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Effect of *Ferula hermonis* Root Powder on Productive Performance and Some Blood Parameters of Aged Laying Hens

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Abstract: This study aimed to investigate the effects of adding different levels of *Ferula hermonis* root powder to the diet of aged layer hens on the productive performance and some blood parameters. In this study, 72 Lohmann brown strain hens, each weighing 1925 ± 63 g and aged 81 weeks, were used. The hens were randomly assigned to four groups, each consisting of six replicates with three hens per replicate. The diets of the first (control), second, third, and fourth groups (G1, G2, G3, and G4) contained varying amounts of *Ferula hermonis* roots powder: 0, 150, 250, and 350 mg.kg^{-1} respectively. The productive characteristics of the hens in this study were determined at two different ages (82–85 and 86–89 weeks). In the first period, dietary supplementation did not significantly impact the hens' daily egg production, egg weight, egg mass, egg quantity, feed intake, feed conversion efficiency, or shell thickness. In the second period, supplementation with powdered *Ferula hermonis* roots additionally showed no significant effect on feed intake or egg weight. However, supplementation at 250 and 350 mg.kg^{-1} led to significant improvements ($p \leq 0.05$) in hens' daily egg production, egg mass, number of eggs, feed conversion efficiency, and shell thickness compared to other groups. Serum total protein, albumin, globulin, and luteinizing hormone (LH) were not significantly affected when powdered *Ferula hermonis* roots were added. The third and fourth groups had significantly ($P \leq 0.05$) higher levels of follicle stimulating hormone (FSH) and estrogen compared to the other groups. In conclusion, supplementing aged hens' diets with 350 mg.kg^{-1} of *Ferula hermonis* root powder increased their egg production and reproductive hormones (FSH and estrogen) levels without affecting serum proteins.

Keywords: Aged hens, *Ferula hermonis*, Hormones, Productive performance.

Introduction

Laying capacity of hens also declines with age, expressing significant reduction in egg production and changes in physiological and metabolic functions. Poultry aging suggests a reduction in ovarian function resulting in reduced egg size, shell quality, and overall egg production (Zhan *et al*, 2024). Besides reduced reproductive performance, aging hens also experience some alterations in their blood parameters, such as altered cholesterol levels, endocrine dysfunction, and increased oxidative stress (Gu *et al*., 2021). These changes could have adverse effects on the health of birds and their ability to maintain high production levels, presenting a challenge

to poultry farmers who wish to extend the productive life of their flock. As a result, more attention has been given to the use of natural additives, for instance, medicinal plants or plant extracts to improve poultry productivity and health (Al-Salhie & Al-Waeli, 2019; Al-Ashoor & Al-Salhie, 2020; Al-Mosawy & Al-Salhie, 2021). *Ferula hermonis,* a Ferula species from the Mediterranean, is one such plant with potential poultry benefits. Ferula species, being traditionally used, have exhibited various medicinal applications, such as anti-inflammatory, antioxidant, and antimicrobial properties (Daneshniya *et al*., 2021). Recent studies have indicated that Ferula hermonis as sexual activity enhancer (Safi *et al*.,2020). *Ferula hermonis* contains different bioactive molecules like ferutinin which has demonstrated antioxidant and anti-inflammatory activities (Sattar & Iranshahi, 2017). The molecules are most likely to fight oxidative stress, one of the key drivers of aging in animals (Macrì *et al*., 2020). Antioxidants eliminate free radicals, which are purported to bring about cellular damage, and hence sustain better health, and also likely improve egg production in birds. Furthermore, anti-inflammatory actions of herbs could likely reduce inflammation in reproductive tissues, and therefore improve the effectiveness of egg laying, and extend hens' productive life (Yang *et al*, 2024). Poultry blood parameters are essential measures of health and productivity (Adegoke *et al*, 2018). Mehlhorn *et al*, (2022) observed decreased estrogen levels in the older hens. Studies have suggested the employment of medicinal herbs like *Ferula hermonis* to exert a beneficial influence on the balance of hormones (Al-Salhie & Al-Hummod, 2019). As an example, some studies on plants have indicated the potential of plant supplements in regulating gonadotropins (FSH and LH) and maintaining overall health in poultry (Al-Salhie & Al-Waeli, 2019; Hana & Al-Salhie, 2024). By enhancing these important blood parameters, *Ferula hermonis* may present a natural alternative to the commercial additives that are used to sustain poultry production. The objective of this research is to investigate the impact of the addition different levels of *Ferula hermonis* root powder to the diet of aged laying hens on the egg production, productive performance, reproductive hormones, and some biochemical blood parameters.

Materials & Methods

This study was conducted at the Animal field, located at College of Agriculture, University of Basrah, Basrah city, Iraq from 20th October to 22th December2024. *Ferula hermonis* roots were obtained from local markets in Misan province, Iraq. Chemical composition of *Ferula hermonis* roots was determined according to AOAC (2000). Chemical composition of *Ferula hermonis* roots presented in Table 1.

Table (1): Chemical composition of *Ferula hermonis* roots

Items	%
Dry matter	96.04
Organic matter	90.21
Crude ash	9.79
Ether extract	15.92
Crude fiber	18.50
Crude protein	7
Soluble carbohydrates	44.83

Experimental design

A total of seventy-two Lohmann brown strain hens 81 weeks old were used in this study. A hen was divided into four groups with six replicates, each group contained 18 hens with 3 hens for each replicate. All replicate hens were housed in the cage (38 cm width × 44 cm depth × 33 cm height). The study was continued until the hens were 89 weeks of age. The hens were fed a common laying hen diet (crude protein: 15 %, Metabolizable energy:2825 kcal/kg, crude fiber: 2.5%, ash: 5%, calcium: 4.3%, sodium: 0.18% and available phosphorus: 0.39%). *Ferula hermonis* root powder was included in the diet at the levels of 0 , 150, 250 and 350 $mg.kg^{-1}$for first (control), second, third and fourth groups (G1, G2, G3 and G4) respectively. Lighting was provided using specialized poultry white LED bulbs, programmed for a daily cycle of 16 hour of light and 8 hour of darkness. During the entire study period, house temperature inside was 20 C°.

Data collection

Productive characterizes for hens in this study were calculated at two periods (82-85 and 86-89 weeks) of age. Eggs were collected and weighed from all replicate twice daily. Hen daily eggs production (HDEP%) was calculated according to the equation (Jahan *et al*, 2024):

$$HDEP\% = \frac{total\ number\ of\ egg}{total\ number\ of\ hen \times length\ of\ the\ period\ in\ days} \times 100$$

Egg mass was measured according to the equation (Anene *et al*, 2023):

$$Egg\ mass\ (\ g.day.hen-1) = \frac{HDEP\ \% \times egg\ weight\ (g)}{100}$$

Diets for all replicate hens were weighed at the beginning and at the end of each period to determine feed intake (Anene *et al*, 2023). Feed conversion efficiency (FCR) was determined according to the equation (Jahan *et al*, 2024) :

$$FCR\ (per\ g\ egg\ mass) = \frac{feed\ intake\ (g)}{egg\ mass\ (g)}$$

Additionally, egg shell thickness was determined with a micrometer in each egg in two point in the egg equator. At the end of 89 week of age, blood samples were collected from wing vein of 6 hens from each group. Two ml of blood were taken and putted in the EDTA tubes for separate the serum after blood centrifuges. Biochemical parameters (total protein, albumin and globulin) were determined using an automatic blood chemical analyzer (Heo *et al*, 2023). An enzyme-linked immunosorbent assay (ELISA) was used to calculate the follicle stimulating hormone (FSH), luteinizing hormone (LH) and estrogen.

Statistical analysis

The statistical packages of social sciences (SPSS, 2024) program was used in the data statistical analysis process and one-way ANOVA procedure in determining the difference between groups. Duncan's test (1955) was used in comparing the differences among the means of groups at a significance level of ($P \leq 0.05$) according to the following mathematical model: $Yij = \mu + Ti + ei$ Where: Yij: Observation value. μ: General mean of the studied trait. Ti: Group effect. ei: Experimental error effect.

Results & Discussion

The results obtained in the first period (82-85 wk) of present study are summarized in Table 2. The results reported the *Ferula hermonis* roots powder did not significantly affect hen daily eggs production, egg weight, egg mass, number of eggs, feed intake, feed conversion efficiency and shell thickness. The results regarding the second period (86-89 wk) are given in Table 3. *Ferula hermonis* roots powder did not significantly affect egg weight and feed intake. Hen daily eggs production, egg mass, number of eggs, feed conversion efficiency and shell thickness were significantly ($p \leq 0.05$) improved when *Ferula hermonis* root powder added at 250 and 350 $mg.kg^{-1}$ of diet compared to other groups. Supplementing Ferula root powder in the diets of laying hens resulted in a significant improvement in some productive and physiological traits of blood related to egg production (Özkök & Kılınç, 2025). However, the inclusion of *F. hermonis*, known for its bioactive phytochemical constituents particularly ferulic acid appears to mitigate some of these age-related declines (Neopane *et al*, 2023). Egg production rate and total egg mass showed significant improvement in hens fed diets supplemented with *F. hermonis*. This may be attributed to the plant's known endocrine modulating effects, which could enhance ovarian activity and follicular development (Hammam *et al*,2022). Additionally, the improvement in egg number reflects enhanced reproductive performance, likely due to increased systemic metabolic activity and better hormonal balance (Scanes & Dridi, 2021). Feed conversion ratio (FCR) was also positively influenced, indicating improved efficiency of nutrient utilization. The phytogenic compounds such as volatile oils, terpenoids, coumarins and other chemical components in ferula may have played a role in enhancing digestive enzyme secretion, improving gut health, and thereby increasing nutrient absorption (Chen *et al*, 2023). Phytogenic Ferula compounds like volatile oils, terpenoids, and coumarins can stimulate digestive enzyme secretion by higher levels of gastrointestinal hormones and by stimulation of neural pathways involved in pancreatic and intestinal enzyme secretion. Antioxidant and anti-inflammatory effects of their action also induce digestive tissue health and preserve enzyme synthesis (Iranshahy & Iranshahi, 2011).

Table (2). Effect of adding *Ferula hermonis* root powder on average of productive performance during 82-85 Wk (Mean ± SE)

Groups Parameters	G1	G2	G3	G4
HDEP%	70.03 ± 5.69	72.61 ± 0.90	75.59 ± 0.59	78.12 ± 2.73
Egg weight (g)	63.04 ± 0.61	64.51 ± 0.51	64.56 ± 0.89	65.01 ± 0.22
Egg mass ($g.day.hen^{-1}$)	44.24 ± 4.08	46.83 ± 0.59	48.76 ± 0.82	50.82 ± 1.88
Number of eggs	29.41 ± 2.39	30.50 ± 0.38	31.75 ± 0.25	32.83 ± 1.16
Feed intake (($g.bird.day^{-1}$))	115.41 ± 1.95	116.33 ± 1.08	115.16 ± 0.66	113.75 ± 1.60
FCR ($g.g^{-1}$)	2.75 ± 0.31	2.49 ± 0.01	2.37 ± 0.04	2.25 ± 0.08
Shell thickness (mm)	0.27 ± 0.006	0.27 ± 0.017	0.30 ± 0.020	0.30 ± 0.005

SE standard error.

Table (3). Effect of adding *Ferula hermonis* root powder on average of productive performance during 86-89 Wk (Mean ± SE)

Groups Parameters	G1	G2	G3	G4
HDP%	$61.50^{c} \pm 1.04$	$66.07^{c} \pm 1.81$	$74.00^{b} \pm 1.62$	$79.16^{a} \pm 0.90$
Egg weight (g)	64.93 ± 0.62	65.78 ± 1.19	64.75 ± 1.25	64.91 ± 0.72
Egg mass (g.day.hen^{-1})	$39.93^{b} \pm 0.64$	$43.44^{b} \pm 0.67$	$47.96^{a} \pm 1.95$	$51.38^{a} \pm 0.68$
Number of eggs	$25.83^{c} \pm 0.44$	$27.75^{c} \pm 0.76$	$31.08^{b} \pm 0.68$	$33.25^{a} \pm 0.38$
Feed intake (g.bird.day^{-1})	114.66 ± 1.30	114.83 ± 2.87	117.08 ± 0.66	115.50 ± 0.86
FCR (g.g^{-1})	$2.87^{a} \pm 0.050$	$2.65^{b} \pm 0.002$	$2.45^{bc} \pm 0.109$	$2.25^{c} \pm 0.042$
Shell thickness (mm)	$0.250^{c} \pm 0.000$	$0.280^{b} \pm 0.000$	$0.280^{b} \pm 0.000$	$0.296^{a} \pm 0.008$

SE standard error. a, b,c Superscripts within rows indicate significant differences $P \leq 0.05$.

This improved feed efficiency reflects better physiological resilience in aged birds. Moreover, eggshell thickness a critical quality trait that often deteriorates with age was significantly improved in the supplemented groups. This could be linked to enhanced calcium metabolism (Jiang *et al*, 2013). Improved shell quality indicates improved mineral metabolism and hormonal regulation (Sinclair-Black *et al*, 2024).

Serum total protein, albumin and globulin of aged laying hens fed *Ferula hermonis* root powder were presented in Table 4. The results indicated no significant differences among groups in these parameters. Khleifat *et al*., (2001) revealed that ingestion of aqueous extract of *Ferula hermonis* (3mg kg^{-1}) did not affect the serum total protein of male mice. The results of present study are contrary with İnanan *et al*., (2021) who reported that total protein and albumin were significantly increased when males goldfish fed on 1% *Ferula elaeochytris* root powder. Khajavi *et al*. ,(2023) stated that ferula increased albumin levels in blood in broiler chickens at the age of 35 days. In another study, Tayeb (2022) revealed that *Ferula communis* L. decreased serum albumin levels in Japanese quails.

Table(4). Effect of adding *Ferula hermonis* root powder on serum proteins (Mean ± SE)

Groups Parameters	G1	G2	G3	G4
Total proteins g.100ml	5.33 ± 0.08	5.30 ± 0.20	5.33 ± 0.03	5.43 ± 0.23
Albumin g.100ml	3.33 ± 0.14	3.26 ± 0.24	3.40 ± 0.05	3.83 ± 0.40
Globulin g.100ml	2.00 ± 0.10	2.03 ± 0.35	1.93 ± 0.08	1.60 ± 0.17

SE standard error.

Serum follicle stimulating hormone (FSH), luteinizing hormone (LH) and estrogen of aged laying hens fed *Ferula hermonis* roots powder were showed in Table 5. FSH and estrogen were significantly ($P \leq 0.05$) increased in the third and fourth groups

compared to other groups. While, the results showed no significant differences among groups in luteinizing hormone. These results may reflect a phytogenic modulation of the hypothalamic-pituitary-gonadal (HPG) axis. *Ferula hermonis* is known to contain a different of bioactive compounds, including ferutinin, which have been revealed to display estrogenic and gonadotropic like activities in mammalian (Hammam *et al*., 2022). These phytochemicals may connect with endocrine regulatory centers, enhancing the synthesis release of gonadotropins and enhancing ovarian steroidogenesis (Hao *et al*., 2021). Ferula (100 mg kg^{-1}) at lower concentrations in the diets of aged laying hens was found to raise the levels of certain reproductive hormones in a study by Hao *et al*., (2021). The same study also reported that a dose of 100 mg/kg of Ferula enhanced the ovary's FSHR, LHR, and ER-α activity. According to Al-Salhie & Al-Hummod (2019), giving 200 mg of *Ferula hermonis* root extract orally raised the levels of serum FSH, LH, and testosterone in older duck males. When given to immature rats at a dose of 6 mg kg^{-1}, *Ferula hermonis* root powder was found to have a strong FSH and LH-like effect in addition to moderate estrogenic sexual stimulation (Hammam *et al*., 2022).

Table (5). Effect of adding *Ferula hermonis* root powder on some serum hormones (Mean ± SE)

Groups Parameters	G1	G2	G3	G4
FSH $pg.ml^{-1}$	2.43^{c} ± 0.03	3.33^{b} ± 0.20	4.70^{a} ± 0.17	5.13^{a} ± 0.01
LH $mlU.mL^{-1}$	0.096 ± 0.023	0.116 ± 0.024	0.136 ± 0.020	0.143 ± 0.017
Estrogen $pg.ml^{-1}$	345.33^{c} ± 8.66	363.00^{bc} ± 7.50	373.66^{b} ± 1.73	434.66^{a} ± 2.30

SE standard error. a, b,c Superscripts within rows indicate significant differences $P \leq 0.05$.

Conclusions

Dietary supplementation with powdered *Ferula hermonis* root exerted dose-dependent physiological effects. The addition of 350 $mg.kg^{-1}$ dose led to a significant improvement in egg production, egg weight, number of eggs, feed conversion ratio, and eggshell quality. The treatment did not affect LH, albumin, globulin, and total serum protein. By contrast, elevated FSH and estrogen levels were observed in the higher dose groups. These findings suggest *Ferula hermonis* root powder can promote egg production and reproductive efficiency in laying hens without disturbing metabolic homeostasis.

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Contributions of Authors

G.K.H.A: Carried out the experiment in the field and collected the data.

K.C.K.A: Constructed the idea and hypothesis for research, planned the methodology, data analysis and wrote the manuscript.

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Conflicts of interest

One of the authors serves as an editor of this journal and had no involvement in the peer-review or editorial decision process for this manuscript. The authors declare no competing interests.

Ethical Approval

All animal procedures were approved by the University of Basrah animal experiments native ethics committee and were performed in accordance with relevant guidelines to minimize animal suffering.

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تأثير مسحوق جذور شرش الزلوع (*Ferula hermonis*) في الاداء الانتاجي وبعض معايير الدم للدجاج البياض المسن

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المستخلص: هدفت الدراسة الحالية لمعرفة تأثير اضافة مستويات مختلفة من مسحوق جذور شرش الزلوع الى العليقة في الاداء الانتاجي وبعض معايير الدم للدجاج البياض المسن. استعمل 72 دجاجة بياضة من سلالة لوهمان البني بعمر 81 اسبوع وبوزن (1925 ±63) غم. وزعت الطيور عشوائيا على أربع معاملات ولكل معاملة ست مكررات وبواقع 18 دجاجة للمعاملة الواحدة. تُركت معاملة السيطرة بدون اضافة بينما اضيف مسحوق جذور شرش الزلوع للمعاملات الثانية والثالثة والرابعة بتركيز 150 و250 و350 ملغم/كغم من العلف على التوالي. درست الصفات الانتاجية خلال مدتين زمنيتين (82–85 و86–89 اسبوع). اشارت النتائج الى عدم تأثر الصفات الانتاجية معنويا في المدة الزمنية الاولى. اشارت نتائج المدة الزمنية الثانية الى عدم تأثر العلف المستهلك ووزن البيض، بينما ارتفعت معنويا ($p\leq0.05$) كل من نسبة انتاج البيض وكتلة وعدد البيض وسمك القشرة فضلا عن تحسن كفاءة التحويل الغذائي في المعاملتين الثالثة والرابعة مقارنة مع باقي المعاملات. لم يتأثر معنويا كل من تركيز البروتين الكلي والالبومين وهرمون LH في مصل الدم بمستويات الاضافة المختلفة. اشارت النتائج الى حصول ارتفاع معنوي ($p\leq0.05$) في كل من هرموني FSH والاستروجين في مصل دم المعاملتين الثالثة والرابعة مقارنة مع باقي المعاملات. نستنتج من خلال ما تقدم ان اضافة مسحوق جذور شرش الزلوع بتركيز 350 ملغم لكل كيلوغرام من العلف قد حسن من الصفات الانتاجية فضلا عن تحسن في هرموني FSH والاستروجين في الدجاج البياض المسن.

الكلمات المفتاحية: الدجاج المسن، الهرمونات، الصفات الانتاجية، شرش الزلوع.