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Effects of *Salvia officinalis* on Production Characteristics of Laying Hens

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ABSTRACT

Due to the extreme importance of the poultry industry in securing animal proteins for humans, it is necessary to expand the research related to increasing egg production without resorting to antibiotics, which pose significant drawbacks. This study explored the impact of sage plant extracts, known for their bioactive compounds, on the production indicators of laying hens. Thirty chickens were randomly assigned to three groups, including a control group and two experimental groups (T1 and T2) receiving sage plant aqueous extract at 0.1% and 0.2% in their diets, respectively. The egg production percentage, egg weight percentage, percentage of daily feed consumption, feed conversion coefficient, and blood calcium concentrations were measured. The results indicated that supplementation of sage extract in the diet of the laying hens under study increased daily egg production percentage and daily egg yield significantly in group T2 (87.63%, 59.7 eggs/day) and improved average egg weight (68.23 grams) in group T1. Moreover, there was no significant difference in daily feed consumption among the tested hens. A notable reduction was also observed in the feed conversion ratio to 2.09 in group T2.

Keywords: Feed additive, Laying hen, Plant extract, Productivity, Sage

INTRODUCTION

The poultry industry plays a vital role in meeting the growing global demand for animal protein owing to the rapid growth rate and efficiency of poultry in food conversion, especially considering the possibility of large numbers of high-density farming in relatively small areas. In line with the global trend, it is recommended to limit the use of antibiotics as growth-stimulating agents in poultry feed due to concerns over residual effects in poultry products and associated side effects that harm human health (Grashorn, 2010). In addition to the emergence of bacterial strains showing resistance to antibiotics, extensive research has been conducted on the use of natural plants and their extracts as safe and effective alternatives to antibiotics. These alternatives aimed to enhance the immunity of poultry (Mustafa and Ihsan, 2022a) and thus improve their productivity represented by growth rates and increased egg production.

Recent studies have indicated that aromatic plants and their extracts, when added to poultry diets, can effectively address current challenges in laying hens' productivity (Galamatis et al., 2021) primarily due to their antioxidant and antimicrobial properties (Khater, 2022).

The use of medicinal plants dates back many centuries, with certain species actively integrated into human life (Datta and Patil, 2020). Nowadays, however, medicinal plants are widely recognized as phytogenic feed additives in poultry nutrition (Karaskova et al., 2015). It worth noting that Sage is considered a medicinal plant that has been known since ancient times for its healing properties in poultry due to its rich profile of active compounds, particularly its polyphenols.

The European Union has banned the use of antibiotics as growth stimulators due to the emergence of bacterial resistance to them. Moreover, using antibiotics has led to the destruction of beneficial intestinal microbes, which has spurred research efforts to find alternative approaches

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(Palamidi et al., 2017) in poultry nutrition to improve the productive qualities of growth and increase egg production without having negative consequences for human or avian health. As a result, medicinal plants have become essential additives in poultry diets. The investigation of the effect of medicinal plants (Aroche et al., 2018), including powder, essential oils, and oil extract as growth-stimulating substances, antioxidants and immune system enhancers, is an active area of poultry research (Mustafa and Ihsan, 2022b).

Therefore, the present study aimed to evaluate the effect of adding an aqueous extract of sage on the egg production parameters, as well as its influence on feed consumption, feed conversion coefficient, and blood calcium concentrations in laying hens.

MATERIALS AND METHODS

Ethical approval

The present study was conducted and approved by the Animal Care and Use Committee of Saydnaya Poultry Facility, General Poultry Corporation, Ministry of Agriculture, Damascus countryside, Syria.

Experimental design

The research was carried out from December 2021 to January 2022 in the poultry field in Saydnaya, which belongs to the public poultry organization, Saydnaya Poultry Facility, General Poultry Corporation, Damascus countryside, Syria. Thirty white laying hens, approximately 32 weeks old and weighing around 1.65 kg each (commencing production at six weeks), with an average production rate of 66% across all groups, were selected for the study.

The hens were randomly assigned to three groups, each consisting of 10 laying hens included a control group and two treatment groups (T1 and T2). Group T1 received an aqueous extract of sage in their diet at a concentration of 0.1% of diet while Group T2 received the extract at 0.2% (Alduri et al., 2016).

The experimental units of laying hens were kept in sheds with each unit having a floor area of 4 m^2. Throughout the experiment, the hens were subjected to a daily lighting program (14 hours of light and 10 hours of darkness). Daily temperatures were recorded and maintained between 20-22 degrees Celsius. The hens had access to feed and water throughout the experimental period.

The feed, provided in the form of crushed pellets, was formulated according to the specifications given in Table 1 by the Department of Medical Biotechnology, National Commission for Biotechnology, Damascus, Syria. Each hens received 115 g of feed per day. Each shed was equipped with an automatic hanging plastic waterer and a hanging plastic feeder.

Table 1. The components of laying hens' diet used in the present study

Diet component	Weight (kg)	Chemical composition	%
Soya	590	Protein	18.70
Corn	230	Fat	4.10
Bran	50	Fiber	22.9
Egg white concentrate	30	Ash	8.50
Sand	100	Carbohydrate	35.10
Antifungal	1	Moisture	8.30
Salt	0.5	Dry matter	97.10
Organic acids	0.5	Energy (kcal/kg)	2273.33
Sage Exract	0.1 - 0.2%		

Preparation of sage aqueous extract

The sage plant (*Salvia officinalis*), belonging to the Labiatae family, was a perennial herbaceous growing plant that can grow up to 60 cm in height. Leaves were collected in the spring from the Damascus countryside, dried at room temperature, and ground into a fine powder. To prepare the extract, 50 grams of dried, ground *Salvia officinalis* leaves were mixed with 250 ml of distilled water and stirred for 24 hours. The mixture was then filtered and subjected to rotary evaporation. Jakovljevi´c et al. (2019) have characterized the chemical composition of *Salvia officinalis* extract as having 49 components including camphor (25.14%), α-thujone (18.83%), 1,8-cineole (14.14 %), viridiflorol (7.98%), β-thujone (4.46%), and β-caryophyllene (3.30%) as the main components, determined by gas chromatography-mass spectrometry.

Measurement of parameters

The 120-day experiment was divided into four equal productive periods of 30 days each (Ceylan et al., 2003). The mortality percentage in each group was calculated using the following equation.

$$\text{Mortality (\%)} = \frac{\text{Total number of hens}}{\text{Number of dead laying hens}}$$

Percentage of egg production

The productivity indicators were studied after collecting the produced eggs and weighing them daily via the following equation.

$$\text{Daily production ratio} = \frac{\text{Number of eggs produced per week}}{7}$$

The eggs were collected once a day at 1:30 in the afternoon for the duration of the experiment and then according to the egg production rate. Hen Day Production

HDP (%) was The number of eggs produced during the experimental period/the number of live chickens at the end of the term × the length of the term in days ×100 (Ceylan et al., 2003).

Percentage of egg weight

The eggs produced at the end of each of the four trial periods were weighed for three consecutive days for each of the treatment groups, where the average weight of the eggs, and mass of eggs produced per hen per day, was calculated using the following equations respectively:

$$\text{Average weight of the eggs} = \frac{\text{Total weight of eggs produced per week}}{\text{Number of eggs produced in the same week}}$$

$$\text{Mass of eggs produced (hen/day)} = \frac{\text{Average daily weight} \times \text{ Daily production ratio}}{100}$$

Percentage of daily feed consumption

The average daily feed consumption per chick was consumed weekly (taking into account the subtraction of the value of the weight of the wasted feed that was collected and weighed on a daily basis (Ceylan et al., 2003).

Feed conversion coefficient

The feed conversion coefficient was calculated using the following equation.

$$\text{Feed conversion coefficient (kg)} = \frac{\text{Amount of feed consumed per day}}{\text{Number of eggs produced per day}}$$

Blood calcium concentrations

Blood was collected using the anterior heart-puncture method (Blalock, 1956), and all calcium determinations were made according to the method described by Fales (1953).

Statistical analysis

The results were reported as the mean ± SD for ten replicate measurements. Statistical analysis was conducted using one-way ANOVA, followed by Tukey's test to compare treatment means, employing MINITAB software 2016 (version 14). Statistical significance was set at $p < 0.05$.

RESULTS

The indicators of productive efficiency in laying hens were studied separately.

Percentage of egg production

Table 2 shows the average percentage of daily egg production during the four weeks of the experiment. Both groups of laying hens that consumed the aqueous extract of sage plant at 0.1% and 0.2% concentrations showed higher daily egg production percentages compared to the control group.

Percentage of egg weight

Table 3 illustrates the daily egg mass per hen, which was higher in both groups of laying hens that consumed the aqueous extract of sage plant at 0.1% and 0.2% concentrations compared to the control group. Additionally, the average egg weight in these groups was also higher, as shown in Tables 4 and 5, respectively.

Percentage of daily feed consumption

As is shown in Table 6, the average of daily feed consumption in both groups of laying hens that consumed the aqueous extract of the sage plant at 0.1% and 0.2% concentrations was higher as compared to the control group.

Feed conversion coefficient

Table 7 indicated that the feed conversion coefficient was lower in both groups of laying hens that consumed the aqueous extract of sage plant at 0.1% and 0.2% concentrations compared to the control group.

Blood calcium concentrations

Table 8 showed that blood calcium concentrations were higher in both groups of laying hens that consumed the aqueous extract of sage plant at 0.1% and 0.2% concentrations compared to the control group.

Table 2. The effect of *Salvia officinalis* extract on the percentage of daily egg production in laying hens

Group	Breeding period (weeks)				Average	p value
Control	66.81 ± 0.89^b	65.42 ± 0.33^c	64.15 ± 0.16^d	67.79 ± 0.18^a	66.04 ± 1.47	0.001
T1	86.3 ± 0.06^c	86.96 ± 0.18^b	87.02 ± 0.33^b	89.48 ± 0.04^a	87.44 ± 1.39	0.001
T2	86.41 ± 0.16^d	87.02 ± 0.13^c	87.91 ± 0.2^b	89.21 ± 0.11^a	87.63 ± 1.21	0.001

The values with the same letters on the same row are not statistically different ($p > 0.05$).

Table 3. The effect of *Salvia officinalis* extract on the egg mass per day in laying hens

Group	Breeding period (weeks)				Average	p value
Control	42.36 ± 5.31[ab]	41.89 ± 4.87[ab]	40.33 ± 5.12[b]	42.97 ± 4.38[a]	41.88 ± 1.12	0.05
T1	58.86 ± 4.21[a]	60,31 ± 3.99[a]	58.46 ± 4.76[a]	61.00 ± 5.23[a]	59.65 ± 1.19	0.03
T2	58.31 ± 5.11	60.16 ± 6.09	59.87 ± 4.63	60.49 ± 4.44	59.70 ± 0.96	0.12

The values with the same letters on the same row are not statistically different (p > 0.05).

Table 4. The effect of *Salvia officinalis* extract on the average of egg weight in laying hens

Group	Breeding period (weeks)				Average	p value
Control	63.42 ± 0.28[a]	61.04 ± 0.85[b]	62.87 ± 1.16[a]	63.39 ± 0.72[a]	62.68 ± 1.12	0.001
T1	68.21 ± 0.77[c]	69.36 ± 0.38[a]	67.19 ± 0.49[b]	68.18 ± 0.26[bc]	68.23 ± 0.88	0.001
T2	67.49 ± 0.38[c]	69.14 ± 0.33[a]	68.11 ± 0.23[b]	67.81 ± 0.36[bc]	68.13 ± 0.71	0.001

The values with the same letters on the same row are not statistically different (p > 0.05).

Table 5. The effect of *Salvia officinalis* extract on the average egg weight in laying hens

Age / Group	End of month 1	End of month 2	End of month 3	End of month 4	Average	p value
Control	61.6 ± 0.12	62.1 ± 0.33	61.4 ± 0.22	60.8 ± 0.42	61.47 ± 0.53	0.61
T1	67.6 ± 0.16	68.1 ± 0.19	68.4 ± 0.12	69.2 ± 0.36	68.32 ± 0.67	0.43
T2	67.3 ± 0.14	67.9 ± 0.28	68.1 ± 0.65	68.8 ± 0.51	68.02 ± 0.61	0.51

Table 6. The effect of *Salvia officinalis* extract on the daily feed consumption of laying hens (Gram/ Hen / Day)

Group	Breeding period (weeks)				Average	p value
Control	121.31 ± 5.3[a]	124.87 ± 6.27[a]	120.83 ± 5.12[a]	122.09 ± 5.19[a]	122.28 ± 1.81	0.001
T1	122.21 ± 4.21[b]	127.24 ± 5.09[a]	123.49 ± 6.46[b]	123.52 ± 6.03[b]	124.12 ± 2.17	0.001
T2	122.61 ± 5.11[d]	126.96 ± 6.19[c]	125.78 ± 4.83[b]	124.12 ± 4.94[a]	124.87 ± 1.9	0.001

The values with the same letters on the same row are not statistically different (p > 0.05).

Table 7. The effect of *Salvia officinalis* extract on the feed conversion coefficient of laying hens

Group	Breeding period (weeks)				Average	p value
Control	2.86 ± 0.34	2.98 ± 0.28	2.99 ± 0.32	2.84 ± 0.41	2.91 ± 0.07	0.41
T1	2.08 ± 0.21	2.1 ± 0.21	2.11 ± 0.16	2.02 ± 0.23	2.07 ± 0.04	0.93
T2	2.1 ± 0.11	2.11 ± 0.09	2.1 ± 0.13	2.05 ± 0.14	2.09 ± 0.02	0.97

Table 8. The effect of *Salvia officinalis* extract on blood calcium concentrations in laying hens

Age / Group	End of the first month	End of the second month	End of the third month	End of the fourth month	Average	p value
Control	9.78 ± 0.72[b]	9.41 ± 0.35[a]	9.26 ± 0.29[a]	10.81 ± 0.12[a]	9.81±0.69	0.004
T1	12.6 ± 0.13	12.10 ± 0.19	11.98 ± 0.54	12.2 ± 0.33	12.22 ± 0.26	0.33
T2	11.9 ± 0.11	12.72 ± 0.28	12.1 ± 0.65	12.6 ± 0.51	12.33 ± 0.39	0.34

The values with the same letters on the same row are not statistically different (p > 0.05).

DISCUSSION

The present study demonstrated that herbal supplementations with *Salvia officinalis* extract may reduce the stress caused by increasing the number of chickens in the same area in different conditions. Specifically, the use of 0.2% sage extract significantly ($p \leq 0.05$) increased egg production to 87.63%, compared to 66.04% in the control group. This finding aligns with previous research indicating a significant ($p < 0.01$) decrease of approximately 3% in egg production when chicks density increased to 10 birds/m^2 without supplementations (Mustafa and Ihsan, 2022a). It has been demonstrated that Plants from the *Labiatae* family promote stability in animal production, also shown in poultry meat and eggs. Table 4 shows data regarding the effect of sage extract on egg weight measurements. Treatments with 0.2% herbals led to a significant ($p \leq 0.05$) increase in egg weight (68.13 g) compared to the control group (62.68 g).

The results in the present study corroborate the findings of Mustafa and Ihsan (2022a) and were consistent with those of Cabuk et al. (2014) who reported increased egg mass in quails fed with sage powder, while parameters such as egg shape index and shell thickness showed non-significant effects (Alduri et al., 2016). Additionally, Alduri et al. (2016) suggested that using sage extracts in layer feed significantly increased egg weight compared with the control group.

The results presented in Table 7 demonstrated that the feed conversion coefficient, which indicated the efficiency of converting feed consumption (Table 6) into egg production during the specified period, was improved with herbal supplementation, consistent with findings by Alduri et al. (2016). This improvement was further supported by Mustafa and Ihsan (2022a), who showed that medicinal herbs from the *Lamiaceae* family, such as sage, enhance feed conversion coefficients in laying hens.

The enhancement in feed utilization and growth performance due to sage supplementation may be attributed to improvements in the metabolic system, balancing beneficial and pathogenic bacteria, increasing enzymatic activity in digestion, and enhancing liver function Farhadi et al. (2020). Additionally, the appealing aroma of sage could potentially increase palatability, encouraging higher feed intake. Furthermore, sage contains antioxidants that scavenge radicals and mitigate lipid oxidation, thereby reducing the feed conversion coefficient in laying hens.

As for the effect of sage aqueous extract on calcium concentrations in blood plasma, its use has been observed to enhance calcium digestion and absorption processes, similar to the findings of Rasouli et al. (2019). Overall, this study emphasized the efficiency of aqueous sage extract in improving egg production and overall health in laying hens (Cabuk et al., 2014), which finally revealed that the intake of aqueous extract of the sage plant may achieve the economic goal sought by poultry breeders.

CONCLUSION

Based on the results of the study, it can be concluded that adding 0.1% (T1) and 0.2% (T2) sage extract to the feed of the laying hens under study was beneficial for several tested parameters involving daily egg production percentage, number of eggs produced per day, and blood calcium concentrations. Notably, group T2 showed superior results compared to group T1. Additionally, the study highlights the positive impact of adding 0.1% (T1) and 0.2% (T2) sage extract to feed diet on increasing average egg weight in laying hens, with group T1 demonstrating higher weights compared to group T2. However, no significant difference was observed in the daily feed consumption of the tested hens. Further investigation into the effects of other medicinal plants known for their high phenolic and flavonoid content, and consequently high bioactivity, on the production characteristics of laying hens was recommended.

DECLARATIONS

Competing interests

The authors declare that there is no conflict of interest.

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Authors' contributions

Frdoos Al Fadel acquired the funds and conceptualized and supervised the work. Rafan Abd Al Hadi collected and analyzed the data, and prepared the manuscript. All authors read and approved the last version of the manuscript.

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Ethical considerations

The authors have avoided plagiarism, misconduct, data fabrication/falsification, and double submission/publication and have given consent to publish this article.

Availability of data and materials

The data and materials are available upon demand from authors.

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