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EFFECT OF HERBAL EXTRACTS IN DRINKING WATER OF LAYER QUAILS ON PERFORMANCE, EGG QUALITY, INTESTINAL HISTOLOGY, AND SOME SERUM BIOCHEMICAL PARAMETERS

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ABSTRACT

This study was conducted to measure the influence of some herbal extracts on performance, egg quality, intestinal histology, and some biochemical measurements in layer local quails. 162 quails, including males and females in their 48 weeks of age were divided equally into 18 separate cages, and where placed different levels of the herbal extract mixture (1 ml/l and 2 ml/l) were placed in drinking water for five weeks. Egg production was monitored daily, performance and egg quality were measured weekly, and intestinal histology and serum biochemical parameters were measured at the end of the experiment. In the results, herbal treatments, age, and interaction significantly improved the body weight, egg mass, egg weight uniformity %, feed conversion ratio, and egg production. However, the egg weight was significantly affected by interaction and age. The egg quality parameters including shape index, shell percentage, yolk height, albumin height, albumin percentage, yolk color, and Haugh unit, were significantly affected by the herbal treatment levels, age, and interaction between them. Although the levels of herbal extracts didn't affect the shell thickness, yolk width, albumin width, and yolk percentage, these were significantly affected by age and interaction. All of the studied serum biochemical and intestinal histology measurements except the AST enzyme were significantly changed in the treated groups compared to the control group. The present results conclude that the administration of selected herbal extracts improved most of the studied parameters in laying local quails.

INTRODUCTION

The quail is regarded as the smallest bird and belongs to the pheasant family (Genchev *et al.*,2008). For their high-quality protein, high biological value, and low-calorie content, quail meat and eggs are regarded as important (Abdulrazaq and Ameen,2023 and Ibrahim *et al.*,2023). Nowadays, using antibiotics to prevent illnesses and boost production performance is a widespread practice. However, continued use of antibiotics in feeds causes issues such as a rise in drug resistance, drug persistence in chicken bodies, and loss of the normal balance of intestinal flora (Lipiński *et al.*,2019). One method used to raise the quality of animal products is dietary modifications including the nutritional, sensory, chemical, physical, and physiological aspects of feed ingredients (Runjaić-Antić *et al.*,2010). For these reasons, studies have concentrated on the use of chemicals that maintain the desirable characteristics while having no detrimental impact on human health or the environment. Herbal extracts and their products play a significant role among the additives (Behnamifar *et al.*,2015). Plant-based medicines have a variety of chemical

properties and exhibit a wide range of pharmacological effects, including antibacterial activity, anti-inflammatory properties, astringent properties, digestion-stimulating properties, laxative properties, sedative properties, spasmolytic properties, and choleretic properties (Runjaic-Antic *et al.*,2010). Additionally, plants include large amounts of vitamins, minerals, and pigments like oxy-carotenoids and xanthophylls that are beneficial for skin and egg pigmentation (D'Mello and Acamovic,1989). Several plants, including black cumin seed, green tea, pawpaw seed, lavender, neem, moringa, garlic, and essential oil, have been utilized as alternatives to antibiotics and growth stimulants in poultry, including broiler, quail, pullets, and turkey (Dhama *et al.*,2015).

Olive trees contain a variety of phenolic compounds, the most notable of which is oleuropein, which has considerable biological effects (Cayan and Erener 2015). Investigations on olive leaves have shown that they contain several pharmacological chemicals with effects that include those that are antihypertensive, antiatherogenic, antiviral, cardioprotective, hypocholesterolemic, anti-inflammatory, hypoglycemic, antitumor, antimicrobial, and antioxidant (Visioli *et al.*,2002 and Botsoglou *et al.*,2013). A study by Cayan and Erener (2015) indicated that the yolk pigmentation was significantly increased under the effect of olive leaf feeding in laying hens. A similar study was performed by Christaki *et al.*, (2011) on laying quail and they found significantly higher yolk color under the effect of olive oil feeding. Additionally, they indicated an increase in the percentage of egg production. Another study by Ait-Kaki *et al.*, (2021) showed a significant reduction in the feed conversion ratio in laying quails having olive leaves in their diet.

Polyphenols are found in pomegranate and pomegranate peel (Sehm *et al.*,2011 and Benn *et al.*,2015). Pomegranate polyphenols comprise flavonoids such as anthocyanins, flavonols, and flavanols, as well as compressed tannins known as hydrolyzable tannins such as proanthocyanidins, ellagitannins, and gallotannins. Pomegranate extract is made up of a variety of phytochemicals, including punicalagin, a kind of tannin that is advantageous to pomegranates and has been proven to have anti-free radical capabilities (Gil *et al.*,2000 and Noda *et al.*,2002). Abdel-Wahab and Mosad (2018) demonstrated that feeding the pomegranate peel to laying quail significantly reduced the feed conversion ratio and feed intake. They also found an improvement in growth performance. Therefore, this study was conducted to show the effect of a product called Enteria (Biodevas lab, France) which is the extract of the herbal mixture on performance, egg quality, intestinal histology, and some serum biochemical parameters in laying Japanese quails production.

MATERIALS AND METHODS

Study location

The experiment was performed in rearing cages located in the Animal Production Department, College of Agricultural Engineering Sciences, University of Duhok, Iraq to evaluate the impact of some herbal extracts on laying local quails.

Ethical approval

The experimental procedure of animal rearing and slaughtering was approved by the Animal ethical committee (Approval no. AEC 280720232), Animal Production Department, College of Agricultural Engineering Sciences, University of Duhok, Iraq.

Birds and Diets

A total of 162 local quails (126 females and 36 males) at the age of 48 weeks with low production (23%) were randomly and equally distributed into three treatments, each containing six replicates. Seven females and two males were put into each replicate. All birds were provided with 20 g/bird feed for the first two weeks, and then for the next two weeks, they were fed 25 g/ bird. 1 m3 cages were used in the experiment for rearing purposes.

Herbal mixture

The product called Enteria from Biodevas laboratories, France was used which contains a mixture of Grapefruit (Citrus paradise), Olive extract (Olea europaea), and Pomegranate extract (Punica granatum). This product was a ready-to-use liquid mixture containing the extracts of the mentioned herbal products.

Treatments

The herbal extract was administrated to the birds through drinking water with different proportions in each treatment as follows;

- T1: control: birds were only provided free water (no herbal extract).
- T2: birds were provided with free water containing 1 ml/l of herbal extract.
- T3: birds were provided with free water containing 2 ml/l of herbal extract.

Performance

The Weight gain (including males and females) and egg quality parameters in each replicate were measured weekly. The Hen Day Egg Production Percentage (HDP %) and egg weight were recorded daily.

Serum biochemical and Intestinal histology

At the end of the study, blood was taken from two birds to measure the serum biochemical. The blood was centrifuged and 2 ml of serum was saved in 1.5 Eppendorf tubes under freezing conditions. The serum biochemical traits including AST, ALT enzymes, Thyroid hormones (T3 and T4), creatine, and uric acid were measured. From the same birds, a part of the small intestine was cut, washed with normal saline, and put in 10% formaldehyde. Haematoxylin and eosin were used for the staining. Finally, the tissue fixation was done with paraffin wax. The light microscope with 10X magnification (Dino-Eye-Microscope Eyepiece 38 digital Camera) was used for reading. The measurement procedure was performed according to Iji *et al.,* (2001). The intestinal histology parameters were villi high, villi apical width, villi base width, crypt depth, villi high/crypt depth, and surface area.

Eggs quality

Two eggs from each replicate within each treatment were randomly taken weekly for egg quality measurements. Egg weight, egg length, egg width, shell thickness, shell percentage, yolk color, yolk high, yolk percentage, albumin high, albumin weight, and albumin width were recorded (Mustafa, 2022).

Statistical analysis

For the performance parameter factorial experimental design (3 x 5) was used to study the influence of some herbal extracts on performance and eggs quality, in layer local quails

Duncan multiple range tests (1955) was also used to test the difference between the sub classes of each factor.

The statistical analysis of data was carried out using the GLM (General Liner Model) with SAS (2001) program as in the following model:

$$Yijk=\mu+Ai+Pj+AP(ij)+eijk$$

Where:
Yijk: observational value of experimental unit of (k) quail for each level of Enteria (i) and quail age (j)
μ= Overall mean.
Ai= Effect of ith level of Enteria (I= 1ml/L and 2 ml/L).
Pj= Effect of jth quail age (J=1, 2, 3,4,5 weeks.(
AP (ij) =Effect of interactions between ith Enteria level and jth quail age .
eijk = Experimental error assumed to be NID with (0, σ2e)
For the serum biochemical and intestine histology one way ANOVA was used.

RESULTS AND DISCUSSION

As shown in Table (1), there were no significant differences in initial body weight. However, body weight was significantly increased under the effect of treatments compared to the control group. Subsequently, in weeks 3 and 4 body weight was significantly higher than in other periods of the experiment. But there were no significant variations in body weight in the interaction. Similar results were achieved by Cayan and Erener (2015) and Ait-Kaki *et al.,* (2021) when they found an increase in the body weight of Japanese laying quails under the effect of various olive oil or powder levels. Mustafa *et al.,* (2022) found an improvement in broiler body weight when they provided the chicken with different levels of herbal compounds in their feed. According to Cayan and Erener, (2015) stated that an increase in body weight and no adverse effect on egg production is beneficial in that the bird will sustain their egg production. This increase in body weight might be due to the polyphenolic compounds in the organic plants fed to animals. These compounds are therefore eliminating the harmful microbial population in the bird's gut as well as reducing toxin production. However, Florou-Paneri *et al.,* (2001) showed that the inclusion of pomegranate peel powder in the laying Japanese quails does not affect body weight.

The HDP%, egg mass, FCR, and egg weight uniformity % were significantly affected ($P<0.0001$) by adding 1 ml/l followed by 2 ml/l compared to the control group. However, the treatments did not affect the daily egg weight. The last week of the experiment had a significant effect ($P<0.0001$) on the studied parameters followed by the third and fourth weeks of rearing. Therefore, in the interaction, almost all the significantly differed measurements were recorded in birds that received 1 ml/l in the fifth week of the experiment. Similar results were obtained by Abbas *et al.,* (2017) used various levels of pomegranate peel powder and they found a significant increase of HDP% in laying quail that received 5% and 7.5% of pomegranate in their feed compared to the negative control. Another study by Abd El-Moneim and Sabic (2019) showed a significant increase in egg weight under the effect of feeding the olive pulps. However, these results are in disagreement with those found by Florou-Paneri *et al.,* (2001) who found an adverse effect of 3% of grapefruit on egg production.

These researchers found no significant differences in egg weight in the fourth week of the experiment while at the later stage of their trial egg weight was significantly increased by 3% and 6% of grapefruit pulp. Cayan and Erener (2015) found a statistical increase but non-significant in egg number of quail that had olive oil. Christaki *et al.,* (2011) in which they found a significant increase in egg production in layer quails feed olive leaves in their diet. But they showed no effect of olive leaves on the egg weight of laying Japanese quails. Similarly, Cayan and Erener (2015) found no effect of olive oils on egg weight. Abdel-Wahab and Mosad (2018) found a significant improvement in FCR in the Japanese quails-fed pomegranate peel compared to the control and antibiotics groups. Antioxidant, antibacterial, and anti-inflammation are the main biological activities of pomegranate and these properties make this plant health beneficial. Therefore, these activities stimulate digestion and lead to greater nutrient absorption (Banerjee *et al.*,2013). According to Abd El-Moneim and Sabic (2019) increase in egg number and egg weight may be due to the high polyunsaturated fatty acids (α-linoleic acid) in the olive oil and its residue. Also, the beneficial effects of olives may be due to the high content of polyphenols and especially the oleuropein which is the main active compound (Malik and Branford 2008).

The egg quality measurements are presented in Table (2 & 3). In Table 2, the weight of two eggs that were used for the egg quality measurements significantly differed in that there is a significant decrease in egg weight in the treatment group compared to the control treatment. The shell thickness was not affected by adding the herbal extracts to the drinking water of laying quails. But, shell% was significantly affected ($P<0.0001$) by adding 2 ml/l of herbal extracts in the drinking water. Additionally, 1 ml/l of herbal extracts had a significant effect ($P<0.0002$) on the shape index of the egg. The shell thickness in week five was significantly thinner ($P<0.0001$). Additionally, the shell% in the first week of the experiment was significantly higher than the other four weeks. The shape index in week two followed by week one was significantly ($P<0.0002$) better than the others. In the interaction, eggs that were collected in week five in all treatments had significantly thinner egg shells. However, the shell% in the fifth week 2 ml/l, and the first week 0, 1, and 2 ml/l had significantly differed from others. The shape index during the first two weeks of the experiment was significantly affected by the administration of 1 ml/l of the herbal extracts. Regarding the effect of the period on the yolk parameters, the yolk height during the second and third weeks of the experiment significantly differed from the other periods of the trial except for the last week. In the interaction of the treatments and age, the yolk height during the second week under the effect of herbal extract (1 ml/l) had significantly affected.

The yolk % during the last two weeks of the experiment was significantly affected in all groups. Albumin height was significantly changed with addition of 1ml/l of herbal extracts. Additionally, this was significantly higher in the first week of the experiment compared to other weeks. Similarly, the albumin height was significantly higher in the first week in all groups (interaction). Lioliopoulou *et al.*, (2023) used different levels of pomegranate peel powder in laying hen diet and they found an increase in egg shape index in the group supplemented with 2.5%. Whereas, Reda *et al.*, (2020), found no effect of olive oil on the egg-shape index of laying Japanese quails. The results of shell thickness under the effect of treatments are in

agreement with those found by Cayan and Erener (2015), Abd El-Moneim and Sabic (2019), Öğütcü *et al.*, (2020), and Reda *et al.*, (2020), who found no significant effects of various herbal products on shell thickness. However, their results are disagreeing with the indications obtained for shell thickness under the effect of interaction (herbal extracts vs. bird age).

In Table (3), albumin percentage was significantly affected by herbal treatment (1 ml/l) compared to control and herbal treatment (2 ml/l). Whereas, the albumin width was not affected in all groups. These parameters were significantly influenced in the last week of the experiment. In the interaction, the eggs collected during week two in the second treatment (1 ml/l) had significantly the lowest albumin height and the highest results recorded in the first week in the control group. The albumin width and albumin % were significantly affected in the last week of the experiment with the addition of 1 ml/l and/or 2 ml/l of herbal extracts. Christaki *et al.*, (2011) and Cayan and Erener, (2015) stated that the inclusion of various levels of olive leaves did not affect egg albumin parameters. Considering the yolk parameters, yolk width and yolk percentage were not affected under the effect of treatments but the yolk height and yolk color were significantly affected ($P<0.004$ and $P<0.0001$, respectively) with the additions of herbal extracts into the drinking water. The yolk % in the first and last two weeks of the experiment was significantly higher than second and third weeks. The yolk color was significantly darker during the last week of the trial than in previous weeks. However, the yolk width was not affected. The yolk color was significantly affected in the last week in eggs collected under the effect of different levels of herbal extracts. However, yolk width was not affected during the entire experiment. Abd El-Moneim and Sabic (2019), found that the inclusion of olive pulp into the laying Japanese quails diet significantly increased the yolk percentage in the last period of the experiment and this result was similar to our findings. Yolk color score is mainly affected by the type of ingredients of the diet fed to animals. Some consumers and industries (e.g. pastry) prefer the darker yolk color. This change is due to the carotenoid which plays a major role in the yolk pigmentation. Olive leaves contain a large amount of this product (Cayan and Erener, 2015). These authors found a significant increase in the yolk color under the effect of feeding olive leaf powder in laying hen feed. Similar findings were obtained in several studies indicating the effect of herbal administrations on yolk color (Christaki *et al.*,2011).

Table (1): The impact of herbal extracts mixture on quail production performance.

	Initial body weight (g)	Body weight (g)	HDP%	Egg weight (g)	Egg mass (g/bird/week)	FCR (g/g)	Egg weight uniformity %
Interaction							
Week 1 x 0 ml/L		208.24 ± 2.58	36.32 h ± 0.62	10.85 abc ± 0.14	28.23 ef ± 0.69	4.97 b ± 0.126	31.09 g ± 0.49
Week 1 x 1 ml/L		212.40 ± 2.17	52.04 de ± 1.02	10.73 bc ± 0.09	39.11 d ± 0.75	3.58 fgh ± 0.066	45.46 c ± 0.55
Week 1 x 2 ml/L		211.11 ± 2.67	41.49 g ± 1.01	11.05 ab ± 0.11	32.12 e ± 1.03	4.38 ced ± 0.153	37.46 e ± 0.49
Week 2 x 0 ml/L		211.32 ± 2.85	32.99 h ± 0.97	10.20 d ± 0.10	23.60 g ± 0.91	5.97 a ± 0.226	31.44 g ± 0.70
Week 2 x 1 ml/L		209.07 ± 3.25	43.88 fg ± 0.69	10.48 dc ± 0.12	31.49 e ± 0.89	4.46 bcd ± 0.129	48.32 b ± 0.73
Week 2 x 2 ml/L		211.62 ± 3.18	34.35 h ±1.22	10.10 d ± 0.06	24.31 fg ± 0.98	5.80 a ± 0.227	38.59 ed ± 1.07
Week 3 x 0 ml/L		212.63 ± 2.40	53.40 cd ± 4.78	11.18 ab ± 0.17	40.18 d ± 3.24	4.50 bcd ± 0.381	33.32 fg ± 0.72
Week 3 x 1 ml/L		211.38 ± 5.34	64.62 b ± 1.72	11.13 ab ± 0.23	45.09 c ± 1.81	3.91 efg ± 0.160	49.60 ab ± 0.74
Week 3 x 2 ml/L		219.55 ± 5.42	58.84 c ± 3.22	11.23 ab ± 0.27	44.65 c ± 2.97	4.01 def ± 0.283	39.92 d ± 0.61
Week 4 x 0 ml/L		212.98 ± 3.37	47.96 ef ± 1.02	11.06 ab ± 0.17	37.35 d ± 0.79	4.69 bc ± 0.100	32.16 fg ± 0.60
Week 4 x 1 ml/L		220.73 ± 5.73	66.67 b ± 0.43	11.17 ab ± 0.22	52.13 b ± 0.88	3.36 hi ± 0.057	49.50 ab ± 0.76
Week 4 x 2 ml/L		224.61 ± 6.33	57.82 c ± 0.86	11.26 ab ± 0.21	45.60 c ± 0.99	3.84 efgh ± 0.089	40.33 d ± 0.49
Week 5 x 0 ml/L		209.94 ± 1.26	54.42 cd ± 1.13	10.99 abc ± 0.15	40.29 d ± 0.99	4.35 cde ± 0.106	34.16 f ± 0.60
Week 5 x 1 ml/L		215.45 ± 2.22	76.19 a ± 1.45	11.25 ab ± 0.21	58.73 a ± 1.17	3.005 i ± 0.057	50.66 a ± 1.45
Week 5 x 2 ml/L		217.67 ± 2.43	65.30 b ± 1.66	11.43 a ± 0.16	51.14 b ± 1.11	3.42 cde ± 0.074	40.83 d ± 0.83
p value		0.098	0.0001	0.0001	0.0001	0.0001	0.0001
F value		1.60	50.20	5.15	47.48		23.48
Treatments							
Control	207.59 ± 3.49	211.03 b ± 1.12	45.01 c ± 1.89	10.85 ± 0.08	33.93 c ±1.43	4.90 a ± 0.139	32.43 c ± 0.33
1 ml/ L	213.05 ± 1.88	213.81 a ± 1.83	60.68 a ±2.17	10.95 ±0.09	45.23 a ±1.82	3.66 c ± 0.101	48.71 a ± 0.50
2 ml/L	215.27 ± 3.17	216.91 a ±2.02	51.56 b ± 2.29	11.01 ±0.11	39.56 b ±1.94	4.29 b ±0.165	39.43 b ± 0.38
p value	0.196	0.044	0.0001	0.349	0.0001	0.0001	0.0001
F value	1.82	3.24	84.41	1.07	56.06	54.87	585.67
Age							
Week 1		210.58 b ± 1.41	43.28 c ± 1.66	10.88 b ± 0.07	33.15 c ± 1.18	4.32 b ± 0.152	38.01 c ± 1.45
Week 2		210.71 b ± 1.70	37 .07 d ± 1.29	10.26 c ± 0.06	26.46 d ± 1.01	5.41 a ± 0.196	39.45 b ± 1.74
Week 3		214.52 a ± 5.23	58.95 b ± 2.18	11.18 a ± 0.12	43.30 b ± 1.58	4.14 bc ± 0.169	40 .95 a ± 1.66
Week 4		219.41 a ±1.35	57.48 b ± 1.90	11.16 a ± 0.11	45.03 b ± 1.54	3.96 c ± 0.141	40.66 ab ± 1.75
Week 5		214.35 ab ± 1.35	65.30 a ± 2.29	11.22 a ± 0.10	49.93 a ± 1.89	3.59 d ± 0.143	41 88 a ± 1.73
p value		0.025	0.0001	0.0001	0.0001	0.0001	0.0001
F value		2.92	113.23	16.29	95.82	40.48	11.84

Means within each column different superscript letters are statistically variable.

The Haugh unit which is regarded as the indicator of egg quality significantly differed in the treatments but they were not significantly different from the control group. This parameter was significantly elevated with the time in which the first week of the experiment was significantly higher than others and the lowest Haugh unit was recorded in the last week of the experiment. In the interaction, similar results were obtained in which the Haugh unit was significantly higher in the first two weeks of the experiment in all groups, except week 2/ 1 ml/l, compared to other periods and treatments. Similar results were achieved by Lioliopoulou *et al.,* (2023) in which the Haugh unit was significantly increased in eggs from laying hens supplemented with pomegranate peel powder. On the other hand, Reda *et al.,* (2020) stated that the inclusion of olive oil in laying Japanese quails did not affect the Haugh unit. Intestinal histology (jejunum) parameters are shown in Table 4. All the measured traits were significantly increased ($P<0.0001$) by herbal treatments compared to the control group except the crypt depth which was significantly increased in the control group compared to treated groups. Both the villi high and surface area were significantly higher ($P<0.0001$) with administration of 2 ml/l than 1 ml/l. The present results are in line with our previous findings (Hassan *et al.,* 2023) in which the ENTERIA (mixture of herbal extracts) significantly affected the jejunum histology measurements. Similar results were obtained by Ding *et al.,* (2020) when they found significant changes in these parameters in ducks fed herbal extracts. However, these results partially agree with those found by Abbas *et al.,* (2017) in which they stated that the pomegranate peel powder significantly decreased the cryptic depth. The jejunum is highly related to nutrient digestion and absorption, therefore improvement in villi height increases nutrient uptake and impacts the health of the animal. Subsequently, this leads to an increase in egg production (Svihus,2014).

Table (2): Egg quality parameters of quail under the impact of herbal extract mixture.

	Egg weight (g)	Shell thickness (mm)	Shape index	Shell percentage	Yolk Height (mm)	Albumin Height (mm)
Interaction						
Week 1 x 0 ml/L	9.95 e ±0.30	0.25 bc ±0.007	0.78 cdef ±0.005	13.98 a ±0.40	11.23 f ±0.15	3.20 a ±0.11
Week 1 x 1 ml/L	9.83 e ±0.26	0.28 ab ±0.020	0.81 ab ±0.015	13.65 ab ±0.39	11.30 f ±0.19	2.9 abc ± 0.08
Week 1 x 2 ml/L	9.80 e ±0.34	0.25 bc ±0.012	0.80 bc ±0.011	13.89 a ±0.29	11.55 ef ±0.24	3.08 ab ±0.12
Week 2 x 0 ml/L	9.89 e ±0.14	0.28 a ±0.012	0.78 cdef ±0.003	13.12 abc ± 0.22	11.22 f ± 0.08	3.11 ab ±0.10
Week 2 x 1 ml/L	10.33 ed ±0.16	0.27 ab ±0.009	0.82 a ±0.002	12.47 cd ±0.14	13.08 a ±0.21	2.32 h ±0.02
Week 2 x 2 ml/L	10.22 ed ±0.23	0.27 ab ±0.004	0.79 bcd ±0.003	12.84 abcd ±0.29	12.20 bc ±0.27	3.06 ab ±0.07
Week 3 x 0 ml/L	11.42 bc ±0.31	0.28 a ±0.012	0.78 cdef ±0.006	12.65 bcd ±0.32	11.66 cdef ±0.27	2.65 defg ± 0.12
Week 3 x 1 ml/L	11.34 bc ±0.34	0.27 ab ±0.009	0.76 ef ±0.009	12.15 cd ±0.37	12.22 bcd ±0.24	2.90 bcd ±0.13
Week 3 x 2 ml/L	11.10 bc ±0.27	0.27 ab ±0.004	0.79 bcd ±0.005	11.71 d ±0.83	12.26 bc ±0.17	2.78 cde ±0.09
Week 4 x 0 ml/L	11.76 b ±0.18	0.27 ab ±0.006	0.77 ef ±0.009	12.50 bcd ±0.24	11.51 ef ±0.24	2.40 gh ±0.06
Week 4 x 1 ml/L	11.21 bc ±0.14	0.27 ab ±0.007	0.80 bcd ±0.008	11.95 cd ±0.008	11.95 ef ±0.25	2.53 efgh ±0.01
Week 4 x 2 ml/L	11.67 b ±0.16	0.28 ab ±0.002	0.75 e ±0.005	12.90 abcd ±0.33	11.93 bcde ±0.13	2.71 cdef ±0.03
Week 5 x 0 ml/L	12.67 a ±0.13	0.21 d ± 0.001	0.77 def ± 0.004	12.13 cd ±0.15	12.34 b ±0.11	2.58 efgh ± 0.11
Week 5 x 1 ml/L	10.71 cd ±0.15	0.21 d ±0.002	0.79 bcd ±0.005	11.77 d ± 0.14	11.64 def ±0.14	2.49 fgh ±0.04
Week 5 x 2 ml/L	11.27 bc ±0.19	0.22 cd ± 0.005	0.78 bcde ±0.006	13.88 a ±0.41	12.06 bcde ±0.13	2.67 cdefg ±0.07
p value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
F value	13.16	7.36	5.44	4.66	7.26	9.40
Treatments						
Control	11.14 a ±0.17	0.26±0.005	0.78 b ±0.002	12.88 b ±0.14	11.59 b ±0.09	2.78 a ±0.06
1 ml/ L	10.68 b ±0.12	0.26±0.005	0.80 a ±0.004	12.40 b ±0.15	11.96 a ±0.11	2.63 b ±0.04
2 ml/L	10.81 b ±0.14	0.26±0.003	0.78 b ±0.003	13.04 a ±0.23	12.01 a ±0.09	2.86 a ±0.04
p value	0.016	0.760	0.0002	0.020	0.004	0.001
F value	4.23	0.27	9.23	3.96	5.70	6.77
Age						
Week 1	9.86 b ± 0.17	0.26 a ±0.008	0.80 ab ±0.006	13.84 a ±0.20	11.36 c ±0.11	3.07 a ±0.06
Week 2	10.14 b ±0.10	0.27 a ±0.005	0.80 a ±0.003	12.81 b ±0.13	12.16 a ±0.17	2.83 b ±0.07
Week 3	11.92 a ±0.17	0.27 a ±0.005	0.78 c ±0.004	12.17 b ±0.32	12.05 a ±0.14	2.77 b ±0.06
Week 4	11.55 a ±0.09	0.27 a ±0.003	0.77 c ±0.005	12.45 b ±0.17	11.67 bc ±0.09	2.55 c ±0.03
Week 5	11.55 a ±0.16	0.21 b ±0.002	0.78 bc ±0.003	12.59 b ±0.21	12.01 ab ±0.08	2.58 c ±0.04
p value	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001
F value	31.02	22.65	5.93	8.73	7.22	13.28

Means within each column with different superscript letters are statistically variable.

Table (3): Egg quality parameters of quail under the impact of herbal extract mixture.

	Yolk width (mm)	Albumin width (mm)	Albumin percentage	Yolk percentage	Hugh unit	Colour degree
Interaction						
Week 1 x 0 ml/L	22.39±0.34	56.77 def ±1.80	47.66 d ±0.69	31.90 bcd ±0.29	96.94 a ±0.36	2.75 gh ±0.13
Week 1 x 1 ml/L	22.44±0.36	53.17 f ±2.20	46.88 d ±0.59	32.90 bc ±0.68	95.88 ab ±0.37	3.02 defgh ±0.12
Week 1 x 2 ml/L	22.55±0.39	56.03 ef ±2.63	48.28 cd ±0.83	32.45 bc ±0.69	96.56 a ±0.66	2.75 gh ±0.13
Week 2 x 0 ml/L	21.17±0.30	62.15 abcd ±1.46	49.67 abcd ±0.56	30.30 d ±0.43	96.61 a ±0.35	2.50 h ± 0.43
Week 2 x 1 ml/L	22.05±0.02	58.96 cde ±0.67	50.88 abc ±0.11	30.35 d ±0.08	93.03 ef ±0.17	2.91 efgh ±0.08
Week 2 x 2 ml/L	22.61±0.33	59.23 cde ±1.13	48.62 bcd ±0.71	31.97 bc ±0.39	96.24 a ±0.35	2.83 fgh ±0.11
Week 3 x 0 ml/L	23.56±0.33	61.88 abcd ±3.40	48.35 cd ±2.73	30.94 cd ±0.57	93.61 cdef ±0.58	3.33 bcdef ±0.14
Week 3 x 1 ml/L	22.77±0.41	64.95 ab ±1.79	51.36 abc ±0.79	31.36 cd ±0.60	94.80 bc ±0.55	3.51 bcd ±0.15
Week 3 x 2 ml/L	22.80±0.49	63.99 ab ±2.07	51.10 abc ±0.88	31.79 cd ±0.56	94.51 bc ±0.42	3.41 bcde ±0.14
Week 4 x 0 ml/L	24.16±0.24	60.72 bcde ±1.13	49.49 abcd ±0.33	32.44 bc ±0.64	92.46 f ±0.30	3.41 bcde ±0.14
Week 4 x 1 ml/L	23.07±0.24	62.24 abc ±0.92	51.76 ab ±1.02	34.30 a ±0.33	93.40 def ±0.07	3.41 bcde ±0.14
Week 4 x 2 ml/L	23.54±0.21	60.50 bcde ±0.80	51.23 abc ±0.58	31.97 bc ±0.58	93.85 cde ±0.17	3.75 bc ±0.25
Week 5 x 0 ml/L	23.47±0.24	64.36 abc ±0.39	51.29 abc ±0.28	33.29 ab ±0.28	92.65 ef ±0.52	3.25 cdefg ±0.13
Week 5 x 1 ml/L	21.58±0.22	63.35 ab ± 0.78	52.26 a ±0.24	32.22 bc ±0.26	93.52 def ±0.20	4.91 a ±0.31
Week 5 x 2 ml/L	23.80±0.19	64.29 a ±1.44	51.72 ab ±1.11	33.09 ab ±0.60	93.92 cde ±0.35	3.83 b ±0.16
p value	0.157	0.0001	0.0002	0.0001	0.0001	0.0001
F value	1.40	5.29	3.14		14.88	12.89
Treatments						
Control	22.95 ± 0.18	61.18±0.89	49.29 b ± 0.58	31.77±0.24	94.45 ab ±0.31	3.05 c ±0.07
1 ml/ L	23.18±0.72	60.93±0.84	50.59 a ±0.37	32.12±0.25	94.13 b ±0.19	3.55 a ±0.12
2 ml/L	23.06±0.16	61.41±0.88	50.19 ab ±0.40	32.25±0.25	95.01 a ±0.23	3.31 b ±0.09
p value	0.936	0.904	0.094	0.326	0.008	0.0001
F value	0.07	0.10	2.39	1.13	4.97	9.85
Age						
Week 1	22.45±0.20	55.32 d ±1.22	47.61 c ±0.41	32.25 a ±0.33	96.46 a ±0.28	2.83 c ±0.07
Week 2	23.27±1.21	60.11 c ±0.68	49.73 b ±0.33	30.87 b ±0.23	95.19 b ±0.32	2.75 c ±0.07
Week 3	23.04±0.24	63.60 ab ±1.43	50.21 ab ±0.99	31.36 b ±0.33	94.31 c ±0.30	3.41 b ±0.08
Week 4	23.59±0.15	61.16 bc ±0.55	50.83 ab ±0.40	32.90 a ±0.34	93.24 d ±0.15	3.52 b ±0.19
Week 5	22.95±0.20	65.67 a ±0.58	51.76 a ±0.38	32.86 a ±0.25	93.36 d ±0.23	4.01 a ±0.16
p value	0.714	0.0001	0.0001	0.0001	0.0001	0.0001
F value	0.53	16.29	7.74	9.01	27.23	25.39

Means within each column with different superscript letters are statistically variable.

Table (4): Jejunum histology parameters of quail under the effect of herbal extract mixture.

Traits	Control	1 ml/ L	2 ml/ L	F value	*p* value
Villi height(µm)	416.53 c ± 7.45	525.88 b ± 7.48	548.26 a ± 7.52	89.12	0.0001
Crypt depth (µm)	167.64 a ± 3.91	133.15 b ± 3.90	134.35 b ± 3.87	25.22	0.001
Villi apical width (µm)	56.20 b ± 1.09	81.16 a ± 1.11	78.74 a ± 1.12	157.43	0.0001
Villi base width (µm)	71.20 b ± 1.09	96.16 a ± 1.07	93.74 a ± 1.13	156.42	0.0001
Villi height/ crypt depth	2.56 b ± 0.07	4.18 a ± 0.14	4.30 a ± 0.15	55.13	0.0001
Surface area (µm2)	947.38 c ± 17.59	1152.50 b ± 16.74	1202.51 a ± 16.94	62.51	0.0001

Means within each row with different superscript letters are statistically variable.

In the serum biochemical parameters (Table 5), the uric acid, creatine kinase, and ALT enzyme were significantly decreased ($P<0.0001$) in the herbal groups compared to the control group. However, the thyroid parameters (T3 and T4) were both significantly increased ($P<0.0001$) under the influence of herbal treatments compared to the control group. But there was no significant change in AST enzyme in all groups. Ameen *et al.,* (2023) and Hassan *et al.*, (2023) are agreeing with the current results in which they obtained significant improvement in serum biochemical parameters in different birds. These results indicate the health of the liver under the effect of these herbal extracts (Abd El-Hady *et al.*,2020). However, Abd El-Moneim and Sabic (2019) found no effect of olive pulp on AST and ALT levels. Additionally, Kamel *et al.,* (2021) showed that the pomegranate peel powder significantly reduced the AST level as well as did not affect uric acid and creatinine levels in serum. Hassan et al., (2016) fed broilers different levels of Moringa Oleifera and they measured an increase in thyroid hormone levels which is similar to our findings. These researchers indicated that thyroid hormones (T3 and T4) are important for protein synthesis and growth performance.

Table (5): Quail serum biochemical measurements under the impact of herbal extract mixture.

Traits	Control	1 ml/ L	2 ml/ L	F value	*p* value
AST (UI/L)	171.08 ± 1.78	170.16 ± 1.82	175.16 ± 1.80	2.18	0.128
ALT (UI/L)	47.66 b ± 0.58	46.67 b ±0.61	56.66 a ± 0.60	82.27	0.0001
T3 (nmol/ml)	3.45 a ± 0.04	3.11 b ± 0.07	2.41 c ± 0.05	103.91	0.0001
T4 (nmol/ml)	5.66 a ± 0.09	5.73 a ± 0.11	4.53 b ± 0.10	40.98	0.0001
Uric acid (mg/dl)	3.53 c ± 0.15	4.83 a ± 0.11	4.03 b ± 0.13	34.56	0.0001
Creatine kinase (mg/dl)	3.48 b ± 0.17	4.82 a ± 0.14	3.48 b ± 0.17	23.69	0.0001

Means within each row with different superscript letters are statistically variable.

CONCLUSIONS

This study concludes the effect of the mixture of herbal extracts on quail performance, egg production and quality, intestinal histology, and serum biochemical traits. Most of the studied parameters were significantly improved under the herbal extracts administration. In most of the cases, 1 ml/l of these herbal extracts obtained significantly better results than 2 ml/l and both of them were significantly variable with the control group. Further studies are needed to monitor the impact of these herbal extracts on serum antioxidant and specific stress-related gene expression in laying Japanese quails. In addition, although the combination of these herbal extracts was ready-to-use from a poultry company, various combinations of herbals and their proportions are needed to evaluate their effect on the studied traits.

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CONFLICT OF INTEREST

The authors stated that there are no conflicts of interest with the publication of this work.

تأثير المستخلصات العشبية في مياه الشرب لطيور السمان البياض على الأداء الانتاجي وجودة البيض والأنسجة المعوية وبعض المعايير الكيموحيوية في مصل الدم

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الخلاصة

أجريت هذه الدراسة لقياس تأثير بعض المستخلصات العشبية على الأداء وجودة البيض وأنسجة الأمعاء وبعض القياسات الكيموحيوية في طائر السمان المحلي البياض. تم توزيع 162 طائرا من ذكور واناث السمان (بعمر 48 أسبوعًا بالتساوي إلى 18 قفصًا منفصلاً، حيث تم اضافة مستويات مختلفة من خليط المستخلص العشبي (1 مل/ لتر و2 مل/ لتر) في مياه الشرب لمدة خمسة أسابيع. وتمت مراقبة إنتاج البيض يوميًا، وثم قياس الأداء وجودة البيض أسبوعيًا، وكذلك قياس الأنسجة المعوية والمعايير الكيموحيوية في المصل في نهاية التجربة. اظهرت النتائج بأن النباتات العشبية والعمر والتداخل بينهما أدت إلى تحسين ملحوظ في وزن الجسم وإنتاج وكتلة البيض ونسبة تماثل وزن البيض وكفاءة التحويل الغذائي. وكذلك تأثر وزن البيضة معنويا بالتداخل والعمر. كما تأثرت معايير جودة البيض بما في ذلك دليل شكل البيض، ونسبة القشرة، وارتفاع الصفار والبياض، ونسبة البياض، ولون الصفار، ووحدة هيو بشكل معنوي بمستويات المعالجة بالأعشاب، والعمر، والتداخل بينهما. على الرغم من أن مستويات المستخلصات العشبية لم تؤثر على سمك القشرة وعرض الصفار وعرض البياض ونسبة الصفار، إلا أنها تأثرت بشكل كبير بالعمر والتداخل. جميع القياسات البيوكيميائية في المصل والأنسجة المعوية المدروسة باستثناء AST قد تغيرت بشكل ملحوظ في المجاميع المعاملة مقارنة بمجموعة

السيطرة. توصلت النتائج الحالية إلى أن إعطاء المستخلصات العشبية المختارة أدى إلى تحسين معظم المؤشرات المدروسة في طائر السمان المحلي البياض.

الكلمات المفتاحية: النباتات العشبية، الوزن، الانسجة المعوية، سمان البياض، جودة البيض.

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