Available online at www.garmian.edu.krd

Passer Journal of Basic and Applied Sciences

Passer 8 (Issue 1) (2026) 521-527

Original Article

Evaluation of Performance, Egg Quality and Hatchability Using *Salvia Indica* Supplementations under Stocking Density of Local Quails

Haval Ismail Aziz [1], Rebin Aswad Mirza * [1], Alaa Abdulmajeed Mustafa [1], Karwan Yaseen Karim [1], Payam Sadiq Sabir [1]

[1] *Animal Production and Health Department, College of Agricultural Engineering Sciences, Salahaddin University, Erbil 44001, Kurdistan Reign, Iraq.*

Received 15 November 2025; revised 06 February 2026;
accepted 20 February 2026; available online 04 March 2026

DOI: 10.24271/PSR.2026.559865.2435

ABSTRACT

The study was carried out to investigate the influence of virous levels of *Salvia indica* supplementation under high stocking density on bird's performance, egg qualities, biochemical parameters, and hatchability of local quail's (Coturnix coturnix). Accordingly, 99 eight-week-old quails were randomly distributed into five treatments with three replicates for each, including negative control (five birds/replicate), positive control (seven birds/replicate), and three groups supplemented by 0.1%, 0.2%, and 0.3% *Salvia indica* under the same density (seven birds/replicate) for eight weeks. The achieved results showed that the supplemented *Salvia indica* significantly increased (P<0.05) egg weight and egg mass without a significant effect on total egg production. The 0.3% *Salvia indica* recorded the highest values (12.04 g and 10.53 g, respectively). Treatments did not impact either feed intake or feed conversion ratio. Biochemical analyses showed that the Salvia indica has significantly impacted the lipid profiles through increasing the levels of triglycerides, decreasing LDL while keeping blood glucose unchanged. Hatchability was improved considerably (P<0.05) in groups supplemented by Salvia indica and reached 93.3% and 81.7% compared with the negative control. Salvia indica increased albumen weight and egg surface area without changes in shell thickness or any parameter of yolk, according to the egg quality traits. Correlation analysis revealed a strong positive relationship between egg weight and either albumen or yolk weights. In brief, supplementing Salvia indica, at the rate of 0.3%, enhanced hatchability, lipid metabolism, and egg quality traits without depressing productivity in local quails. Thus, Salvia indica may be incorporated as a natural additive into the quail diets under high stocking density conditions to enhance its performance and economic efficiency.

Keywords: Salvia indica, Stocking density, Quails, Performance.

1 Introduction

Owing to their fast growth rate, high reproductive efficiency, and the growing demand for eggs in the world market, there has been a growing interest in the intensive rearing of local quails for the production of eggs and meat in various parts of the world. Diet and stocking density are some of the important rearing conditions that deserve great attention to maximize productivity and ensure sustainability in quail farming. One such dietary strategy is the supplementation of natural plant-based products, which may affect growth performance, egg quality, and hatchability in poultry species [1].

* Corresponding author
E-mail address rebin.mirza@su.edu.krd (Instructor).
Peer-reviewed under the responsibility of the University of Garmian.

Salvia indica, popularly known as Indian sage, has emerged to be a potentially active feed supplement due to the presence of flavonoids, alkaloids, and essential oils, which present antioxidant, antimicrobial, and anti-inflammatory properties. In some cases, scientific data have suggested that such phytocompounds can play a role in improving physiological performance in poultry through enhancing immunity, reducing oxidative stress, and maintaining good health [2]. Furthermore, Salvia species increased parameters of egg quality, like the thickness of the shell, weight of the egg, and yolk color, factors responsible for consumer preferences and marketability [3].

Other key factors influencing performance in quails are stocking density, which refers to the number of birds per unit area. Usually, high stocking densities are related to enhanced competition for resources, stress, and poor health outcomes, which could decrease productivity. Overcrowding, according to previous studies, has

been associated with low egg production, reduced hatchability, and poor egg quality [4]. On the other hand, proper stocking densities would ensure that optimal health, welfare, and growth performance are achieved accordingly using with herbal as anti-stress reducer. In this regard, dietary supplementation with *Salvia indica* coupled with the appropriate management of stocking density could represent a combined approach for improving the productive and reproductive performances of local quails.

The present study will evaluate the productive performance, egg quality, and hatchability of the local quail under the influence of different levels of dietary *Salvia indica* supplementation combined with different stocking densities. The present study aims to develop practical strategies to elucidate how plant-based dietary supplements interact with the rearing environment to improve quail production efficiency.

2 Material and Methods

2. 1 Ethic approval

The Committee on Scientific Ethics of Salahaddin University-Erbil, Department of Animal Production and Health, College of Agricultural Engineering Sciences approved the study on 20 July 2023 (No.: 2133).

2. 2 Experimental Design

The study was conducted in Grdarasha Field Station, College of Agricultural Engineering Sciences, Salahaddin University, Erbil. Total of 99 (eight week old) local quails were dispersed into five treatments randomly in cages (60×30×25 cm) with three replicates of each treatment during the breeding period from 8 weeks to 18 weeks. The dietary treatments were designed as follows; T1: five birds/replicate (4 Female + 1 Male), T2: seven birds/replicate (6 Female + 1 Male), T3: 0.1% of *Salvia indica* additive with stocking density seven birds/replicate (6 Female + 1 Male), T4: 0.2% of *Salvia indica* additive with stocking density seven birds/replicate (6 Female + 1 Male) and T5: 0.3% of *Salvia indica* additive with stocking density seven birds/replicate (6 Female + 1 Male). The chicks had unlimited access to feed and water. The control diet's ingredients are listed in **(Table 1).**

Table 1: The basal diets composition for the trial (%).

Ingredients	(%)
Corn	19.5
Soybean meal	34.1
Wheat	40.0
Limestone	1.5
Sunflower Oil	1.6
Di calcium phosphate	0.6
Enzyme	0.1
Premix[1]	2.5
Anti-oxidant	0.1
Total	100%
Value calculated [2]	
ME (kcal/kg)	3000 kcal/kg
Crude Protein %	23%
Lysine %	1.19%
Methionine %	0.47%
Calcium %	0.81%
Available phosphate %	0.45%

[1]Premix: each 1 kg contain: Crude protein15%. Crude fat 2%. Crud fiber4%. Calicium4% Phosphorus (Av.) 8.6%. Methionine5.2%. Methionine+cystine5.4%. Lysine2.5%. sodum5%. VitA480.000IU. VitD3120.000IU. VitE1000mg. Vit K80mg. Vit B180mg. Vit B240mg. Vit B3,600mg. Vit B6,120mg. Vit B12 1mg. Niacin1.200mg. Folic acid, 40mg. Biotin,6mg. CholinChlorid12.000mg. Iron,2.800mg. Zinc2.400mg. Copper320mg. Manganese3.000mg. Iodine1100mg. Selenium 8mg.

2. 3 Productive Performance

Egg weight and Feed intake was measured during the whole experiment, and the formula for calculating feed conversion ratio (FCR) was derived by dividing feed intake per unit by egg weight increase. The influences of additives on hatchability percentage, dead embryo and chicks' weight were estimated.

$$\text{Egg Production} = \frac{X}{Y \times Z} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [5]$$

Whereas:

X = number of eggs produced during a specific time period.

Y = duration of the same period (days).

Z = number of birds at the end of the period.

2. 4 Incubation and Hatching

A total of 300 eggs with a weight value of 12.35±0.18 g (60 eggs per treatment) from 16 weeks old were collected in sterile conditions. The influences of additives of hatching egg on

hatchability percentage of total and fertile eggs, dead embryo and chick weight were estimated.

2. 5 Evaluation of egg quality

At 15 weeks of age egg samples (9 eggs per replicate) were collected and analyzed for external and internal quality characteristics of egg. The length and width of eggs, shell thickness, albumen height, and yolk height (mm) were calculated using an electronic digital caliper. While, the whole egg weight (g), albumen, yolk, and egg shell weight were measured using an electronic digital balance. The egg shape index was determined using the formula egg width/egg length x 100. The shell percentage was calculated using shell weight/egg weight×100, along with the egg shell ratio. Additionally, Sezer (2007) determined the egg surface area (cm^2) to be $3.9782W0^{.7056}$, where W is the egg weight. Each egg's individual weight as well as the weight of its constituent parts were used to compute the albumen and yolk ratios. The following formula was used to measure the Haugh Unit:

Haugh Unit = 100 log (height Albumen + 7.57 - 1.7 × egg weight $^{0.37}$) ……. [6]

2. 6 Biochemical Parameters

At the end of the trail, five female birds from each treatment were chosen randomly, and blood samples were obtained from the wing vein and preserved in sterile tubes for the measurement of biochemical variables and profiles of lipid (triglycerides, LDL, and cholesterol) using an instrument known as the Roche Cobas® 6000 analyzer series (Switzerland).

2. 7 Statistical Analysis

The data was assessed using a one-way ANOVA analysis using software that used SPSS version 27 [7]. The summary statistics data comprised means and standard error. Significant differences among the various parameters were determined using the Duncan's test at 0.05 levels [8]. Pearson correlation was used to determine the correlation between interior and exterior egg quality.

3 Results and Discussion

The influence of various levels of *Saliva indica* under stocking density on feed intake and feed conversion ratio (FCR) are displayed in **table 2**. There were no significant (P>0.05) differences in feed intake (Bird/day) among the treatment groups. Similarly, FCR was not significantly (P>0.05) affected by the treatments. Likewise, the non-significant improvement trend in FCR from 2.68 in the negative control to 2.51 in the 0.3% *Saliva indica* group suggests a possible enhancement in nutrient utilization efficiency. The bioactive components of *Saliva* plants, such as phenolic acids, flavonoids, and essential oils, are known to support digestive enzyme activity, improve gut microflora balance, and reduce oxidative stress [9]. However, the lack of a significant response in the study may be attributed to the relatively low inclusion rates or sufficient baseline nutritional quality of the basal diet that masked potential benefits of *Saliva indica* supplementation. Similar neutral effects on FCR were also reported in hens supplemented with other herbal extracts such as *Thymus vulgaris* and *Rosmarinus officinalis* [2], indicating that the impact of phytogenic additives may depend on dosage, bird age, environmental conditions, and duration of feeding. In contrast, the results are not agreed with the researcher who resulted that dietary inclusion of salvia powder 1 kg/ tone of in laying quail diets improved FCR from 2.61 to 2.37 [10].

Table 2: Influence of adding different concentration of *Saliva indica* plants on total egg production, egg weight and egg mass during production (Mean±SE).

Treatment	Feed Intake (Bird/Day)	FCR
T1 Normal (4/1)	34.25±0.22 [a]	2.68±0.14 [a]
T2 Stocking Density (6/1)	34.46±0.18 [a]	2.64±0.11 [a]
T3 0.1% SI (6/1)	33.72±0.19 [a]	2.61±0.09 [a]
T4 0.2% SI (6/1)	34.26±0.24 [a]	2.53±0.08 [a]
T5 0.3% SI (6/1)	33.81±0.17 [a]	2.51±0.13 [a]
P. value	0.155	0.142

[a,b] The means within the same column are indicated by distinct superscripts (P<0.05).

The effects of different levels of *Saliva indica* under stocking density on the total egg production, egg weight, and egg mass are displayed in **table 3**. There were no significant (P>0.05) differences was recorded in the total egg production (%) among the treatment groups. All groups showed comparable egg production levels, ranging from 83.33 % in the positive control to 87.70 % in the 0.1% *Saliva indica* group. In contrast, weight of eggs was significantly (P<0.05) affected by the treatments. The highest egg weight was observed in the 0.3% *Saliva indica* group (12.04 g), which was significantly (P<0.05) more than the positive control group (10.98 g). The 0.2% *Saliva indica* (11.90 g) and 0.1% *Saliva indica* (11.73 ± 0.21 g) groups also showed increased significantly (P<0.05) egg weights compared to the control groups, while the positive control (11.21 g) had intermediate values. A highly significant (P<0.05) difference was observed in egg mass among the treatments. All levels of *Saliva indica* additives significantly (P<0.05) increased egg mass compared with T1 and T2. While, there were no significant (P>0.05) was observed among the additive groups.

Table 3: Influence of adding different concentration of *Saliva indica* plants on total egg production, egg weight and egg mass during production (Mean±SE).

Treatment	Total Egg Production (%)	Egg Weight (g)	Egg Mass (g)
T1 Normal (4/1)	84.52±0.78 a	11.21±0.30 bc	9.47±0.08 b
T2 Stocking Density (6/1)	83.33±2.27 a	10.98±0.23 c	9.15±0.24 b
T3 0.1% SI (6/1)	87.70±1.46 a	11.73±0.21 abc	10.28±0.17 a
T4 0.2% SI (6/1)	84.32±0.60 a	11.90±0.25 ab	10.03±0.07 a
T5 0.3% SI (6/1)	87.49±1.12 a	12.04±0.27 a	10.53±0.13 a
P. value	0.159	0.024	0.001

[a,b,c] The means within the same column are indicated by distinct superscripts (P<0.05).

The current findings indicate that total production of eggs were not significantly (P>0.05) influenced by the inclusion of *Saliva indica* at different levels. While, both egg weight and egg mass were significantly (P<0.05) improved, particularly at higher inclusion levels of *Saliva indica*. This suggests that while *Saliva indica* may improve certain egg quality parameters, its effect on overall egg production may be limited or impacted by other elements like breed, circumstances of the environment, or the duration of supplementation. Moreover, medicinal plants contain more bioactive compounds that enhance digesting enzyme activity [11]. The content of salvia are effective antioxidant, flavonoids, and polyphenolic compounds possibly enhance laying performance [12, 13].

The impact of the various level of *Saliva indica* under stocking density on triglycerides, cholesterol, low-density lipoprotein (LDL), and blood sugar levels are shown in **table 4**. A significant (P<0.05) difference in cholesterol levels was observed among the treatment groups. The 0.2% *Saliva indica* group had the highest cholesterol concentration (382.93 mg/dl), which was significantly greater than the values in the control groups and other *Saliva indica* treatments. The lowest cholesterol level was recorded in the 0.1% *Saliva indica* group (233.73 mg/dl), while the negative control (314.66 mg/dl) and 0.3% *Saliva indica* (328.83 mg/dl) groups showed intermediate values. Triglyceride levels also showed significant (P<0.05) variation among groups. The highest triglyceride concentration was recorded in the 0.3% *Saliva indica* group (1130.96 mg/dl), followed by the 0.1% and 0.2% *Saliva indica* groups. The lowest value was observed in the negative control (965.36 mg/dl) that significantly (P<0.05) less than the majority of other groupings. There was a highly significant (P<0.05) difference in LDL levels among treatments. The 0.3% and 0.2% *Saliva indica* groups exhibited the lowest LDL concentrations (143.00 mg/dl and 179.33 mg/dl) respectively, which were lower than those in the control groups significantly (P<0.05). The highest LDL level was found in the negative control group (353.00 mg/dl), followed by the 0.1% *Saliva indica* group (337.00 mg/dl). In contrast, blood sugar levels were not significantly (P>0.05) impacted by the treatments. All groups showed similar values, ranging from 308.20 mg/dl in the 0.3% *Saliva indica* group to 320.56 mg/dl in the positive control group. According to the result of the researcher chicks fed a 12 g salvia powder/kg feed supplement had the lowest plasma cholesterol level [14]. Furthermore, the researcher results that the total cholesterol level could be dropped in serum by adding 0.2% of salvia powder in the diet [15].

Table 4: Influence of adding different concentration of *Saliva indica* plants on biochemical parameters at eighteen weeks of age (Mean±SE).

Treatment	Cholesterol (mg/dl)	Triglycerides (mg/dl)	LDL (mg/dl)	Blood Sugar (mg/dl)
T1 Normal (4/1)	314.66±23.06 [b]	965.36±4.88 [c]	353.00±28.93 [a]	314.73±10.20 [a]
T2 Stocking Density (6/1)	289.30±10.65 [bc]	1037.86±40.45 [b]	277.66±14.16 [b]	320.56±4.04 [a]
T3 0.1% SI (6/1)	233.73±7.02 [c]	1067.23±13.96 [ab]	337.00±27.18 [ab]	319.66±8.81 [a]
T4 0.2% SI (6/1)	382.93±29.20 [a]	1052.66±14.60 [b]	179.33±9.26 [c]	318.33±9.74 [a]
T5 0.3% SI (6/1)	328.83±8.55 [ab]	1130.96±9.99 [a]	143.00±8.14 [c]	308.20±6.12 [a]
P. value	0.002	0.003	<0.001	0.815

[a,b] The means within the same column are indicated by distinct superscripts (P<0.05).

Table 5 showed that the hatchability of total eggs was significantly (P<0.05) influenced by the treatments. The highest hatchability percentage was observed in the 0.3% *Saliva indica* group (93.3%), which was significantly (P<0.05) more than all other groups. The 0.2% *Saliva indica* group also showed a significantly higher hatchability (85.0%) compared to the positive control (80.0%) and negative control (81.7%). Similarly, hatchability of fertile eggs differed significantly (P<0.05) among treatments. The 0.3% *Saliva indica* treatment recorded the highest value (96.7%), followed by 0.2% *Saliva indica* (93.3%) and 0.1% *Saliva indica* (90.3%). Both control groups significantly (P<0.05) lower values than others, the positive control showing 85.0% and the negative control 81.7% compared with all additive groups. Numerically, chicks from the 0.3% and 0.2% *Saliva indica* groups had higher weights (9.23 g and 9.12 g, respectively) compared to other groups.

Table 5: Influence of adding different concentration of *Saliva indica* plants on external and internal egg quality characteristics of local quails at 18 weeks of age (Mean±SE).

Treatment	Hatchability (%)		Chicks weight (g)
	Hatchability of total eggs (%)	Egg Weight (g)	
T1 Normal (4/1)	81.70±1.03 ^{bc}	81.70±1.73 ^{c}	8.09±0.11 ^{a}
T2 Stocking Density (6/1)	80.00±1.73 ^{c}	85.00±1.73 ^{c}	7.76±0.57 ^{a}
T3 0.1% SI (6/1)	83.33±1.24 ^{bc}	90.33±0.71 ^{b}	8.02±0.80 ^{a}
T4 0.2% SI (6/1)	85.00±1.27 ^{b}	93.30±1.15 ^{ab}	9.12±0.46 ^{a}
T5 0.3% SI (6/1)	93.30±1.09 ^{a}	96.70±1.15 ^{a}	9.23±0.34 ^{a}
P. value	<0.001	<0.001	0.098

^{a,b,c} The means within the same column are indicated by distinct superscripts (P<0.05).

Table 6 displays the results of varying *Saliva indica* concentrations under stocking density on external and internal egg characteristics. Egg weight was significantly (P<0.05) influenced using *Saliva indica* under stocking density treatment, with the highest weight observed in the 0.3% *Saliva indica* group (12.04 g), followed by the 0.2% *Saliva indica* (11.90 g), and 0.1% *Saliva indica* (11.73 g) groups. In contrast, the egg length and egg width did not show significant (P>0.05) differences among treatments. Egg surface area was also significantly (P<0.05) affected, with the 0.3% *Saliva indica* treatment also showed the largest area (23.02 cm²). No significant (P>0.05) differences were observed in egg shape index, shell weight, shell percentage, and shell thickness. Regarding the internal components, there was a substantial (P<0.05) variation in albumin weight, with the 0.2% *Saliva indica* treatment having the highest albumin weight compared to both controls. The researcher revealed a high stocking density in quail decrease external and internal egg quality characteristics [16]. Moreover, the results are in agreement with the researchers who showed that salvia powder improved ISA browns egg quality traits [17]. According to the result of the researchers resulted that the addition of salvia as a powder to the feeds of quail greater egg mass recorded whereas form index eggs, shell thickness and the shell thickness not significantly (P>0.05) affected [18].

Table 6: Influence of adding different concentration of *Saliva indica* plants on external and internal egg quality characteristics of local quails at 18 weeks of age (Mean±SE).

Parameters	Treatment					P. value
	T1 Normal	**T2** Stocking Density	**T3** 0.1% SI Stocking Density	**T4** 0.2% SI Stocking Density	**T5** 0.3% SI Stocking Density	
Egg weight (g)	11.21±0.30 ^{bc}	10.98±0.23 ^{c}	11.73±0.21 ^{abc}	11.90±0.25 ^{ab}	12.04±0.27 ^{a}	0.024
Egg length (mm)	32.24±0.32	33.31±1.32	35.04±0.35	33.26±0.54	33.89±0.46	0.151
Egg width (mm)	25.55±0.24	25.87±0.32	26.88±0.22	26.25±0.50	25.91±0.16	0.056
Egg surface Area (cm^3)	21.88±0.41 ^{bc}	21.57±0.32 ^{c}	22.60±0.28 ^{abc}	22.82±0.34 ^{ab}	23.02±0.36 ^{a}	0.024
Egg shape index	78.67±0.78	78.27±1.97	76.79±1.14	79.07±1.87	76.55±1.03	0.652
Shell Weight (g)	1.25±0.05	1.13±0.02	1.20±0.05	1.20±0.03	1.24±0.04	0.360
Shell %	11.21±0.442	10.33±0.29	10.28±0.49	10.09±0.22	10.31±0.21	0.187
Shell Thickness (mm)	0.43±0.03	0.41±0.04	0.52±0.05	0.43±0.02	0.41±0.044	0.226
Albumin Weight (g)	6.15±0.20 ^{bc}	5.93±0.17 ^{c}	6.71±0.14 ^{a}	6.51±0.17 ^{ab}	6.68±0.15 ^{a}	0.008
Albumin %	54.85±0.77	53.99±1.08	57.25±1.09	54.70±0.75	55.54±0.55	0.113
Albumin Height (mm)	4.76±0.13	4.58±0.22	4.15±0.27	4.96±0.15	4.67±0.23	0.107
Yolk weight (g)	3.80±0.13	3.92±0.15	3.82±0.17	4.18±0.12	4.11±0.11	0.226
Yolk %	35.66±1.10	33.93±1.01	32.50±1.16	35.20±0.68	34.14±0.60	0.167
Yolk Height (mm)	11.86±0.18	11.94±0.20	11.74±0.16	12.50±0.22	12.25±0.22	0.067
Yolk Diameter (mm)	26.12±0.47	26.06±0.50	26.31±0.33	26.73±0.36	26.43±0.25	0.765
Haugh Unit	91.22±0.62	90.35±1.12	87.24±1.57	91.75±0.88	89.97±1.43	0.087

^{a,b,c} The means within the same row are indicated by distinct superscripts (P<0.05).

Table 7 showed the correlation coefficients among the characteristics of external and internal egg characteristics in local quails with different concentrations of *Salvia indica* plants under stocking density reveal strong significant (P<0.05) relationships. Egg weight shows strong positive correlations with weight of albumen and weight yolk, indicating that as egg weight increases, both albumen and yolk weights also tend to increase. It also positively correlates with egg surface area and egg length, suggesting that larger eggs have more surface area and greater length. However, a moderate negative correlation is observed with the egg shape index, implying that larger eggs may be slightly less spherical. Yolk weight shows strong positive correlations with egg weight and egg surface area, further supporting the idea that larger eggs contain more yolk. A strong

positive correlation with yolk height and yolk diameter suggests that eggs with more yolk tend to have larger yolk size. Interestingly, yolk percentage shows a significant (P<0.05) positive correlation with egg shape index, suggesting that eggs with a more spherical shape tend to have a higher proportion of yolk. However, shell weight and shell ratio show weak correlations with other traits, with shell ratio showing a negative relationship with yolk percentage, indicating that a higher shell ratio is associated with a lower proportion of yolk. Finally, Haugh unit, a freshness indicator, shows weak negative correlations with egg weight, egg surface area, and yolk characteristics, indicating only minor relationships with egg quality traits. Overall, the results suggest that larger eggs tend to have higher albumen and yolk weights, with egg shape and surface area playing key roles in the distribution of internal components.

Table 7: Correlation coefficients among the external and internal egg quality traits in Japanese quails with different concentration of *Saliva indica* plants.

Parameters	Egg Weight (g)	Egg Surface Area (cm2)	Egg Length (mm)	Egg Width (mm)	Egg shape Index (%)	Shell Weight (g)	Shell Ratio (%)
Albumen Weight (g)	0.845**	0.847**	0.426**	0.350*	-0.260	0.391**	-0.174
Albumen %	0.099	0.101	-0.001	0.009	-0.027	0.038	-0.030
Albumen height (mm)	0.017	0.019	-0.004	0.164	0.151	0.161	0.167
Yolk Weight (g)	0.653**	0.652**	0.402**	0.316*	-0.216	0.068	-0.393**
Yolk %	-0.020	0.888**	0.055	0.027	0.910**	-0.320*	-0.340*
Yolk Height (mm)	0.403**	0.403**	0.133	0.158	-0.009	0.229	-0.046
Yolk Diameter (mm)	0.532**	0.531**	0.252	0.420**	-0.004	0.109	-0.254
Haugh Unit	-0.168	-0.165	-0.118	0.079	0.220	0.074	0.203

* Significant at level (P<0.05) and ** significant at level (P<0.01).

4 Conclusions

In conclusion, adding *Salvia indica* plant as feed additive with stocking density to local quails feed improved productivity by increasing the number of birds per area without any effect on the performance, by improving the feed conversion ratio, *Salvia indica* plant can be used as an efficient feed additive to enhance the hatchability and decreased the stress on the birds. Thus, these effects may lead to increased economic efficiency in the egg's local quails. Additionally.

Conflict of interest

No conflicts of interest are disclosed by the authors.

References

[1] Mirza. R. A. and Kareem K. Y. Bioactive additives in poultry health and production. Salahaddin University, Erbil, Iraq (2023).

[2] Abd El-Hack, M. E., Alagawany, M., Taha, A. E. Salvia species as a novel functional feed ingredient for poultry: A review. *Journal of Animal Science and Biotechnology*, **10,** (1), 33 (2019).

[3] Hashem, N. M., Ibrahim, N. M., & El-Ghany, M. E. A. The effects of *Salvia officinalis* and Salvia indica on egg quality and growth performance of laying hens. *Poultry Science*, **99,** (4), 1875-1884 (2020).

[4] Al-Daraji, H. J., Al-Baadani, H. H., & Al-Rubaye, A. S. Effect of stocking density on productive performance, egg quality, and welfare of laying hens. *Journal of Animal and Veterinary Advances*, **11,** (18), 3271-3277 (2012).

[5] Al-Zubaidi, S. S. A. Poultry management. Basra university press and the ministry of higher education and Scientific research. Iraq, (1986).

[6] Haugh, R., The Haugh unit for measuring egg quality. U.S. Egg Poult Mag, **43**, 552-555, 572-573 (1937).

[7] SPSS IBM Corp. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp (2020).

[8] Duncan, D. B. Multiple range and multiple "F" test. Biometrics. **11**, 1-42 (1955).

[9] Ryzner, M., Taká˘cová, J., Cobanov ˇ á, K.; Plachá, I. Venglovská, K. and Faix, Š. Effect of Dietary Salvia officinalis Essential Oil and Sodium Selenite Supplementation on Antioxidative Status and Blood Phagocytic Activity in Broiler Chickens. Acta Vet. Brno, **82**, 43-48 (2013).

[10] Saleh, A.A., Shimaa, H., Aziza, M. H., Khairy, A., Wael, A., Mohammed, H. A. and Mustafa, S. Productive performance, ovarian follicular development, lipid peroxidation, antioxidative status and egg Quality in Laying Hens Fed Diets Supplemented with *Salvia officinalis* and Origanum Majorana powder levels. *Animals*, **11**, 3513 (2021).

[11] Ooi, P. S., Rohaida, A. R., Nur Hardy, A. D., Devina, D., Borhan, A. H., Kartini, S., Jupikely, J. S., Abdul Rahman, M. and Alimon, A. R. Effect of local medicinal herbs as feed additives on production performance and fecal parameters in laying hens. *Mal. J. Anim. Sci,* **21**, 2, 59-67 (2018).

[12] Al-Qudah, M. A., Al- Jaber, H.I., Abu Zarga, M. H. and Abu Orabi, S. T. Flavonoid and phenolic compounds from *Salvia Palaestina* L. growing wild in Jordan and their antioxidant activities. *J. Phytochemistry*, **99**, 115-120 (2014).

[13] Saleh, A. A., Ahmed, E. A. M. and Ebeid, T. A. The impact of phytoestrogen source supplementation on reproductive performance plasma profile, yolk fatty acids and antioxidative status in aged laying hens. Reproduc. in Domes. Anim., **54,** (6), 846- 854 (2019).

[14] El-Garhy, O. Effect of dietary sage plant leaves powder and ascorbic acid supplementation on the performance of broiler

chickens under Iraq conditions. *Annals of Agricultural Science. Moshtohor*, **56,** (4), 37-46 (2018).

[15] Farhadi, M., Hedayati M., Manafi M. and Khalaji S. Influence of using Sage powder (*Salvia Officinalis*) on performance, blood cells, immunity titers, biochemical parameters and small intestine morphology in broiler chickens. *Iranian Journal of Applied Animal Sciences*. **10,** (3), 509-516 (2020).

[16] El Sabry, M.I., Saber, S. A. H., Manal, M. Z. and Farid, K. R. S. Stocking density: a clue for improving social behavior, welfare, health indices along with productivity performances of quail (Coturnix coturnix)- a review. Trop. *Animal Health and Production*. **54**, 83 (2022).

[17] Alduri, A., Tarik,N., Firas, K. A. and Al-Khailani, M. The effect of different levels of sage plant powder Salvia officinalis on the production performance of ISA Brown commercial laying hens. *Kufa J. for Vet. Med. Sci*., **7**,1, (2016).

[18] Al-Zangana, N. N. A., Qana. H. A. Mohammed I. A. and Alneemi A. H. Effect of Salvia officinalis supplementation with or without the addition of enzymes in the blood qualities of Japanese quail. Supplement proceedings of the 3rd International Agri. Conference, College of Agri. and Forestry, Univ. of Mosul and College of Agri. Engineering Sciences, Univ. of Duhok. *Mesopotamia J. of Agri.*, **47**, 202-214, (2019).