area to achieve the highest economic return. The numbers of birds per square meter usable area is defined as stocking density. The maximum density of birds was assigned to 9 per square meter, according to the European Union Council Directive 1999/74/EC (European Communities, 1999). Whereas, The Korean Council Directive 2012–68 (APQA, 2012), recommended the stock density of the birds not more than 7 per square meter which achieved the minimum standards of welfare for laying hens in Korea. Many workers had been establishing the negative effects of stock density on body weight, feed intake, egg production, egg weight, egg mass, egg quality and mortality rate (Anderson et al., 2004; Benyi et al., 2006 ;Jalal et al., 2006; Nicol et al., 2006; Tang et al., 2012; Kang et al., 2018; Zhang et al., 2018). However, feeding strategies are important in preventing the loss of yield and product quality as a result of the stress caused by high stocking density. For this purpose, the supplementation of additives are effective in reducing high stocking density stress. The use of medicinal plants has increased due to their beneficial effects in animals, poultry, and humans (Dhama et al., 2018). Moreover, medicinal additives to the birds feed have gained attention because of their beneficial effects on productive performance and poultry health. (Dhama et al., 2014; Yadav, et al., 2016; Ashraf, et al., 2017).

Licorice (Glycyrrhiza glabra), the root of the leguminous glycyrrhiza plant species, (family Leguminosae) contains flavonoids, triterpene saponins (glycyrrhetinic acid, glycyrrhizin and licorice acid), starch, sugars, amino acids, ascorbic acid, choline, tannins, phytosterols, coumarins, and some bitter substances (Shalaby et al., 2004). Licorice root is one of the most popular herbs in the world. Its botanical name comes from the Greek words meaning "sweet root." The ancient Egyptians used it as a pharmaceutical, and copious supplies were found in King Tut’s tomb. Egyptian hieroglyphics record the use of licorice as a popular beverage among the men of the time. It noted that licorice has multiple benefits for the body, as it protects the liver, anti-inflammatory, liver-protective, immunostimulant, detoxifying, anti-carcinogenic, anti-aging, antioxidant and anti-microbial (Karkanis et al., 2016; Karahan et al., 2016). Sedghi et al. (2010b) pointed that hens fed licorice extract at 4 g/kg had greater egg production and thicker shell thickness. Moreover, Shahryar et al., (2018) revealed that adding different levels of licorice powder could be significantly improving the egg quality and the performance of laying hens especially at 2.0% of Licorice powder, without having any significant effects on serum biochemical parameters. Therefore, the present study was conducted to reduce the negative effects of increasing stocking density by adding licorice powder to laying hen diets. Also, evaluate the impact of these treatments on productive and physiological performance of Inshas laying hens.

MATERIALS AND METHODS

The experimental work of this study was carried out at Sakha Poultry Research Station, Animal Production Research Institute, Agriculture Research Center, Giza, Egypt.

stocking density, licorice, Laying hens, Performance, Blood constituents.

Birds, managements and experimental design:

A 3x3 factorial design experiment was performed including three stocking densities (6, 9 or 12 birds/m^2) using floor pens with dimensions of 2 × 2 m and three dietary levels of licorice (0.0, 0.5 and 1.0% diet) and 2 replicates. A total number of 216 hens of Inshas local strain at 44 weeks of age were randomly distributed into 9 treatment groups with nearly similar average body weight. Each of 1^{st}, 2^{nd} and 3^{rd} groups was consisted of 48 hens in two replicates (24 hens each) and placed in 6 birds /m^2 and fed on the basal diet supplemented with 0.0, 0.5% and 1.0% licorice powder, respectively. While, each of 4^{th}, 5^{th} and 6^{th} groups included 72 hens in two replicates (36 hens each) and placed in 9 birds / m^2 and fed on the basal diet supplemented with 0.0, 0.5% and 1.0% licorice powder, respectively. Whereas, each 7^{th}, 8^{th} and 9^{th} groups included 96 hens in two replicates (48 hens each) and placed in 12 birds / m^2 and fed on the basal diet supplemented with 0.0, 0.5% and 1.0% licorice powder, respectively. The basal diet without any supplementation was kept as control (Table 1). The experimental treatments were set up in 18 separate identical pens (each treatment in two pens) measuring 2× 2 meter. Brids were placed on wheat straw liter at depth of 5 cm during the experimental period (44 -56 wks of age), birds were fed a commercial layer diet (16.97% crude protein and 2777 kcal ME/kg). Feed and water were supplied ad libitum throughout the experimental period. All experimental birds were kept under normal experimental conditions at ambient temperature fluctuated between 28.6 °C and 20.3 °C and relative humidity of 60 % - 55 %. Birds subjected to 16 hours light and 8 hours dark during the experimental period.

Productive parameters and egg quality:

Initial and final live body weights were individually recorded at 44 and 56 weeks of age, respectively. Egg weight (g) and egg number were recorded daily, while feed consumption was recorded weekly. Egg mass (g/h/d) and feed conversion (g feed/g egg) were calculated through the experimental period. No mortality was recorded during experimental period.

A total of 5 fresh eggs from each replicate pen, giving a total of 10 eggs for each treatment, were randomly taken at 48, 52 and 56 weeks of age to measure egg quality. Eggs were weighted with grams and egg shape index was calculated. The heights of the albumen and yolk in millimeter were measured. Yolk was separated from the albumen and weighted; the weight of albumen was calculated. Yolk, albumen and egg shell weight were expressed as a percentage of egg weight. The shell thickness with membrane (mm) was measured at three places in egg shell using a micrometer. Yolk color was recorded. Also, haugh unit and yolk index were calculated.

Blood constituents:

At 56 wks of age, blood samples were randomly taken from 6 hens from each treatment (3 hens / replicate) in heparinized tube from the brachial wing vein. A portion of the fresh blood was used to count the white blood cells (WBCs), lymphocytes (L), heterophils (H), red blood cells (RBCs), and measure hemoglobin (Hb) and packed cell volume (PCV). Plasma was obtained from the blood samples by centrifugation for 15 min. at 3000 rpm and was stored at -20 ˚C until the time of analysis. Plasma total protein, albumin, total lipids, cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), total antioxidants capacity (TAC) ,alanine aminotransamenase (ALT), asparatate aminotransamenase (AST), calcium (Ca) and phosphorus (P) were determined spectrophotometrically using available commercial Kits. Globulin was calculated by subtracting albumin from total protein concentrations.

Fertility and hatchability:

At 52 wks of age, hens were inseminated twice a week with diluted semen (1:1) from cocks that received the same treated diets. Hatching eggs were collected daily from each treatment group at 53, 54 and 55 wks of age. Egg fertility was estimated as a percentage of fertile eggs out of the number of eggs set. Hatchability of fertile eggs was estimated as a percentage of sound chicks out of the fertile eggs.

Statistical analysis:

Using 3 × 3 factorial design, data were analyzed statistically according to SAS program (SAS, 2004) using the following model:

$Y_{ijk} = \mu + H_i + S_j + HS_{ij} + e_{ijk}$

Where, Y_{ijk} = an observation; μ = overall mean; Hi = stocking density levels effect (i = 6, 9 and 12); S_j = licorice level effect (j = 0.0, 0.5 and 1); HS_{ij} = the interaction between stocking density and licorice levels and e_{ijk} = = random error.

Significant differences among means were tested using Duncan's Multiple Range test (Duncan, 1955).

Economic efficiency

The total feed cost (L.E/hen) included feeding and licorice costs at the end of the experiment for each treatment was calculated depending on the local market prices of the ingredients used for formulating the experimental diet. Price of one eggs/hen was put according to the local market prices of the eggs during the experimental period. Economic efficiency (EE) was calculated using the following equation: EE = Net return LE /Total feed cost LE.

RESULTS AND DISCUSSION

Productive performance

Performance of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction are given in Table 2. Data cleared that Inshas laying hens kept at 9 birds/m^2 showed the highest ($p \leq 0.01$) egg production, egg number/hen and the best feed conversion. This improvement may due to the useful effect of dietary licorice especially the level of 0.5%. However, the lowest averages of egg production, egg number/hen, egg weight, egg mass and the worst feed conversion for Inshas laying hens were obtained at the density of 12 birds/m^2. In this regard, Kang, et al. (2016) indicated that hens stocked at 10 birds/m^2 were less hen/day egg production, egg mass, and feed intake compared to other stock densities (5, 6, 7 birds/m^2). Sohail et al., (2001) found that increasing the density of cage leading to a significant decrease in egg production and egg mass. With regard to productive performance of Inshas laying hens as affected by licorice supplementation (Table 2), results of egg production, egg number/hen, egg weight, egg mass and feed conversion ratio were significantly ($p \leq 0.01$) improved by dietary licorice supplementation. On the other hand, feed consumption was not significantly affected by dietary licorice supplementation. The best values of egg production, egg number/hen, egg weight, egg mass and feed conversion were observed for hens fed diet supplemented with licorice at level of 0.5%. The improvement in feed conversion may be due to a decrease in feed consumption and an increase in egg weight. The improvement in the production performance may be due to quercetin, one of the six subclasses of flavonoid compounds in licorice, with a wide range of biological activities, plays a significant role in improving the production performance in laying hens. Moreover, this improvement may be due to the oestrogen-like effect of quercetin, which leads to elevate releasing of hormones and enhance reproductive organ growth (Yang et al., 2018). These findings are harmony with those of Awadein et al. (2010) who reported that adding 0.5% licorice to the diet of Mandarah laying hens significantly improved egg weight and feed conversion ratio. Also, Myandoab and Mansoub (2012) revealed that feeding the quail diet containing 200 ppm of licorice root extract and 1% probiotic resulted in significant reduction in feed conversion ratio. Contrary to our results, Dogan et al. (2018 b) reported that licorice supplementation at levels of 0.5, 1.0 and 1.5% had no effect ($P > 0.05$) on feed intake, feed conversion ratio and egg weight of Japanese quail. Concerning the interaction between birds density and licorice supplementation, it could be observed that the highest egg production and egg weight as well as the best feed conversion and the lowest feed consumption were achieved by dietary hens 0.5% licorice at stocking density of 9 birds/m^2. However, both of egg number/hen and egg mass were not significantly affected by the interaction between stock density and licorice addition.Results in Table 3 showed that increasing stocking density had significant negative effect ($p \leq 0.05$) on final body weight of hens at the end of experimental periods. These results are in agreement with those obtained by Widowski et al. (2013) and Widowski et al. (2016) who reported that hens reared in high stocking density had the lowest body weight. Zhang et al. (2013) returned the dropping in performance at high density to the rise in the surrounding environment temperature and a decreasing in the flow of air at the level of the birds, consequently a decrease in body heat loss. Regardless of stocking density hens received licorice supplemented to the diet had recorded significantly ($p \leq 0.01$) lower body weight than non-supplemented ones (Table 3). These results are in agreement with the findings of Dogan et al. (2018a), who reported that body weights were depression with raising level of licorice in the diets of laying hens. Similarly, some studies have shown that licorice flavonoids have reduced body weight by reduction the body fat mass ((Armanini et al., 2003; Nakagawa et al., 2004; Tominaga et al., 2006). They suggested enhancement of fatty acid oxidation and reduction in biosynthesis of fatty acids are possible mechanisms for the reduction of abdominal fat and lower body weight. However, body weight of hens was significantly affected by interaction between stocking density and licorice supplementation. The lowest values of final body weight of hens were obtained by dietary 0.5% licorice at stocking densities of 9 and 12 birds/m^2.

Fertility and hatchability percentage

As shown in Table 3, stocking density of 12 birds/m^2 showed statistically ($p \leq 0.01$) lower fertility and hatchability of fertile eggs percentages. While, stocking density of 6 and 9 birds/m^2 had recorded closely similar values for fertility percentage. In this respect, Tollba et al. (2006) reported that fertility and hatchability percentages were decreased due to keeping the Dandarawy and Bandarah hens at highest stocking densities 12 and 16 birds /m^2, respectively.

Licorice supplementation significantly increased fertility ($p \leq 0.05$) and hatchability ($p \leq 0.01$) of fertile eggs percentages (Table 3). Al-Daraji and Ameen (2007) reported that the addition of licorice extract (2mg/ 100 ml of diluent) to the semen diluents led to significant ($p \leq 0.05$) improvement in the percentage of hatchability from total and fertile eggs. In regarding to the interaction effect between additions of licorice and stocking density, results of Table 3 showed that fertility and hatchability of fertile eggs percentages were not significantly affected by adding licorice to hen diets under different stocking densities. However, the treatment of 0.5% dietary added licorice with stocking density of 9 birds /m^2 was recorded the highest values fertility and hatchability percentages comparing to all experimental groups. Meanwhile, the worst percentages were exhibited by stocking density 12 birds /m^2 without dietary licorice supplementation.

Egg quality traits

Regardless licorice addition, results of Table 4 referred that stock density had insignificant effect on egg quality traits. These results agreed with those reported by Kang, et al. (2016) who observed that eggshell thickness, egg yolk color and Haugh unit did not significant differ among different stocking densities. Also, Tollba et al., (2006) denoted that egg quality traits were not affected, when stocking density of laying hens were 8, 12 and 16 birds /m^2. Sohail et al., (2001) showed that there were no significant effects of the different densities on egg quality traits (egg weight, specific gravity, shell weight, shell percent) of laying hens at 81 weeks of age.

It's apparent from the obtained results that all traits of egg quality were not significant affected by supplementation hen diet with graded levels of Licorice powder, except shell thickness, Haugh unit and egg yolk color which were significantly ($p \leq 0.05$) increased epically for the treatments supplemented with 0.5% of Licorice. Similarly, Shahryar et al. (2018) found significant increase in both of Haugh unit and egg yolk color by adding licorice to laying hen diets. Also, the present results were partially concur with those reported by Sedghi et al. (2010b) who obtained an improvement in egg shell thickness by adding licorice to laying hen diets , while the rest of egg quality characteristics were not significantly affected. Liu et al., (2013) indicated that flavonoids improve egg shell thickness via calcium metabolism regulated by their estrogen-like effects.

Results in Table 4 cleared that the combination between stock densities and inclusion of licorice in hen’s diet had no significant effect on the egg quality traits.

Hematological parameters

Results presented in Table 5 showed that all hematological parameters were significantly ($p \leq 0.01$) affected by hen’s density except both of WBCs count and Hb values. Where, increasing stocking density to 12 birds/m^2 significantly decreased values of RBCs and PCV while, heterophils (H), lymphocytes (L) ratios, and heterophils / lymphocytes ratio (H/L ratio) significantly increased. Kang et al., (2016) explained that laying hens stocked at 10 birds/m^2 showed significantly higher heterophils, H/L ratio, and serum corticosterone than in those stocked at 6–7 birds/m^2. However, numerous of authors indicated that the higher value of H/L ratio was an indication of poultry stress by increasing the density of the stock, moreover, increasing stocking density reduced locomotor activity which increases H/L ratio and oxidative stress. (Feddes et al., 2002; Simitzis et al., 2012).

Licorice powder supplementation significantly increased ($p \leq 0.01$) RBCs, WBCs, Hb and PCV values comparing with control. The highest values of RBCs, WBCs, Hb and PCV were obtained with 0.5% licorice. Conversely, supplementation licorice powder significantly decreased ($p \leq 0.01$) lymphocytes (L), heterophils (H) and heterophils / lymphocytes ratio (H/L ratio). The positive changes that took place in the values of RBCs, WBCs, Hb and PCV in licorice treatments may be a reflection of the positive changes that have occurred in the productive performance of birds treated with licorice powder supplementation. These results are agree with those of Amen and Muhammad (2016) who recorded that the highest significant ($p \leq 0.05$) value of RBCs, Hb and PCV were achieved by supplementing 1.25 g licorice extract/kg diet at 42 days of age. While addition of 1.50 g licorice extract/kg diet had higher value ($p \leq 0.05$) in WBCs at 42 days of age. Sedghi et al. (2010a) reported that licorice supplementation at 1 g /kg had increased the value of WBCs ($p \leq 0.05$) over the control and had no effects on L, H, H/L ratio and red blood cells. Also, the H, L and H/L ratio were not affected by supplemented different levels of licorice in drinking water (Moradi et al., 2014).

Interaction between stocking density and dietary licorice powder had highly significant ($p \leq 0.01$) effect on all hematological parameters except for heterophils (H), lymphocytes (L) and heterophils / lymphocytes ratio (H/L ratio). However, inclusion of licorice powder in laying hen diets significantly increased the values of all previous parameters under all stocking densities comparing with licorice non supplemented diets under the same stocking densities. The highest values of RBCs, WBCs, Hb and PCV were recorded by dietary 0.5% licorice with stocking density of 9 birds /m^2.On the other hand, the lowest values of the previous parameters were recorded for treatments without licorice addition under all stocking densities used in this study.

Blood constituents

The data of blood constituents revealed that there were no significant differences in most studied traits due to stocking density (Table 6). Meanwhile, values of globulin and phosphorus were significantly affected. However, stocking of 9 birds/m^2 recorded the highest significant ($p \leq 0.01$) value of globulin comparing with birds stocked at 6 and 12 birds/m^2. In this regard, it could be noticed that increasing stocking density had significantly decreased plasma phosphorus concentration. These results are harmony with those obtained by Mousa and Shoeib (2012) who referred that serum globulin value was significantly ($p \leq 0.05$) decreased while, serum total protein, albumin, AST and ALT values were insignificantly affected by increasing stocking density from 10 to12 or 14 birds / m^2. The results of plasma calcium and phosphorus are partially coincided with results obtained by Gharib et al., (2005) who stated that increasing cage density significantly reduced serum calcium and phosphorus.

It appears from the results of Table 6 that supplemental licorice powder significantly ($p \leq 0.01$) increased plasma globulin, Ca, P and TAC compared with non-supplemented diets. While, dietary licorice powder supplementation had insignificant effect on plasma total protein, albumin, ALT and AST concentrations which agree with Amaral et al., (2017) who suggested that there were no significant differences in ALT and AST concentrations due to addition of licorice, therefore, licorice has not any toxic or harmful effect in the animal. Rezaei et al., (2014) showed that in broiler dietary inclusion of 0.5% licorice extracts significantly increased serum globulin level which is responsible for increasing immune status. In addition, the improvement in plasma calcium in this study due to both of Glycyrrhzin and Glycyrrhetic acid (one of licorice compounds) which have steroid- like action, where it is known that steroid hormones are constructive (anabolic) hormones, which lead to calcium survival of the body and increase the basal metabolic rate (Sturkie, 2000). The results of plasma TAC in the present study smoothly correlate with Dogan et al. (2018a) who explained that total antioxidant capacity levels significant ($p \leq 0.01$) increased by dietary licorice root powder for laying hens. Moreover, Dogan et al. (2018b) showed that added different levels of licorice to the feed of laying quails had enhancement total TAS while, depression total oxidant status and oxidative stress index .

The interaction between stocking density and dietary licorice powder had insignificantly effect on blood constituents except plasma globulin. The best values of plasma globulin were recorded by dietary 0.5% licorice at stocking densities of 9 and 12 birds /m^2.

Lipid profile

As shown in Table (7) stocking density at 9 birds/m^2 had significantly ($p \leq 0.01$) decreased total lipids comparing with 6 and 12 birds /m^2, whereas, the least concentrations of plasma cholesterol and LDL were recorded for stocking density of 6 birds /m^2. On the other hand, stocking density had no significant effect on plasma HDL concentrations. El-Shafei et al. (2012) found that a significant increase in total lipids and cholesterol with increasing stocking density. While, insignificant differences were observed for HDL and LDL.

Results in table (7) indicated that plasma concentrations of total lipids, cholesterol and LDL were significantly ($p \leq 0.01$) decreased as a result of adding licorice powder, on the other hand, HDL concentration was significantly ($p \leq 0.01$) increased in licorice treated groups. However, dietary supplementation of 0.5% Licorice exhibited the lowest value of total lipids, cholesterol, and LDL concentrations and the highest value of HDL concentration. The reduction in lipid components may be attributed to saponin in licorice, which is capable of reducing the levels of LDL-associated carotenoids, inhibition the formation of lipid peroxides, and augmentation of the conversion of cholesterol to bile acids. Bile acids have many functions, including eliminating cholesterol from the body and emulsifying fat-soluble vitamins to enable their absorption. Also, the roots of the plant contain both ascorbic acid and flavonoids that could have contributed to an increase in HDL cholesterol concentrations in treated hens. Ascorbic acid seems to affect the post transcriptional step of the expression of apolipoprotein A-I (major constituent protein of HDL) and seems to increase the activity of lipoprotein lipase, which in turn appears to participate in the regulation of HDL metabolism. In agreement with our results, Sharifi et al. (2013) found a depression in serum cholesterol and LDL and an increasing in HDL levels by feeding broilers on diet containing 2mg / kg licorice. In another study, Sedghi et al. (2010b) found that the concentrations of cholesterol were decreased as dietary licorice extracts at different levels. Moreover, Naser et al. (2017) showed that licorice extracted supplemented in drinking water decreased LDL and total cholesterol ($p \leq 0.05$) but increased the HDL/LDL ratio in serum of broiler chickens. This due to an increase in the concentration of flavonoids in licorice. Contrary to our results, Sedghi et al. (2010b) found that plasma HDL concentrations were not significantly affected by dietary licorice supplementation to broilers diet.

The interaction between stocking density and dietary licorice powder had significantly ($p \leq 0.01$) effect on plasma total lipids and LDL concentrations only. While, plasma concentrations of cholesterol and HDL were not significantly affected as shown in Table (7). There was a significant reduction in plasma total lipids and LDL due to feeding 0.5 % licorice under stocking density of 9 birds /m^2. However, under each stocking density of 9 and 12 birds /m^2 there were a significant reduction in plasma total lipids and plasma cholesterol levels for hens fed diet supplemented with licorice comparing with those fed licorice un supplemented diets. Generally, there were decreases in plasma cholesterol and increases in plasma HDL concentrations were recorded by feeding licorice supplemented diets under all stocking densities compared to un supplemented ones under the same stocking densities.

Economic efficiency

Data of economic efficiency are summarized in Table 8. It was deserved that all dietary licorice added groups under stocking densities of 9 and 12 birds/m^2 had higher net return (per hen) and economic efficiency over than licorice un supplemented groups at the same stocking densities. However, stocking density of 9 birds/m^2 with 0.5% added licorice exhibited the highest net return (per hen) and economic efficiency. While the lowest net return and economic efficiency values were recorded by hens fed diet without licorice with stocking density of 12 birds/m^2.

The results of the present study suggest that stocking density (9 birds /m^2) used in this research with 0.5 dietary added licorice powder was efficient in improving productive performance as well as blood parameters and economic efficiency. To our knowledge there were no available literatures on the study of the interactions between laying hen stocking density and dietary licorice addition on productive and physiological traits as well as economic efficiency.

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

Ingredients	%
Yellow corn	66.33
Soybean meal (48%CP)	24.2
Limestone	7.5
Dicalcium phosphate	1.32
Vit+Min Premix	0.25
Nacl	0.25
DL-methionine	0.15
Total	100
Calculated analysis,%	
ME, Kcal/ Kg	2777
C/P ratio	163.6
Methionine,%	0.39
Methionine+ Cystine,%	0.67
Lysine%	0.8
Calciun,%	3.1
Phosphorous available,%	0.45
Values (AOAC) analyzed	
Dry matter,%	90.73
crude protein,%	16.97
Ether extract,%	2.45
Ash,%	3.96
Nitrogen free extract,%	6.37
	60.98

Vit+Min mixture provide per kilogram of diet : vitamin A,12000IU; vitamin E,10IU; menadione, 3mg; Vit D3, 2200ICU; riboflavin, 10mg; Ca pantothenate,10mg; nicotinic acid, 20mg; choline chloride, 500mg;vitamin B12, 10µg; vitamin B6, 1.5mg; vitaminB1, 2.2mg;folic acid, 1 mg; biotin, 50µg; Trace mineral (milligrams per Kilogram of diet): Mn, 55; Zn, 50;Fe,30;Cu,10;Se,0.10;Anti-oxidant,3mg.

Table (2): Performance of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Treatments \ Traits	Egg production (%)	Egg number/hen (44-56)	Egg weight (g)	Egg mass (g/hen/day)	Feed consumption (g/hen/day)	Feed conversion ratio (g feed/g egg)
Main effects:						
Stock density (S) (birds /m^2)						
6	59.78^{b}	50.22^{b}	51.12^{a}	31.01^{a}	119.38	3.97^{b}
9	61.49^{a}	51.65^{a}	50.76^{a}	30.90^{a}	119.17	3.79^{c}
12	57.62^{c}	48.23^{c}	50.50^{b}	29.07^{b}	119.26	4.19^{a}
SEM	0.414	3.447	0.017	0.493	0.099	0.067
P value	**	**	**	**	N.S.	**
Licorice (L) (%)						
0.0 (control)	54.58^{c}	45.86^{b}	50.46^{c}	27.46^{b}	119.34	4.39^{a}
0.5	62.77^{a}	52.73^{a}	51.16^{a}	32.11^{a}	119.19	3.74^{b}
1.0	61.53^{b}	51.51^{a}	51.04^{b}	31.59^{a}	119.29	3.81^{b}
SEM	0.395	3.915	0.023	0.422	0.101	0.058
P value	**	**	**	**	N.S.	**
Interaction effect						
S × L						
6 × 0.0	59.12^{c}	50.28	50.17^{f}	29.53	119.63^{a}	4.35^{b}
6 × 0.5	59.97^{c}	49.35	51.24^{c}	32.29	119.43^{ab}	3.72^{d}
6 ×1.0	60.24^{c}	50.91	51.94^{a}	31.20	118.96^{bc}	3.84^{dc}
9 × 0.0	54.39^{d}	49.91	50.26^{f}	27.61	119.26^{abc}	3.85^{dc}
9 × 0.5	65.21^{a}	55.17	52.04^{a}	32.82	118.76^{c}	3.66^{d}
9 × 1.0	64.86^{ab}	54.41	49.99^{g}	32.79	119.55^{a}	3.66^{d}
12 × 0.0	50.24^{e}	42.26	50.76^{d}	25.23	119.24^{abc}	4.05^{c}
12 × 0.5	63.13^{b}	52.97	50.64^{e}	31.21	119.33^{ab}	4.78^{a}
12 × 1.0	59.48^{c}	45.70	51.47^{b}	30.77	119.29^{abc}	3.94^{dc}
SEM	0.624	4.039	0.038	0.667	0.157	0.090
P value	**	N.S.	**	N.S.	*	**

^{a,b,c,d,e,f} Means within a column within each main effects with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS Not significant. SEM= Standard error of means. P value = Probability level.

Table (3): body weight and hatching traits of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Traits / Treatments	Final body weight (g)	Fertility (%)	Hatchability (%)
Main effects: **Stock density (S) (birds /m^2)**			
6	1736.79^a	84.67^a	87.03^a
9	1712.56^b	83.77^a	85.74^b
12	1702.06^b	81.78^b	82.72^c
SEM	0.009	0.222	0.233
P value	*	**	**
Licorice (L) (%)			
0.0 (control)	1730.94^a	81.89^b	83.19^c
0.5	1714.42^{ab}	84.58^a	87.26^a
1.0	1705.98^b	83.74^a	85.06^b
SEM	0.008	0.223	0.278
P value	**	*	**
Interaction effect S × L			
6 × 0.0	1733.04^b	83.23	85.47
6 × 0.5	1794.63^a	85.23	88.27
6 ×1.0	1682.71^{cd}	85.53	87.37
9 × 0.0	1744.17^b	82.00	82.77
9 × 0.5	1671.00^d	85.90	89.17
9 × 1.0	1722.50^{bc}	85.07	85.30
12 × 0.0	1715.63^{bcd}	80.43	81.33
12 × 0.5	1677.63^d	82.60	84.33
12 × 1.0	1712.74^{bcd}	82.30	82.50
SEM	0.014	0.085	0.904
P value	**	N.S.	N.S.

^{a,b,c,d} Means within a column within each main effects with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS Not significant. SEM= Standard error of means. P value = Probability level.

Table (4): Egg quality of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Traits / Treatments	Egg shape index (%)	Yolk weight (%)	Albumen weight (%)	Shell weight (%)	Yolk index (%)	Shell thickness (mm)	Haugh unit	Yolk color
Main effects:								
Stock density (S) (birds /m^2)								
6	77.75	34.37	52.29	13.34	37.91	38.80	74.33	7.77
9	78.26	34.13	52.78	13.12	37.88	38.17	77.39	8.03
12	77.43	33.82	52.70	13.48	37.40	37.92	74.73	7.97
SEM	0.51	0.381	0.420	0.196	0.550	0.449	1.240	0.106
P value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Licorice (L) (%)								
0.0 (control)	78.25	34.20	52.40	13.29	37.45	37.47^{b}	73.55^{b}	7.68^{b}
0.5	77.65	34.07	52.92	13.36	38.19	38.97^{a}	77.66^{a}	8.05^{a}
1.0	77.54	34.05	52.69	13.30	37.55	38.58^{ab}	75.23^{ab}	8.03^{a}
SEM	0.507	0.387	0.425	0.198	0.534	0.447	1.213	0.103
P value	N.S.	N.S.	N.S.	N.S.	N.S.	*	*	*
Interaction effect								
S × L								
6 × 0.0	78.36	34.51	52.26	13.23	37.36	37.25	74.09	7.80
6 × 0.5	77.54	34.14	52.68	13.18	38.95	39.55	78.18	7.80
6 ×1.0	77.34	34.46	51.93	13.61	37.42	39.60	70.72	7.70
9 × 0.0	78.88	34.25	52.52	13.23	36.68	37.20	75.38	7.55
9 × 0.5	78.54	34.05	53.06	12.89	39.05	39.50	78.00	8.10
9 × 1.0	77.36	34.10	52.65	13.25	37.91	37.80	78.80	8.45
12 × 0.0	77.52	33.85	52.75	13.40	38.30	37.95	71.19	7.70
12 × 0.5	76.86	34.03	51.97	14.00	36.56	38.45	76.82	8.25
12 × 1.0	77.93	33.58	53.37	13.05	37.33	37.35	76.17	7.95
SEM	0.854	0.653	0.714	0.339	0.894	0.754	2.057	0.173
P value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

^{a,b} Means within a column within each main effects with different superscripts are significantly different ($P \leq 0.05$). * = ($P \leq 0.05$). NS Not significant. SEM= Standard error of means. P value = Probability level.

Table (5): Hematological parameters of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Traits / Treatments	RBCs (10^6/mm^3)	WBCs (10^3/mm^3)	H %	L %	H/L	Hb (g/dl)	PCV (%)
Main effects:							
Stock density (S) (birds /m^2)							
6	2.16^a	6.05	29.00^c	59.22^c	0.489^c	10.07	36.48^a
9	2.19^a	6.13	33.89^b	63.72^b	0.531^b	10.28	36.64^a
12	1.99^b	6.01	36.33^a	65.22^a	0.555^a	9.93	34.44^b
SEM	0.276	0.309	3.31	1.743	0.041	0.334	1.582
P value	**	N.S.	**	**	**	N.S.	*
Licorice (L) (%)							
0.0 (control)	1.77^b	4.94^b	37.44^a	64.33^a	0.580^a	9.04^c	29.84^b
0.5	2.33^a	6.74^a	30.56^b	61.83^b	0.493^b	11.01^a	39.27^a
1.0	2.24^a	6.51^a	31.22^b	62.00^b	0.501^b	10.22^b	38.46^a
SEM	0.049	0.177	3.282	2.743	0.031	0.230	0.887
P value	**	**	**	**	**	**	**
Interaction effect							
S × L							
6 × 0.0	1.72^c	4.40^e	32.33	60.33	0.535	8.40^d	34.77^c
6 × 0.5	2.40^a	6.93^{ab}	27.33	59.00	0.463	11.27^{ab}	37.47^b
6 ×1.0	2.36^a	6.83^{ab}	27.33	58.33	0.469	10.53^{bc}	37.20^b
9 × 0.0	1.82^c	4.73^e	39.33	66.00	0.596	8.90^d	30.40^d
9 × 0.5	2.44^a	7.06^a	31.00	62.5	0.496	11.60^a	40.90^a
9 × 1.0	2.32^a	6.60^{abc}	31.33	62.67	0.500	10.33^c	38.63^{ab}
12 × 0.0	1.79^c	5.70^d	40.67	66.67	0.610	9.83^c	24.37^e
12 × 0.5	2.14^b	6.23^{bcd}	33.33	64.00	0.541	10.17^c	39.43^{ab}
12 × 1.0	2.04^b	6.10^{cd}	35.00	65.00	0.535	9.80^c	39.53^{ab}
SEM	0.151	0.196	4.541	3.058	0.050	0.824	0.691
P value	**	**	N.S.	N.S.	N.S.	**	**

[a,b,c,d,e] Means within a column within each main effects with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS Not significant. SEM= Standard error of means. P value = Probability level. RBCs= red blood cells. WBCs= white blood cells. H= Heterophils. L= Lymphocytes. H/L= Heterophils: Lymphocytes. Hb= hemoglobin. PCV= packed cell volume.

Table (6): Blood constituents of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Traits / Treatments	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	AST (U/L)	ALT (U/L)	Ca (mg/dl)	P (mg/dl)	TCA (mg/dl)
Main effects:								
Stock density (S) (birds /m^2)								
6	5.62	3.68	1.99[b]	61.22	31.44	14.64	7.03[a]	1.06
9	5.66	3.46	2.15[a]	61.22	32.78	14.22	6.97[b]	1.14
12	5.17	3.44	1.96[b]	60.89	32.11	14.03	6.48[b]	1.08
SEM	0.295	0.156	0.082	0.856	1.014	0.514	0.255	0.073
P value	N.S.	N.S.	**	N.S.	N.S.	N.S.	*	N.S.
Licorice (L) (%)								
0.0 (control)	5.41	3.56	1.91[b]	61.11	31.89	12.68[c]	6.01[b]	0.91[b]
0.5	5.49	3.35	2.14[a]	61.56	32.11	15.78[a]	7.35[a]	1.22[a]
1.0	5.66	3.67	1.99[ab]	60.67	32.33	14.44[b]	7.11[a]	1.15[a]
SEM	0.377	0.146	0.083	0.850	1.044	0.274	0.344	0.050
P value	N.S.	N.S.	**	N.S.	N.S	**	**	**
Interaction effect								
S × L								
6 × 0.0	5.85	3.83	2.02[ab]	61.00	30.33	13.17	6.17	1.00
6 × 0.5	5.02	3.18	1.85[b]	61.35	31.33	15.33	7.23	1.17
6 ×1.0	5.98	3.88	2.10[ab]	61.37	32.673	15.43	7.68	1.02
9 × 0.0	5.38	3.33	2.05[ab]	61.38	2.33	12.70	6.25	0.89
9 × 0.5	6.00	3.63	2.37[a]	62.33	33.00	16.03	7.66	1.29
9 × 1.0	5.61	3.58	2.03[ab]	60.00	33.00	13.93	6.99	1.25
12 × 0.0	5.00	3.30	1.70[b]	61.06	33.00	12.17	5.62	0.85
12 × 0.5	5.46	3.09	2.37[a]	61.00	32.00	15.99	7.16	1.21
12 × 1.0	5.05	3.20	1.85[b]	60.67	31.33	13.94	6.65	1.19
SEM	0.447	0.197	0.070	1.407	1.90	0.333	0.277	0.091
P value	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.

[a,b,c] Means within a column within each main effects with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS Not significant. SEM= Standard error of means. P value = Probability level. AST= asparatate aminotransamenase. ALT = alanine aminotransamenase. Ca=Calcium. P = Phosphorus. TAC=total antioxidants capacity.

Table (7): lipid profile of Inshas laying hens as affected by stocking density, licorice supplementation and their interaction.

Traits / Treatments	Total lipids (mg/dl)	Cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)
Main effects:				
Stock density (S) (birds /m^2)				
6	206.78^a	140.44^b	41.05^b	55.92
9	193.00^b	141.44^{ab}	45.92^{ab}	55.96
12	214.22^a	153.11^a	47.73^a	54.77
SEM	7.016	11.267	2.385	2.24
P value	**	*	**	N.S
Licorice (L) (%)				
0.0 (control)	225.11^a	187.11^a	52.03^a	49.54^b
0.5	186.78^c	119.11^b	38.69^c	61.12^a
1.0	202.11^b	128.78^b	43.99^b	55.98^a
SEM	5.573	4.447	1.897	1.733
P value	**	**	**	**
Interaction effect				
S × L				
6 × 0.0	212.67^b	185.00	41.03^c	50.87
6 × 0.5	202.33^b	124.33	40.93^c	57.17
6 ×1.0	205.32^b	112.00	41.20^c	59.73
9 × 0.0	231.67^a	185.33	59.27^a	48.87
9 × 0.5	152.67^c	110.67	36.77^c	65.00
9 × 1.0	194.67^b	128.33	42.13^c	54.00
12 × 0.0	231.00^a	191.00	55.80^a	48.90
12 × 0.5	205.33^b	122.33	38.77^c	61.20
12 × 1.0	206.33^b	146.00	48.63^b	54.20
SEM	5.356	6.148	1.94	2.894
P value	**	N.S.	**	N.S.

^{a,b,c} Means within a column within each main effects with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS Not significant. SEM= Standard error of means. P value = Probability level. HDL= High density lipoprotein. LDL= Low density lipoprotein.

Table (8): Economic efficiency of Inshas laying hens as affected by licorice supplementation, stocking density and their interaction.

Traits	Treatments								
	6S × 0.0L	**6S× 0.5L**	**6S× 1.0L**	**9S× 0.0L**	**9S× 0.5L**	**9S× 1.0L**	**12S × 0.0L**	**12S× 0.5L**	**12S ×1.0L**
Average feed consumption Kg / hen during weeks of age	10.021	10.032	9.993	10.017	9.976	10.042	10.016	10.024	10.020
Cost /kg feed L.E[1].	6.40	6.57	6.73	6.40	6.57	6.73	6.40	6.57	6.73
Total feed cost L.E[2].	64.13	65.19	67.25	64.11	65.54	67.58	64.10	65.86	67.43
Egg number/hen (44-56)	50.28	49.35	50.91	49.91	55.17	54.41	42.26	52.97	45.70
Price of one eggs/hen L.E[3].	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Total price of eggs /hen L.E.	92.01	90.31	93.17	91.34	100.96	99.57	77.34	96.94	83.63
Net return / hen L.E[4].	27.88	25.12	25.92	27.23	35.42	31.99	13.24	31.08	16.20
Economic efficiency[5].	0.43	0.39	0.39	0.42	0.54	0.47	0.21	0.47	0.24

L = licorice supplementation. S = stocking density. L.E. = Egyptian pound.

1-Price of one 1 kilogram of licorice = 33 LE. 2- According to local price of different ingredients available in Egypt at the experimental period.

3- According to local price of egg at the experimental period. 4-Net return / hen = Total price of eggs /hen – Total feed cost. 5-Economic efficiency = Net return/total feed cost.

REFERENCES

Al-Daraji, H.J.; and Ameen, M.H.M. 2007. The addition of licorice extract to roosters' diluent for improve quality and fertilizing ability of spermatozoa of white leghorn roosters. Iraqi Poult. Sci. J., 2:46 – 57.

Amaral, P. C.; Zimermann, C.; Santos, L. R.;Noro, M.; Prá, M. D.; Pilotto, F.;Rodrigues, L.B.; and Dickel, E. L. 2017. Evaluation of physiological parameters of broilers with dorsal cranial myopathy. Brazilian J. Poult. Sci., 19: 69-74.

Amen, M. H. M.; and Muhammad, S. S. 2016. Effect of dietary licorice extract on some physiological and productive traits of Ross 708 broiler chicken. International Journal of Current Research 8: 36116-36121.

Anderson, K. E.; Davis, G. S.; Jenkins, P. K.; and Carroll, A. S. 2004. Effect of bird age, density and molt on behavioral profiles of two commercial layer strains in cages. Poult. Sci., 83:15–23.

APQA. 2012. Livestock farm animal welfare certification standards (regulation No. 2012-68). Animal and Plant Quarantine Agency, Republic of Korea.

Armanini , D.; De Palo, C. B.; Mattarello, M. J.; Spinella, P.; Zaccaria, M.; Ermolao, A. ; Palermo, M.; Fiore, C.; Sartorato, P.; Francini-Pesenti, F.; Karbowiak, I. 2003. Effect of licorice on the reduction of body fat mass in healthy subjects. J.Endocrinol.Invest., 26:646-650.

Ashraf, A.; Ashraf, M.M.; Rafiqe, A.; Aslam, B.; Galani, S.; Zafar, S.; Asad, F.; Asghar, R.D.; Akram, S.; Ahmed, H.; . Shah, S. M. A.; and Asif, R. 2017. In vivo antiviral potential of Glycyrrhiza glabra extract against Newcastle disease virus. Pak. J. Pharm. Sci., 30: 567–572.

Awadein, N. B.; Y.Z. Eid; and Abd El-Ghany, F. A. 2010. Effect of dietary supplementation with phytoestrogens sources before sexual maturity on productive performance of Mandarah hens. Egypt. Poult. Sci.J., 30: 829-846.

Benyi, K.; D. Norris; and P. M. Tsatsinyane. 2006. Effects of stocking density and group size on the performance of white and brown Hyline layers in semi-arid conditions. Trop. Anim. Health Prod. 38:619–624.

Dhama, K.; Karthik, K.; Khandia, R.; Munjal, A.; Tiwari, R.; Rana, R.; Khurana, S.K.; Sana Ullah, K.R.; Alagawany, M.; Farag, M.R.; Dadar, M.; and Joshi, S.K. 2018. Medicinal and therapeutic potential of herbs and plant metabolites/extracts countering viral pathogens-Current knowledge and future prospects. Curr. Drug Metab., 19: 236–263.

Dhama, K.; Tiwari, R.; Khan, R.U.; Chakraborty, S.; Gopi, M.; Karthik, K.; Saminathan, M.; Desingu, P.A.; Sunkara, L.T. 2014. Growth promoters and novel feed additives improving poultry production and health, bioactive principles and beneficial applications: The trends and advances–A Review. Int. J. Pharmacol., 10: 129–159.

Dogan, S.C.; Baylan, M.; Erdo ˘gan, Z.; Küçükgül, A.; and Bulancak, A. 2018a. The effects of Licorice (Glycyrrhriza glabra) root on performance, some serum parameters and antioxidant capacity of laying hens. Braz. J. Poult. Sci., 20: 699–706.

Dogan, S.C.; Erdoğan ,Z.; Şekeroğlu , A.; Baylan, M.; and Küçükgül, A.

2018b. The effects of licorice root powder (Glycyrrhriza glabra) on performance, serum parameters, egg yolk cholesterol and antioxidant capacity of laying Japanese quail. Turkish Journal of Agriculture - Food Science and Technology, 6: 1290-1296.

Duncan, D.B. 1955. Multiple Ranges and Multiple F- test. Biometrics., 11 : 1-42.

El-Shafei, A. A.; Abdel–Azeem, A. F.; and Abdullaha, E. A. 2012. Stocking density effects on performance and physiological changes of laying Japanese quail. J. Anim. Poult. Prod., 3: 379-398.

European Communities. 1999. Council Directive 1999/74/EC. Official Journal of the European Communities, L203/53.

Feddes, J. J.; Emmanuel, E. J.; and Zuidhoft, M. J. 2002. Broiler performance, body weight variance, feed and water intake, and carcass quality at different stocking densities. Poult. Sci., 81:774– 779.

Gharib, H. B. A.; El-Menawey, M. A.; Attalla, A. A.; and Stino, F. K. R. 2005. Effect of cage density and housing system on productive performance and physiological indicators of White Leghorn type layers. Egypt. Poult.Sci. J., 25:797-824.

Jalal, M. A.; Scheidelser, S. E.; and Marx, D. 2006. Effect of bird cage space and dietary metabolizable energy level on production parameters in laying hens. Poult. Sci., 85:306–311.

Kang, H. K.; Park, S. B.; Kim, S. H.; and Kim, C. H. 2016. Effects of stock density on the laying performance, blood parameter, corticosterone, litter quality, gas emission and bone mineral density of laying hens in floor pens. Poult. Sci., 95: 2764-2770.

Kang, H. K.; S. B. Park; J. J. Jeon; H. S. Kim; S. H. Kim; E. Hong; and C. H. Kim. 2018. Effect of stocking density on laying performance, egg quality and blood parameters of Hy-Line Brown laying hens in an aviary system. Eur. Poult. Sci. 82:1-13.

Karahan, F.; Avsar, C.; Ozyigit, I.I.; and Berber, I. 2016. Antimicrobial and antioxidant activities of medicinal plant Glycyrrhiza glabra var. glandulifera from different habitats. Biotechnol. Biotechnol. Equip., 30, 797–804.

Karkanis, A.; Martins, N.; Petropoulos, S.A.; and Ferreira, I.C.F.R. 2016. Phytochemical composition, health effects, and crop management of liquorice (Glycyrrhiza glabra L.): A medicinal plant. Food Rev. Int., 34, 1–22.

Liu, Y.; Li, Y.; Liu, H. N.; Suo, Y. L.; Hu, L. L.; Feng, X. A.;and Jin, F. 2013. Effect of quercetin on performance and egg quality during the late laying period of hens. Br. Poult. Sci., 54: 510-514.

Moradi, N.; Ghazi, S.; Amjadian, T.; Khamisabadi, H.; and Habibian, M. 2014. Performance and some immunological parameter responses of broiler chickens to licorice (Glycyrrhiza glabra) extract administration in the drinking water. Annu. Res. Rev. Biol., 4: 675–683.

Mousa, S.M.M.; and Shoeib, M.S. 2012. The influence of stocking density and dietary silymarin level on productive performance and some physiological traits of Inshas cocks local strain. J. Product. Dev., 17:79-103.

Myandoab, M.P.; and Mansoub, N.H. 2012. Comparative effect of Liquorice root extract medicinal plants and probiotic in diets on performance, carcass traits and serum composition of Japanese quails. Global Veterinarian, 8:39-42.

Nakagawa, K.; Kishida, H.; Arai, N.; Nishiyama, T.; and Mae, T. 2004. Licorice flavonoids suppress abdominal fat accumulation and increase in blood glucose level in obese diabetic KK-A(y) mice. Biol. Pharm. Bull., 27: 1775-1778.

Naser, M.; Shahab, G.; and Mahmood, H. 2017. Drinking water supplementation of licorice (Glycyrrhiza glabra L. root) extract as an alternative to in-feed antibiotic growth promoter in broiler chickens GSC. Biol. Pharm. Bull., 1: 20–28.

Nicol, C. J.; Brown, S. N.; Glen, E.; Pope, S. J.; Short, F. J.; Waross, P. D.; Zimmerman, P. H. ; and Wilkins, L. J. 2006. Effects of stocking density flock size and management on the welfare of laying hens in single-tier aviaries. Br. Poult. Sci., 47:135–146.

Rezaei, M. ; Kalantar, M. ;and Nasr, J. 2014. Thymus vulgaris l., glycyrrhiza glabra, and combo enzyme in corn or barley-basal diets in broiler chickens. Int. J. Plant, Anim. Environ. Sci., 4:418-423.

SAS., 2004. SAS\STAT Users Guide. Version 9.1 . SAS Inst. I.C., Carry,Nc,USA.

Sedghi, M.; Golian, A.; Kermanshahi, H.; and Ahmadi, H. 2010a. Effect of dietary supplementation of licorice extract and a prebiotic on performance and blood metabolites of broilers. South African J. Anim. Sci., 40: 371-380.

Sedghi, M.; Golian, A.G.H.; and Soleymani, P. 2010b. Effect of dietary supplementation of licorice extract on egg quality and performance of hens. Veterinary Clininal Pathology, 4:933-941.

Shahryar, H.A.; Ahmadzadeh, A.; and Nobakht, A. 2018. Effects of different levels of Licorice (Glycyrrhiza glabra) medicinal plant powder on performance, egg quality and some of serum biochemical parameters in laying hens. Iranian J. Appl. Anim. Sci., 8: 119–124.

Shalaby, M. A.; Ibrahim, H. S.; Mahmoud, E. M.; and Mahmoud, A. F. 2004. Some effects of Glycyrrhiza glabra (liquorice) roots extract on male rats. Egyptian Journal of Natural Toxins, 1: 83-94.

Sharifi, S.D.; Saeedeh, H.; Khorsandi, A.; Khadem, A.; Salehi, A.; and Moslehi, H.R. 2013. The effect of four medicinal plants on the performance, blood biochemical traits and ileal microflora of broiler chicks. Veterinarski arhiv., 83:69-80.

Simitzis, P. E.; Kalogeraki, E.; Goliomytis, M.; Charismiadou, M. A.;Triantaphyllopoulos, K.; Ayoutanti, A., Niforou, K.; , Hager-Theodorides, A.L.; and Deligeorgis, S.G. 2012. Impact of stocking density on broiler growth performance, meat characteristics, behavioural components and indicators of physiological and oxidative stress. Br. Poult. Sci., 53: 721—730.

Sohail, S. S.; Bryant, M. M.; Rao, S. K.; and Roland, D. A. 2001. Influence of cage density and prior dietary phosphorous level on phosphorus requirement of commercial Leghorns. Poult. Sci., 80: 769-775.

Sturkie, P.D. 2000. Avian Physiology. 5thEdition. Springe rVerlag. NewYork. Copy right 2000 by Academic press.

Tang, J. P.; H. Y. Cai; W. H. Chang; G. H. Liu; S. Zhang; R. B. Liao; and H. L. Deng. 2012. Effects of stocking density and dietary energy level on growth performance and meat quality of broilers. Chin. J. Anim. Nutr. 24:239–251.

Tollba, A.A.H.; Rizkalla, H. E.; and Abd El-Samad, M. H. 2006. Effects of stocking density on productive and physiological performance of Egyptian laying chickens. Egypt. Poult. Sci.J., 26: 335-346.

Tominaga, Y.; Tatsumasa, M.; Mitsuaki, K.; Yoshiro, S.; Hideyuki, I. and Nakagawa, N. 2006. Licorice flavonoid oil effect body weight loss by reduction of body fat mass in overweight sub-ject. J. Hlth. Sci., 52: 672-683.

Widowski, T.M.; Classen, H.; Newberry, R.C.; Petrik, M.; SchweanLardner, K.; Cottee, S.Y.; and Cox, B. 2013. Scientists Committee Report on Priority Welfare Issues for Laying Hens, National Farm Animal Care Council.

Widowski, T.M.; Hemsworth, P.H.; Barnett, J.L.; and Rault, J.L. 2016. Laying hen welfare I. Social environment and space, World's Poult. Sci. J., 72: 333-342.

Yadav, A.S.; Kolluri, G.; Gopi, M.; Karthik, K.; Malik, Y.S.; Dhama, K. 2016. Exploring alternatives to antibiotics as health promoting agents in poultry–A review. J. Exp. Biol. Agri. Sci., 4: 368–383.

Yang, J. X.; Chaudhry, M. T.; Yao, J. Y.; Wang, S. N.; Zhou, B.;Wang, M.; Han, C. Y.; You, Y.;and Li, Y. 2018. Effects of phyto-oestrogen quercetin on productive performance, hormones, reproductive organs and apoptotic genes in laying hens. Journal of Animal Physiology and Animal Nutrition, 102: 505–513.

Zhang, H. Y.; Piao, X. S.; Zhang, Q.; Li, P.; Yi, J. Q.; Liu, J. D.; and Wang, G. Q. 2013. The effects of Forsythia suspensa extract and berberine on growth performance, immunity, antioxidant activities, and intestinal microbiota in broilers under high stocking density. Poult. Sci., 92: 1981–1988.

Zhang, M.; C. X. Huang; Q. X. Yue; J. Z. Xi; Z. H. Dai; X. Y. Zhao; and H. Chen. 2018. Effects of stocking density on growth performance, immune organs indexes and serum antioxidant capacity of Dawu Jinfeng commercial layer chicks. China Poult. 40:37–41.

الملخص العربى

تأثير الكثافة و أضافة مسحوق العرقوسوس على الحالة الانتاجية و بعض الصفات الفسيولوجية للدجاجات البياضة

مايسه مصطفى حنفى [١] ، فؤاد أحمد توفيق [١]، ابتسام السيد ابراهيم [١]، محمد السيد فراج[٢]

[١]قسم بحوث تربية الدواجن، معهد بحوث الانتاج الحيوانى، مركز البحوث الزراعية، وزارة الزراعة
[٢]قسم بحوث تغذية الدواجن، معهد بحوث الانتاج الحيوانى، مركز البحوث الزراعية، وزارة الزراعة

أجريت هذة الدراسة بهدف تقليل التأثير السلبي لزيادة الكثافة باضافة مستويات مختلفة من مسحوق العرقسوس لعلف الدجاجات البياضة و تأثير هذه المعاملات على الأداء الانتاجى و الفسيولوجى لدجاجات انشاص البياضة.حيث تمت الدراسة لتجربة عاملية ٣ × ٣ تضمنت ثلاث مستويات من الكثافة (٦-٩-١٢) وثلاث مستويات من مسحوق العرقسوس (صفر- ٥ ,- ١%).أجريت هذه الدراسة على ٢١٦ دجاجة من سلالة انشاص المحلية عمر٤٤ أسبوع قسمت عشوائيا إلي ٩ معاملات وتحتوى المعاملة علي مكررتين وسكنت أثناء فترة التجربة من عمر ٤٤ حتى عمر ٥٦ أسبوع فى أعشاش أرضية ذات أبعاد ٢× ٢ متر. ويمكن تلخيص النتائج المتحصل عليها كما يلى :

وجد أن زيادة كثافة الطيور إلى ١٢طائر / م٢ أدى إلى أنخفاض معنوى فى معظم الصفات الانتاجية وكل من النسبة المئوية للخصوبة و التفريخ للبيض المخصب بالضافة إلى مقايس الدم المدروسة. فى حين أدى خفض كثافة الطيور إلى ٦ و ٩ طائر/ م٢ إلى تفادى التأثير السلبى للكثافة المرتفعة. عموما تم الحصول على أفضل النتائج للصفات السابقة عند تسكين الطيور بكثافة ٩ طائر / م٢.

بصرف النظر عن كثافة الطيور فقد وجد أن أضافة العرقسوس أدى إلى ارنفاع معنوى فى كل من انتاج البيض بالاضافة إلى عدد ووزن و كتلة البيضة مع حدوث تحسن فى كفاءة التحويل الغذائى . في حين لم يتأثر معنويا كمية الغذاء المستهلك. بالأضافة إلى ماسبق فقد أدى أضافة العرقسوس إلى تحسن فى نسب الخصوبة والفقس وصفات جودة البيضة (سمك القشرة- وحدات هاف - لون الصفار) بالاضافة إلى معظم صفات الدم المدروسة. عموما تم الحصول على أفضل النتائج للصفات السابقة باضافة ٥, % عرقسوس للعلف.

فيما يتعلق بالتداخل بين كثافة الطيور و مستوى الأضافة للعرقسوس فقد تم الحصول على أفضل النتائج لمعدل انتاج البيض ووزن البيضة وكفاءة تحويل الغذاء و الكفاءة الاقتصادية و أقل غذاء مستهلك باستخدام كثافة طيور بمعدل ٩ طائر/ م٢ مع أضافة ٥,% عرقسوس للعلف كما حققت نفس المعاملة السابقة أفضل القيم لصفات الدم و أقل تركيز للدهون الكلية و LDL.

التوصية توضح هذه الدراسة ان تسكين دجاج انشاص المربي فى أعشاش أرضية بمعدل ٩ طائر / م٢ مع أضافة ٥, % مسحوق العرقسوس للعلف يؤدى إلى تحسين صفات الانتاج و الحصول على أعلى كفاءة أقتصادية.