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AN ATTEMPT TO IMPROVE THE PRODUCTIVE PERFORMANCE, HATCHING TRAITS AND BLOOD INDICES OF LAYING HENS DURING SUMMER SEASON BY ADDING LICORICE TO THE DIET

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

1Poult.Breed. Res. Dep., Anim. Prod. Res. Inst., Agric. Res. Center, Egypt

2Poult.Nutr. Res. Dept., Anim. Prod. Res. Inst., Agric. Res. Center, Egypt

Corresponding author: Maysa, M.Hanafy1 Email: maysam_hanafy@yahoo.com

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ABSTRACT: This study aimed to evaluate the effectiveness of dietary licorice supplementation on productive and reproductive performance with physiological response of Inshas local chicken strain in summer months. A total of one hundred and ninety two laying hens of Inshas local strain at 36 weeks of age were housed in floor pens and randomly distributed into four treatment groups. Each treatment consisted of 48 females in three replicates, with 16 hens per replicate. Birds in control group were fed on a basal diet without any additives, while, other treatments were fed basal diet supplemented with 0.5% , 1.0 % and 1.5 % licorice powder, respectively. The experiment was conducted under summer condition in Egypt and commenced eight weeks through July and August months. According to the results, supplementation the diets of laying hens with licorice powder significantly increased productive performance (egg production, egg weight and egg mass). Also, feed conversion ratio was improved for all treatments compared to control group, while there were no significant differences with regard to feed consumption. In addition, all studied concentrations of licorice powder significantly improved percentages of fertility and hatchability of fertile eggs compared to control. Besides, concentration of 1 and 1.5% licorice powder significantly enhanced hatched chick weight compared to those for control group. Moreover, some egg quality traits such as yolk index, shell thickness and Haugh unit had been significantly improved with all concentrations of licorice powder supplementation, while yolk colour had been improved with 1.0 % and 1.5 % licorice powder only. Values of RBC's, WBC's , Hb, globulin, total antioxidant capacity and HDL were significantly increased by supplementing the diet with all experimental concentrations of licorice powder compared with those for control. Moreover, values of packed cell volume and plasma calcium represented the same significant increase response of licorice except that with 0.5% , while, H/L ratio, total lipids, cholesterol and LDL were significantly decreased due to all studied licorice concentrations compared to control.

In conclusion, supplementing the diet of laying hens in summer season with concentrations of 1.0 or 1.5 % licorice powder could be a good tool for maximizing productivity and reproductivity coincided with improving blood parameters and lipid profile.

Key words: Licorice ,Summer season ,Performance,Blood constituents, Laying hens

INTRODUCTION

Heat stress is considered one of the most important environmental stresses to which poultry are exposed worldwide and it is defined as continuous exposure to thermal disturbances (Lara and Rostagno, 2013). Exposing birds to heat stress increase the production of free radicals, which in turn causes cell damage and metabolic disorders (Hassan et al., 2016). Elnagar et al.(2010) found an increase in blood PH, which hinders the presence of bicarbonate in the blood, which is necessary for the formation of eggshells, and thus the level of calcium in the blood decreases and affects egg shell quality. Also, heat stress affects the levels of reproductive hormones and the absorption of calcium from the stomach, especially for females, through disrupting the normal state of hormones in the ovaries and thus reduces the levels and function of the system (Rozenboim et al.,2007). Moreover, heat stress had negative effect on egg production, feed conversion, fertility, hatchability and blood parameters (Fouad et al., 2016; Farghly et al., 2019).

Several methods are available to alleviate the negative effects of hot weather, mostly focused on dietary manipulation. Medicinal plants are one of the methods being studied to determine their effects during hot weather (Al-Khateeb and Al-Sufi, 2023). Licorice (*Glycyrrhizaglabra*) is an important herb and it is native to Eurasia, North Africa and West Asia (Pastorino et al., 2018). It contains many compounds that are closely related to reducing heat stress on birds, including glycyrrhizin, glycyrrhetinic acid, flavonoids, isoflavones and triterpenoid saponins (Wang et al., 2015). Glycyrrhizin contains a structure similar to adrenal steroid hormones (corticosteroids and adrenocorticotropic hormones) (Shibata, 2000). Also, it helps to increase energy because the taste of licorice is sweeter than sucrose (Vlaicu et al.,2021). Licorice powder has antioxidant properties as it works as a scavenger of free radicals (Saxena,2005). As for the flavonoids, it works to increase the period of activity of vitamin C inside the body, which in turn works to increase the tolerance of birds to heat stress and resistance to the factors causing it (Al–Daraji et al., 2006).

Gowthaman et al. (2021) attributed the improvement of feed conversion ratio and average body weight to adding liquorice root extract (200 ppm) and probiotic (1%) in diet of quails. Moreover, Hanafy et al. (2022) pointed out the improvement of performance traits, fertility, hatchability percentages, egg shell thickness and lipid profile in Inshas local chicken strain supplemented with 0.5% licorice powder.

The present experiment was undertaken to evaluate the ability of licorice in the diet of laying Inshas chickens for facing the heat stress of the summer months in Egypt and studying the productive performance, hatching traits and biochemical blood parameters under this circumstances.

MATERIALS AND METHODS

The present experiment was conducted at Sakha Poultry Research Station, Animal Production Research Institute, Agriculture Research Center, Giza, Egypt. A total of one hundred and ninty two laying hens of Inshas local strain at 36 weeks of age were housed in pens with dimensions of 2 × 2 m and randomly distributed randomly into four treatment groups. Each treatment was consisted of 48 females in three replicates, Each pen represents replicate (16 hens). Birds in control group were fed on a basal diet without any supplementation, the other three treatments were fed basal diet supplemented with 0.5,1.0 and 1.5 % licorice powder, respectively. All experimental birds were raised during the months of July and August as summer conditions. The temperature ranged between 30-32 °C and 65-70 % relative

humidity (RH). The experiment lasted 8 weeks from 36 - 44 weeks of age. Birds were fed a commercial layer diet (16.97% crude protein and 2777 kcal ME/Kg) according to the recommendation of Animal Production Researsh Institue (Table 1). Feed and water were supplied *ad libitum* throughout the experimental period. The birds received 16 hours of light and 8 hours of darkness during the experimental period.

Data Collection and Estimated Parameters:

Laying performance traits:

Eggs were collected and recorded daily, the percentage of egg production for each hen was calculated as hen day egg production. Also, Eggs were individually weighed daily to the nearest 0.1 g for each replicate. Egg mass was calculated by multiplying the number of eggs by average egg weight per hen (g/hen/day). Feed consumption was calculated every week for each replicate. Feed conversion ratio was calculated as amount of consumed feed (gm) required for producing a unit (gm) of egg mass (g feed/ g egg). Also, final live body weight (g) were individually estimated at 44 weeks of age.

The reproduction traits:

Hens were inseminated twice a week with diluted semen (1:1) from cocks that received the same treated diets from 41 to 44 weeks of age. Hatching eggs were collected daily from each group at 42, 43 and 44 weeks of age. A total of 1600 hatching eggs representing the four experimental dietary groups were incubated in Egyptian-made incubator at 37.8°C and 55% RH during incubation and transferred to hatcher operated at 37.2°C and 65% RH. Macroscopic 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. All percentages data of hatchability were subjected to arcsine square root percentage transformation prior to analyses. Hatched chicks were weighed to nearest gram on the day of hatch .

Egg quality parameters:

A total number of 96 eggs (24 from each treatment) were randomly taken at 40 and 44 weeks of age (8 eggs/pen) to determine some egg quality parameters. Eggs were weighted with gram and egg shape index was calculated by dividing the egg width on the egg length and multiplied by 100**.** Eggs were individually broken out, the height of yolk and albumen were measured by using tripod micrometer and caliper with a vernire scale to the nearest 0.1 mm. Albumen, yolk and shell weights were measured to the nearest 0.1 gm and their relative weights were calculated as percentage of egg weight. The yolk index was estimated by dividing the height of yolk on its diameter and multiplyed by 100. Egg shell thickness with membrane was measured for three equatorial regions using a manual micrometer. The Haugh units were calculated on the basis of the individual egg weight and the albumen height. The yolk colour score was determined by comparing with the roch yolk colour (RYC) fan (F.Hoffmann – La – Roche Ltd., Basal , Switzerland).

Blood hematology and biochemical constituents

At 44 wk of age, thirty six blood samples were randomly taken from the branchial wing vein in heparinized tubes from 9 hens from each dietary treatment (3 hens / replicate) at 9:00 AM before access to feed and water. Half of the blood samples were taken to measure red blood cells (RBC's) (10^6/mm^3), white blood cells (WBC's) (10^3/mm^3) counts, heterophil (H) % , lymphocyte (L) %, hemoglobin (Hb) (g/dl) and packed cell volume (PCV) %. The other blood samples were centrifuged at 3000 rpm for 20 minutes to obtain the plasma, and then stored at -20 ˚C. Plasma total protein (g/dl), albumin (g/dl), aspartate amino transaminase

(AST) (U/L), alanine amino transaminase (ALT) (U/L) , calcium (Ca) (mg/dl), phosphorus (P) (mg/dl), total antioxidant capacity (TAC) (mg/dl), total lipids (mg/dl), cholesterol (mg/dl), LDL (mg/dl) and HDL (mg/dl) were measured by using available commercial kits. Globulin values (g/dl) were obtained by substracting the values of albumin from the corresponding values of total protein,

Statistical analyses

Data were statistically analysed according to the SAS (2004). Statistical analysis was performed using one-way ANOVA. Significant differences among treatment groups were subjected to Duncan's Multiple (Duncan, 1955). Results were considered significant at $p \leq 0.05$. The statistical model used was as follows:

$X_{ij} = \mu + T_I + e^{ij}$

Where: x_{ij} is the value of the measured variable, μ is the overall mean, T_i is the effect of treatment (i= 4 treatments), and e_{ij} is the random error.

RESULTS AND DISCUSSION

Laying Performance Traits:

Productive parameters were influenced by licorice supplementation for Inshas laying hens during summer months as apparent in Table 2. The results of this research proved that the addition of licorice powder to the diet during hot weather led to a significant increase in egg production (%), egg weight (g) and egg mass (g/hen/day) compared to those for control group. Also, feed conversion ratio had been improved, while there were no significant differences between the groups with respect to feed consumption. The results also indicated that 1% licorice is best concentration for improving all mentioned parameters of productivity , followed by 1.5% and 0.5%.

It appears from the current results that laying performance traits (egg production, egg weight, egg mass and feed conversion ratio) showed good response to dietary treatment licorice powder under stress, and this could be due to that licorice powder plays a role similar to that of corticosterone and adrenocorticotropic hormones and hence its role in improving the resistance of body to stress as drawn by Al-Daraji (2012), Also, it contains flavonoids that plays an important role in improving organ growth (Yang et al., 2018) and increasing the duration of vitamin C activity in the body, as vitamin C plays an effective role in increasing resistanceof birds to heat stress (Al-Khateeb and Al-Sufi, 2023). Moreover, the results of feed consumption in this research are consistent with those obtained by Sedghi et al. (2010) who stated that adding licorice powder at levels of 0.5, 1.0 , or 2 g / kg diet had no significant effect on feed consumption. Also, licorice root powder significantly improved all laying productive performance at 500 up to 1000 mg in diets compared with that fed basal diet under hot conditions in quail (Waleed et al., 2021). Furthermore, Hanafy et al. (2022) suggested that addition of licorice to the diet significantly increased laying performance traits and improved feed conversion but feed consumption was not affected. Whereas, Dogan et al. (2018) mentioned that the licorice root supplementation decreased ($p \leq 0.05$) feed consumption with increasing licorice root concentration, also, egg weight and feed conversion ratio did not represent any significant change.

Final Body Weight and Reproduction Traits

Data of final body weight and reproduction traits as affected by supplementation of licorice powder in the diet of Inshas chickens during summer season are presented in Table 3. Final body weight was significantly increased ($p \leq 0.05$) due to supplementation with 0.5% licorice compared with those for control and 1% licorice groups. These results are in line with these reported by Cook and Samman (1996) who found improvement ($p<0.05$) in the average live

body weight with adding licorice extract at 450 mg / liter of water for broilers exposed to heat stress. Also, Abd El-Hakim and Abd El-Magied (2009) indicated that supplementation licorice at 0.25 and 0.5% to the diets led to a significant increased in body weight of broilers in the summer. Additionally, the highest body weight was observed for group that fed diet supplemented with 1 g/kg licorice root extract at sixth week in broilers reviewed by Amen and Muhammad (2016). Also, Jena et al. (2022) stated that high ambient temperatures have an antagonistic effect on performance and feed supplementation with licorice powder at the dose rate of 1000 mg/kg reduced the stress and growth retardation due to high ambient temperature and humidity in ducks.

Also, we observed from data of Table 3 that body weights for hens fed on 1% and 1.5% licoricewere decreased compared with those for 0.5% licorice group. Some researchers indicated that body weight decrease is related to the increase of licorice powder concentration, and this is due to flavonoids that found in licorice, which reduce body fat content and thus reduce body weight (Nakagawa et al., 2004; Tominaga et al., 2006).

Data of fertility (%), hatchability of fertile eggs (%) in Table 3 represented significant ($p \leq 0.01$) improvement with addition of 1.5 % licorice powder compared with those for other studied experimental concentrations and control. In addition, both concentrations of 1.0 and 1.5 % licorice significantly enhanced chick body weight at hatch compared to control. The observed increase of hatched chick weight for 1% licorice group compared to the others could be due to the increase of egg weight as supported by Abiola (1999) who pointed that there is a close correlation between the weight of hatched eggs and the weight of chick. Also, Mcloughlin and Gous (1999) demonstrated that offsprings with small hatched chick weight were produced from small eggs compared to those from larger ones. Improving aforementioned traits by adding licorice under hot conditions might be due to the fact that licorice powder contains substances such as glycerin, which turns into glycerinic acid in the acidic medium and glycerinic acid acts as cortisone in its effectiveness against stress factors due to the similarity of their structural structure as previously documented by Al–Daraji et al. (2006). Licorice extract also contains water-soluble vitamins (B_6, B_3, B_2, B_1) and an important mineral elements (calcium, cobalt, iron, zinc, tin, magnesium and phosphorous), which are involved in formationand motivation many hormones and enzymes necessary for the vital processes in the body (Yang et al., 2018). The present results are in accordance with the findings of Al-Daraji and Ameen (2007) who found a significant increase ($p \leq 0.05$) in the hatchability of fertile eggs when adding licorice powder with 2 mg/ 100 ml of diluents to the semen diluents. Moreover, Hanafyet al. (2022) reported that there was significant improvement in fertility and hatchability of fertile eggs percentages by licorice supplementation in diet for Inshas local strain under normal condition.

Egg quality parameters

Mentioned data in Table 4 revealed that dietary supplementation of licorice powder had no significant influence on the following parameters of egg quality: egg shape index, yolk weight (%), albumen weight (%) and shell weight (%). Whereas, eggs produced from hens fed diet enriched with licorice powder represented significant improvement in yolk index ($p \leq 0.05$), shell thickness and Haugh unit ($p \leq 0.01$) compared with those produced from control group. In addition, licorice supplementation with 1% or 1.5% increased ($p \leq 0.01$) yolk color compared to control group.

Different researchers supported the current effect of licorice supplementation on egg quality parameters. Ghasemi et al. (2010) reported that yolk color increased with increasing levels of licorice powder. Also, Sedghi et al. (2010) concluded that egg shell thickness improved by using licorice extract in the diet. The improvement of eggshell thickness is due to that licorice powder contains flavonoids, which regulate calcium metabolism (Liu et al., 2013). In addition, Badr et al. (2013) indicated that licorice extract contains a high concentration of calcium (1720 mg/100 g). Shahryar et al. (2018) reported that adding licorice powder at 2% improved egg shell thickness, haugh unit and yolk color index. Moreover, Hanafy et al. (2022) proved that licorice supplementation to laying hen diets significantly ($p \leq 0.05$) improved eggshell thickness, Haugh unit score and egg yolk color .

Hematological Parameters

Data of Table 5 illustrate that RBC's, WBC's and Hb values were significantly increased by supplementing the diet with all experimental concentrations of licorice powder compared with those for control in summer season condition. Whereas, PCV % represented the same significant increase response except that with 0.5%. On the contrary, heterophils and H/L ratio were significantly decreased with all studied concentrations of licorice powder compared to control. Besides, licorice supplementation had no significant influence on lymphocytes values % for Inshas laying hens. The improvement of the studied hematological parameters in this study due to supplementing the diet with licorice powder is keeping with previous mentioned researches, Al-Daraji (2012) cited that licorice powder addition for broilers kept in heat stress significantly increased WBC's, RBC's , PCV , while reduced significantly the H/L ratio. Also, Licorice increasing WBC via stimulate their production in the body, so enhance immunity. On similar lines, Amen and Muhammad (2016) mentioned that licorice powder supplementation significantly increased most of hematological parameters as WBC's, RBC's, PCV and Hb. In addition, increasing values ($p \leq 0.01$) of RBC's, WBC's, Hb and PCV were observed by adding licorice powder to the diet (Hanafy et al., 2022). Also, Toson et al. (2023) suggested that supplementing 2 and 3 g licorice extract/kg diet led to a higher value of haemoglobin, while there was significant ($p \leq 0.01$) decrease in heterophils and heterophils / lymphocytes ratio comparing with control group in broiler. While, other researchers (Moradi et al., 2014; Sedghi et al., 2010) have proven that there is no effect on values of lymphocytes, heterophils, monocytes, or H/L ratio by licorice supplementation in broilers. Also, Al-Sofee (2018) confirmed that adding licorice in the diet did not significantly affect the PCV of Japanese quail.

Biochemical Constituents

Licorice supplementation at different levels to diets of laying hens led to a significant decrease in concentration of plasma albumin compared to control group. While, there was a significant increase in plasma globulin and total antioxidant capacity with the nutritional addition (Table 6). Also, the best concentrations of licorice powder were 1.0and 1.5 % that led to an increase ($p \leq 0.05$) plasma calcium concentration values compared to non supplemented group. There was no significant effect of licorice supplementation on concentration of plasma total protein,AST, ALT and P. Similar to the present results, Abdul-Majeed (2019) indicated that valus of total protein in blood serum did not change with addition of licorice powder in Japanese quail. Moreover, the significant decrease in plasma albumin for hens supplemented with licorice related to

that licorice powder acts in a role similar to corticosteroids and adrenocorticotropic hormones, which has elicited gluconeogenesis (Malheiros et al., 2003). In addition, Razaei et al. (2014) observed that the highest values in concentration of globulin was for chicks fed diets supplemented with licorice extract that cause improvement in immune responses. It is also noted by Reda et al. (2021) that adding licorice had no significant effect on levels of ALT and AST, proposing that licorice is non-toxic and does not cause weakness in animals. Licorice powder contains Glycyrrhizin that consists of glycyrrhetinic acid and it includes calcium and potassium salts in its composition (Abdel Hafez, 2006).

The improvements in plasma total antioxidant capacity of Inshas local strain fed licorice powder in hot weather may be linked tolicorice components (flavonoids, saponins, sugars, coumarins, amino acids, starch, tannins, phytosterols, choline, and vitamins) as previously stated by Karahan et al. (2016) and Pastorino et al. (2018). Furthermore, licorice addition affected antioxidant activity of birds by altering the genes associated with antioxidant-related pathways as demonstrated by Abo-Samaha et al. (2022). This conclusion is keeping with those mentioned by different authers as Reda et al. (2021) and Hanafy et al. (2022) indicated that licorice supplementation produced higher levels of TAC compared with non supplemented group. Also, Toson et al. (2023) supported higher value of plasma antioxidant concentration for broilers in the supplemented groups with 2 and 3 g licorice /kg diet.

Lipid profile

Mentioned data in Table 7 revealed that adding licorice powder at different concentrations (0.5%, 1% and 1.5%) in diets of Inshas laying hens during summer months significantly decreased ($p \leq 0.01$) levels of plasma total lipids, cholesterol and LDL, while plasma HDL was increased ($p \leq 0.01$) compared to control group with preferable concentration of 1% licorice powder. The lowest plasma total lipids, cholesterol and LDL for groups fed licorice powder could be due to the role of licorice as enzymes inhibitor like cyclooxygenase and lipoxygenase, which in turn inhibit lipid peroxidationand thusprotects LDL cholesterol from oxidation, also licorice has hypo-cholesterolemia property as previously documented by Fuhrman et al. (2002). Moreover, Sharifi et al. (2013) observed that increasing values of plasma HDL attributed to that licorice cause a decrease in 3-hydroxy-3-Methylglutaryl COA enzyme synthesis. Also, this enzyme is considered one of the important and essential enzyme responsible for the synthesis of cholesterol in the liver. The results reported herein are supported by Visavadiya and Narasimhacharya (2006) who suggested that adding 5 and 10% licorice root in diets of rabbits significantly reduced plasma total lipid, cholesterol and LDL, while HDL-cholesterol content increased. Furthermore, Sedghi et al. (2010) showed that the lowest values of plasma cholesterol was for laying hens fed 0.6% licorice extract in the diets. Also, addition of licorice root extract in water at 0.2 and 0.4% increased ($p \leq 0.05$) values of plasma HDL (Salary et al., 2014). Moreover, Khamisabadi et al. (2014) and Moradi et al. (2017) proved that there was significant reduction in serum LDL and cholesterol values for group of 0.3% licorice extract, while, HDL did not represent any significant change. In addition, using 2% of licorice powder as high level decreased LDL and cholesterol (Shahryar et al., 2018). Moreover, Abdul Majeed (2019) demonstrated that different levels of licorice supplementation significantly decreased values of plasma total lipids andcholesterol compared to the control

group in Japanese quail. Also, Hanafy et al. (2022) reached to the same results and interpreted the decrease in total lipids, cholesterol and LDL in blood plasma is due to that the licorice powder containing saponin, which converts cholesterol into bile acids, which in turn eliminates cholesterol in the body and facilitates the absorption of fat-soluble vitamins by elmulsifying them. Also, the same authors found that the increase in plasma HDL is due that licorice powder contains ascorbic acid and flavonoids.

CONCLUSION

Considering the importance of avian welfare, dietary manipulation, as a powerful practical approach applied during summer months, has proven to improve several physiological, antioxidative and immunological statuses of laying hens, including adding licorice powder in diets. According to the current findings, licorice powder supplementation at 1.0 or 1.5 % in diets is considered effective to combat heat stress in birds by increasing the hens' resistance to high ambient temperature, in addition increasing the productive performance, hatching traits, egg quality, blood constituents and lipid profile under summer condition.

Table (1): Composition and the nutritive value of the basal diets

Ingredients	**%**
Yellow corn	66.33
Soybean meal (44%)	24.2
Dicalcium phosphate	1.32
Limestone	7.5
Salt (Nacl)	0.25
DL – methionine	0.15
Vit& Min mix.*	0.25
Total	100.00
Calculated analysis:	
Metabolizable energy (Kcal/kg)	2777
Crude protein %	16.97
Calcium %	3. 1
Available phosphate %	0.37
Methionine % + cyctine %	0.67
Lysine %	0. 8

* Composition of premix per kilogram diet is : Vit. A, 10.000 IU ; Vit . D3, 100.000 IU ; Vit E , 10.000 mg ; Vit. E,10.000 mg; Vit. K3,1.000 mg; Vit . B1 , 1 mg ; Vit . B2 , 4 mg ; Vit B6 ,1.5 mg ; Vit . B12 , 10 mcg ; Niacin , 20.000 mg ; Pantothenic acid 10.000 mg ; Folic acid , 1 mg ; Biotin , 50 mg ; Choline chloride , 500 mg ; Copper , 4 mg ; Iron , 30 mg ; Manganese , 40.000 mg ; Zinc , 45.000 mg ; Cu , 3.000 mg ; Iodine , 300 mg ; Selenium , 0.1 mg ; Cobalt , 0.1 mg .

Table (2): The impact of licorice powder supplementation on productive parameters of Inshas chickens during summer months

Licorice supplementation (%)	Egg production (%)	Egg weight (g)	Egg mass (g/hen/day)	Feed consumption (g/hen/day)	Feed conversion ratio (g feed/g egg)
0.0	57.12^{c}	49.00^{c}	31.21^{b}	118.70	3.81^{a}
0.5	71.47^{b}	52.48^{b}	37.46^{a}	118.65	3.17^{b}
1.0	74.22^{a}	52.79^{a}	38.91^{a}	118.71	3.06^{b}
1.5	73.52^{a}	52.58^{ab}	38.28^{a}	119.24	3.13^{b}
SEM	0.425	0.066	0.491	0.178	0.047
P	**	**	**	N.S.	**

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

Table (3): The impact of licorice powder supplementation on final body weight and hatching traits of Inshas chickens during summer months

Licorice supplementation (%)	Final body weight (g)	Macroscopic fertility (%)	Hatchability of fertile eggs (%)	Chick weight (g)
0.0	1723.54^{b}	84.00^{d}	69.23^{d}	31.95^{c}
0.5	1764.17^{a}	88.00^{b}	73.17^{c}	32.92^{bc}
1.0	1733.75^{b}	86.00^{c}	73.81^{b}	34.35^{a}
1.5	1744.38^{ab}	90.00^{a}	80.00^{a}	33.25^{ab}
SEM	9.776	0.674	1.162	0.213
P	*	**	**	**

^{a,b,c,d} Means within a column with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). SEM= Standard error of means. P= Probability level.

Table (4): The impact of licorice powder supplementation on egg quality traits of Inshas chickens during summer months

Licorice supplementation (%)	Egg shape index	Yolk weight (%)	Albumen weight (%)	Shell weight (%)	Yolk index (%)	Shell thickness with membranes (mm)	Haugh unit	Yolk color
0.0	73.03	33.70	52.89	13.41	45.94^{b}	35.60^{c}	71.53^{b}	7.50^{b}
0.5	73.08	32.50	53.53	13.97	49.38^{a}	37.95^{b}	77.03^{a}	7.90^{ab}
1.0	73.11	30.94	55.76	13.30	49.30^{a}	39.35^{ab}	78.81^{a}	8.15^{a}
1.5	73.05	31.50	54.74	13.76	49.10^{a}	40.55^{a}	78.63^{a}	8.15^{a}
SEM	0.363	0.386	0.444	0.105	3.400	0.357	0.529	0.083
P	N.S.	N.S.	N.S.	N.S.	*	**	**	**

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

Table (5): The impact of licorice powder supplementation on hematological parameters of Inshas chickens during summer months

Licorice supplementation (%)	RBC's (10^6/mm^3)	WBC's (10^3/mm^3)	H (%)	L (%)	H/L ratio	Hb (g/dl)	PCV (%)
0.0	1.60^{c}	3.60^{c}	35.00^{a}	70.00	0.501^{a}	9.33^{b}	34.33^{c}
0.5	2.16^{b}	4.97^{b}	30.67^{b}	70.00	0.438^{b}	10.80^{a}	35.67^{bc}
1.0	3.04^{a}	6.27^{a}	26.00^{c}	63.67	0.409^{b}	11.67^{a}	39.33^{a}
1.5	2.84^{a}	5.73^{ab}	26.67^{c}	63.33	0.421^{b}	11.37^{a}	39.00^{ab}
SEM	0.174	0.319	1.164	1.332	0.013	0.319	0.783
P	**	**	**	N.S.	*	*	*

^{a,b,c} Means within a column with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS = Not significant. SEM= Standard error of means. P = Probability level. RBC's = Red blood cells. WBC's = White blood cells. H= Heterophils. L= Lymphocytes. H/L= Heterophils: Lymphocytes. Hb= Hemoglobin. PCV= Packed cell volume.

Table (6): The impact of licorice powder supplementation on blood constituents of Inshas chickens during summer months

Licorice supplementation (%)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	AST (U/L)	ALT (U/L)	Ca (mg/dl)	P (mg/dl)	TAC (mg/dl)
0.0	4.91	3.14^{a}	1.77^{b}	65.00	34.33	12.98^{c}	6.42	1.41^{b}
0.5	5.17	2.61^{b}	2.56^{a}	63.33	34.67	13.25^{bc}	6.39	2.23^{a}
1.0	5.64	2.74^{b}	2.90^{a}	65.33	34.67	13.95^{a}	7.44	2.56^{a}
1.5	5.28	2.77^{b}	2.50^{a}	63.33	36.33	13.70^{ab}	7.24	2.46^{a}
SEM	0.133	0.074	0.152	2.089	1.320	0.143	0.234	0.149
P	N.S.	*	*	N.S.	N.S.	*	N.S.	**

^{a,b,c} Means within a column with different superscripts are significantly different (P≤0.05). * = (P≤0.05). ** = (P≤0.01). NS = Not significant. SEM= Standard error of means. P = Probability level.AST= Asparatateaminotransamenase. ALT = Alanine aminotransamenase. Ca=Calcium. P = Phosphorus. TAC=Total antioxidants capacity.

Table (7): The impact of licorice powder supplementation on lipid profile of Inshas chickens during summer months

Licorice supplementation (%)	Total lipids (mg/dl)	Cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)
0.0	280.00^{a}	208.33^{a}	98.33^{a}	42.33^{c}
0.5	248.67^{b}	177.67^{b}	71.67^{b}	51.67^{b}
1.0	216.67^{c}	148.00^{c}	69.33^{b}	60.00^{a}
1.5	227.67^{bc}	173.33^{b}	75.00^{b}	57.00^{ab}
SEM	8.247	6.688	3.956	2.226
P	**	**	**	**

^{a,b,c} Means within a column with different superscripts are significantly different (P≤0.05). ** = (P≤0.01). SEM= Standard error of means. P = Probability level.HDL= High density lipoprotein. LDL= Low density lipoprotein.

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الملخص العربى

محاولة لتحسين الأداء الانتاجى وصفات الفقس و مؤشرات الدم فى الدجاج البياض خلال فصل الصيف عن طريق اضافة العرقسوس الى العلف

مايسة مصطفى حنفى[1] ، ابتسام السيد ابراهيم [1]، محمد السيد فراج [2]، فؤاد أحمد توفيق[1]

[1]قسم بحوث تربية الدواجن ، معهد بحوث الانتاج الحيوانى ، مركز البحوث الزراعية ، وزارة الزراعة .

[2]قسم بحوث تغذية الدواجن ، معهد بحوث الانتاج الحيوانى ، مركز البحوث الزراعية ، وزارة الزراعة .

استهدفت هذه الدراسة تقييم مدى فعالية اضافة العرقسوس على الأداء الانتاجي والتناسلي و الاستجابة الفسيولوجية لدجاج سلالة أنشاص المحلية فى أشهر الصيف. تم تسكين 192 دجاجة بياضة من سلالة أنشاص المحلية بعمر 36 اسبوع فى أعشاش أرضية و تم توزيعها عشوائيا الى أربع مجموعات . تتكون كل معاملة من 48 أنثى فى ثلاث مكررات، بواقع 16 دجاجة لكل مكررة . تم تغذية الطيور في المجموعة الكنترول على عليقة أساسية بدون أية اضافات ، بينما غذيت طيور المعاملات الأخرى على العليقة الأساسية المضاف اليها 0,5 ، 1 ، 1,5 % مسحوق العرقسوس على التوالى . أجريت التجربة فى ظل ظروف الصيف فى مصر و استغرقت 8 أسابيع خلال شهرى يوليو و أغسطس . ووفقا للنتائج ، فان اضافة مسحوق العرقسوس الى علائق الدجاج البياض أدى الى زيادة معنوية فى الأداء الانتاجى (انتاج البيض ووزن البيض وكتلة البيض). كما تحسن معدل التحويل الغذائى لكل المعاملات مقارنة بمجموعة الكنترول ، فى حين لم تكن هناك فروق معنوية فى استهلاك العلف . بالأضافة الى ذلك أدت جميع التركيزات المدروسة من مسحوق العرقسوس الى تحسين نسب الخصوبة و الفقس للبيض المخصب مقارنة بالكنترول . علاوة على ذلك ، فان تركيز 1 و 1,5 % من مسحوق العرقسوس أدى الى زيادة كبيرة فى وزن الكتاكيت الفاقسة مقارنة بتلك الموجودة فى مجموعة الكنترول . اضافة الى ذلك ، فقد تحسنت معنويا بعض صفات جودة البيض مثل دليل الصفار و سمك القشرة و وحدة هوف للالبيومين مع جميع تركيزات مسحوق العرقسوس المستخدمة ، بينما تحسن لون الصفار مع اضافة كل من تركيز 1 و 1,5 % مسحوق العرقسوس فقط. وجدت زيادة معنوية فى قيم RBC's , WBC's والهيموجلوبين و الجلوبيولين و مضادات الأكسدة الكلية و قيم ال HDL باضافة كل تركيزات مسحوق العرقسوس التجريبية الى العلف مقارنة بالكنترول . علاوة على ذلك ، أظهرت كذلك قيم كل من حجم كرات الدم و كالسيوم البلازما نفس الزيادة المعنوية لكل تركيزات العرقسوس المضافة عدا التى لتركيز 0,5 % ، بينما انخفضت معنويا قيم كل من H/L والدهون الكلية و الكوليسترول و LDL نتيجة لكل تركيزات العرقسوس المدروسة مقارنة بالكنترول ومن ذلك نستنتج أن اضافة العرقسوس الى علف الدجاج البياض بتركيزات 1 و 1,5 % وخاصة فى فصل الصيف يمكن أن يكون أداة جيدة لتعظيم العائد من الأداء الانتاجى و التناسلى مع تحسين قياسات الدم و مؤشرات الدهون .