




EFFECT OF DIETARY SUPPLEMENTATION OF FENNEL SEEDS (*FOENICULUM VULGARE*) ON IMPROVING EGG QUALITY IN LAYING HENS

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Article info	Abstract
<p>Received: 2022-07-11 Accepted: 2022-08-09 Published: 2022-12-31</p> <p>DOI -Crossref: 10.32649/ajas.2022.176586</p> <p>Cite as: Haglan, M. M., and A. A. Majed. (2022). Effect of dietary supplementation of fennel seeds (<i>foeniculum vulgare</i>) on improving egg quality in laying hens. <i>Anbar Journal of Agricultural Sciences</i>, 20(2): 377-390.</p> <p>©Authors, 2022, College of Agriculture, University of Anbar. This is an open-access article under the CC BY 4.0 license (http://creativecommons.org/licenses/by/4.0/).</p> 	<p>The purpose of the study was to examine the impact of adding Fennel seeds (<i>Foeniculum vulgare L.</i>) into the diets of laying hens on egg quality. This study was conducted in poultry fields belonging to Department of Animal Production, College of Agriculture, and University of Anbar for 12 weeks. A total of 72 laying hens (Lohman Brown) were used in this experiment, at age 43 weeks. Hens were randomly distributed to six treatments groups and with four replicates per treatment (3 hens/replicate). The treatments were T1: (positive control) based diet containing 1% hydrogenated vegetable fat, T2: (negative control) based diet containing 1% Sheep fat, T3, T4, T5 and T6 The based diet contained 1% Sheep fat + supplementation of 0.25, 0.50, 0.75 and 1% Fennel seeds powder sequentially. The results showed significant ($P \leq 0.05$) differences for the supplementation treatments on the qualitative characteristics of egg quality, as treatment T6 was significantly ($P \leq 0.05$) superior to the rest of the experimental treatments in shell weight, yolk weight, yolk index, percentage of Albumen weight %, Albumen weight (g) and Haugh Unit. Treatments T5 and T6 were significantly ($P \leq 0.05$) superior to the rest of the experimental treatments in shell thickness, percentage of yolk weight%, and Albumen index, while there was no significant effect ($P \leq 0.05$) of the supplementation treatments on (percentage of shell weight%) compared to the two control treatments T1 and T2. It was concluded adding 0.75 and 1% Fennel seeds powder to laying hens' diets improved quality of eggshell, yolk, and egg white.</p>

Keywords: Egg Quality, *Foeniculum vulgare*, Laying Hens, Tallow.

تأثير إضافة مسحوق بذور الحبة الحلوة (*Foeniculum vulgare L.*) الى علائق الدجاج البياض في تحسين صفات جودة البيض

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الخلاصة

اجريت هذه الدراسة في حقول الطيور الداجنة التابعة لقسم الانتاج الحيواني/ كلية الزراعة / جامعة الانبار لمدة 12 اسبوع بهدف دراسة تأثير إضافة بذور الحبة الحلوة (*Foeniculum vulgare L.*) لعلائق الدجاج البياض في تحسين صفات جودة البيض، تم استخدام 72 دجاجة بياضة في هذه التجربة سلالة لوهمان بني (Lohman Brown) بعمر 43 اسبوع وتم توزيعها بصورة عشوائية على ستة معاملات وبأربعة تكرارات للمعاملة الواحدة (3 دجاجة / مكرر). كانت المعاملات T1: (سيطرة موجبة) عليقة اساسية تحتوي 1% دهن نباتي مهرج، T2: (سيطرة سالبة) عليقة أساسية تحتوي 1% دهن حيواني، T3، T4، T5، T6 احتوت عليقة أساسية 1% دهن حيواني + إضافة 0.25، 0.50، 0.75 و 1% مسحوق بذور الحبة الحلوة بالتتابع. أظهرت نتائج التحليل الاحصائي فروقات معنوية ($P<0.05$) لمعاملات الإضافة على الصفات النوعية لجودة البيض اذ تفوقت المعاملة T6 معنوياً ($P<0.05$) على بقية معاملات التجربة في (وزن القشرة، وزن الصفار، دليل الصفار، نسبة وزن البياض %، وزن البياض ووحدة الهو)، وتفوقت المعاملة T5 و T6 معنوياً ($P<0.05$) على بقية معاملات التجربة في (سك القشرة، نسبة وزن الصفار % ودليل البياض)، بينما لم يكن هناك تأثير معنوي ($P>0.05$) لمعاملات الإضافة على (نسبة وزن القشرة % ونسبة وزن القشرة لكل وحدة مساحة سطحية SWUSA) بالمقارنة بمعاملتي السيطرة T1 و T2. نستنتج أن إضافة 0.75 و 1% من مسحوق بذور الشمر إلى علف الدجاج البياض أدى إلى تحسين جودة قشر البيض و صفار البيض و بياض البيض.

كلمات مفتاحية: نوعية البيض، الحبة الحلوة، دجاج بياض، الشحم.

Introduction

Eggs are consumed all over the world, it can provide a person with high quality protein, fats, essential vitamins and minerals when compared to other protein sources like meat, the eggs have been considered an affordable source of animal protein and an excellent way to incorporate many components that promote human health, and specifically the elderly those suffering from cardiovascular diseases caused by cholesterol, whose levels can be controlled by some vegetable additives without affecting the quality of the eggs produced (26). However, Fats are well-known energy sources that have a direct

impact on the laying hen's body, ensuring that their growth, sustainability, and production requirements are met, since the quality and cost of the eggs are linked, it's critical to choose an appropriate fat source for use in chicken feed, as this will have an impact on both production and the overall health of the chickens (9 and 13). Recently, the cost of using vegetable oils has become a factor that burdens specialists in the poultry industry, whether at the level of meat or egg production, which has led to an increase in feed prices in general, which prompted them to think of an alternative source for vegetable oils, such as ruminant fat (Ruminants Tallow) (19). Ruminant fat is one of the most important sources of animal fats and a means by which a very rich source of nutritional energy can be recycled, fat-soluble vitamins and other key nutrients, It is worth noting that although animal fats have benefits, the most important of which is the high energy they contain and their high economic returns as they are considered low-cost, the negative reputation that accompanied these fats for many years is difficult to change represented by the risk of cardiovascular disease, Although, it has been proven that animal fats extracted from ruminant fats contain unsaturated fatty acids known as isomers(isomers of unsaturated fatty acids) the product of natural hydrogenation by microorganisms inside the rumen of ruminants, The most important of which are Trans-vaccenic acid (TVA), rumen (RMA) Rumenic acid and Trans-palmitoleic acid (TPA) these acids are considered neutral towards cardiovascular health, but their use is still debated between supporters and opponents (11).

Recent studies have highlighted on the beneficial effects of medicinal plants used in poultry feeding, the physiological evaluation of medicinal plants in the poultry industry showed a strong effect as a substitute for natural growth stimulants, improved egg components and reduced fat content while increasing alpha-Linolenic acid and n-3 fatty acid content (2, 23 and 25). *Foeniculum vulgare Mill* is a well-known medicinal plant that has been used by humans since ancient times because of its distinctive flavor, it is known worldwide as Fennel, recent developments in the field of genomics and synthetic biology have paved the way for the use of the medicinal properties of this plant, as pharmacological experiments have shown that the Fennel has strong therapeutic effects due to its pharmacological properties that are very important for human health (4). As for the poultry industry, the Fennel when it was included as a feed additive to the diet of laying hens showed significant effects on the external and internal quality characteristics of eggs (31). Few studies have examined the effect of adding Fennel seeds (*Foeniculum vulgare L.*) to laying hens feed as on the quality of their eggs. Therefore, the goal of this study was to investigate the effects of supplementing fennel seeds (*Foeniculum vulgare L.*) into a laying hen's diet on the quality characteristics of eggs.

Materials and Methods

Bird Management: The duration of the study was (12) weeks, in which 72 laying hens (Lohman Brown) from 43 to 54 weeks old were used. Chickens were randomly distributed to six treatments groups and four replicates for each treatment (3 hens/replicate). The treatments were T1: (positive control) basic diet containing 1% hydrogenated vegetable fat, T2: (negative control) basic diet containing 1% sheep fat,

T4, T5 and T6 contain a basic diet of 1% sheep fat + add 0.25, 0.50, 0.75 and 1% Fennel seeds powder sequentially. The diet (110 g/ 1 bird for each day) was provided in fixed quantities for all cages according to the diets shown in Table 1. As for drinking water, it was given freely according to the Nipple Waterer system, and the lighting period was calculated to be 15.5 hours per day. The temperature was from 26-28 °C. "Nutrient requirements of poultry: National Research Council (NRC)" was depended as a program to calculate the formulate diet. The source of feed ingredients is Argentina. Type of chicken was Lohman Brown. The lighting color was white.

Foeniculum vulgare L: Fennel seeds were used, a high-quality Iraqi variety, after grinding the seeds by an electric grinder to get the Fennel seeds powder, which was added to the components of the diet according to the proportions that presented in Table 1.

Sources of Fat Used in the Diet: Two sources of fat were used in the diet, the first was sheep fat after extracting it from sheep fat by heating for an hour, and the second source was hydrogenated vegetable fat (palm oil, sunflower oil, cottonseed oil, rapeseed oil and soybean oil) obtained from the local market, a commercial type according to the percentages mentioned in Table 1.

Characteristics Studied: The shell thickness (mm), shell weight (g), shell weight percentage (%), yolk weight (g), yolk weight percentage (%), yolk index, Albumen weight (g), Albumen weight percentage (%), The index of Albumen, and of Haugh unit were measured according to the methods and equations by (3).

Statistical Analysis: Statistical analysis was carried out using the statistical analysis program SAS (29) to study the effect of experiment coefficients on the studied traits according to a Complete Randomized Design (CRD) (7), polynomial test was conducted to compare the significant differences between the means.

Table 1 The composition (%), calculated and analyzed nutrients contents of the experimental diets fed during 43–54 week.

Ingredient (%)	Treatments					
	T1	T2	T3	T4	T5	T6
Yellow Corn	34.9	34.9	34.9	34.9	34.9	34.9
Wheat	30	30	30	30	30	30
Soybean Meal	23	23	23	23	23	23
Di Calcium Phosphate	1	1	1	1	1	1
Premix*	2.5	2.5	2.5	2.5	2.5	2.5
Salt	0.1	0.1	0.1	0.1	0.1	0.1
Limestone	7.5	7.5	7.5	7.5	7.5	7.5
Hydrogenated Vegetable Fat	1	-	-	-	-	-
Tallow	-	1	1	1	1	1
Total	100	100	100	100	100	100
<i>Foeniculum vulgare</i>	-	-	0.25	0.50	0.75	1
Chemical Analysis**						
Metabolism Energy, kcal/kg	2738	2738	2738	2738	2738	2738
Crud Protein %	17.724	17.724	17.724	17.724	17.724	17.724
Ca, %	3.731	3.731	3.731	3.731	3.731	3.731
Lysine, %	0.885	0.885	0.885	0.885	0.885	0.885
Methionine+ Cystin %	0.6	0.6	0.6	0.6	0.6	0.6
Available Phosphor %	0.39	0.39	0.39	0.39	0.39	0.39

*premix provided per kilogram of diet: 7.8 %crude protein, 29.3 kcal metabolizable energy, 23.1% Ca, 3.8% Ava. P %, 7.7% Methionine+ Cystin, 2.4% Lysine.

** Chemical analysis according to (24).

Results and Discussion

Eggshell Quality: Shell Thickness: Table 2 shows the effect of adding different percentages of Fennel seeds powder to laying hens' diets on eggshell thickness, as the results showed that there were significant ($P \leq 0.05$) differences between the experimental treatments in the thickness of the shell. Significant effect ($P \leq 0.05$) was observed in the thickness of the shell in favor of treatment T5 and treatment T6 compared to the rest of the experimental treatments, which recorded a shell thickness of (0.462 and 0.472 mm) sequentially. The results revealed that there was a significant superiority ($P \leq 0.05$) for treatment T4 and T3 (0.447 and 0.445 mm) sequentially over treatments T1 and T2 (0.422 and 0.430 mm) respectively in the thickness of eggshell. The present results were in agreement with the findings of (14, 21 and 22) who indicated that there were significant differences in shell thickness when adding Fennel seeds and extracts to laying hens' diets. While it disagreed with the results obtained by (1, 10 and 28), who indicated that there were no significant differences in shell thickness when adding Fennel extracts or seeds to laying hens' diets.

The current results also agreed with the findings of (31), who indicated that there were significant differences in the thickness of eggshell when adding (10 mg.kg^{-1}) of Fennel seeds oil to the diets of laying hens type (White Shaver). The Increase in peel thickness may be due to phenolic compounds in Fennel seeds, which increase the secretion of many digestive enzymes that improve the work of the intestines to absorb various nutrients, including calcium. These compounds play an effective role in raising the activity and formation of vitamin D3 and activating the enzyme (Hydroxylase), which increases the absorption of calcium in the digestive system (1 and 15).

Shell Weight: Table 2 shows the effect of adding different percentages of Fennel seeds powder to laying hens' diets on the average egg shell weight, the results indicated that there were significant ($P \leq 0.05$) differences between the experiment treatments in the average shell weight, a significant superiority ($P \leq 0.05$) was observed in the weight of the shells in favor of the T6 supplementation treatment, which had an average shell weight of 6.34 g compared with treatments T1, T2 and T3 5.59, 5.77 and 6.03 g respectively, we also noted that there is a significant superiority ($P \leq 0.05$) of treatment T5 and T4 6.20 and 6.10 g sequentially compared with treatments T1 and T2 in the average shell weight, and treatment T3 was significantly ($P \leq 0.05$) superior to treatment T1 and T2 in the general average of shell weight.

The present findings are in agreement with those of (18, 22 and 32) who indicated that there were significant differences in the weight of eggshell produced when adding Fennel seeds or extracts to the laying hens' diets. While the current results do not agree with the findings of (10 and 28) who indicated that there were no significant differences in the weight of eggshell produced when adding Fennel seeds or extracts to laying hens' diets.

(33) indicated that the increased weight of the shell may be attributed to the indirect role of compounds in herbs, including thymol and anethole, by affecting beta-adrenergic receptors which works to relax the smooth muscles of the uterus and this increases the delay of the egg in the uterus, which increases the secretion of calcium carbonate and thus increases the weight of the egg shell. (20) indicated that medicinal and aromatic plants and herbs have many roles including increasing the secretion of various digestive enzymes as well as improving digestion and absorption of various nutrients including the absorption of a greater amount of calcium. At the same time, medicinal herbs work to raise the proportion of estrogen in the blood, which promotes the synthesis of enzyme (1,25 -Hydroxycholecalciferol), which is responsible for the absorption and deposition of calcium carbonate to form the eggshell.

Percentage of Shell Weight: The results of the statistical analysis indicated in Table 2, which represents the effect of adding different percentages of Fennel seeds powder to laying hens' diets on the percentage of shell weight, the results show that there are no significant differences ($P \leq 0.05$) between the experiment treatments in the percentage of shell weight. The present results are in agreement with the findings of (14, and 22) and (21) who indicated that there were no significant differences in the percentage of shell weight when adding Fennel seeds or extracts to laying hens' diets. While the current results disagree with the findings of (1), who indicated that there were significant differences in the percentage of shell weight when adding 0.5% of Fennel seeds powder in the diets of laying hens (Lohmann Brown).

Table 2 Effect of adding *Foeniculum vulgare* to laying hens diets on quality of eggshell.

Treatments	Eggshell Qualities		
	Shell Thickness (mm)	Shell Weight (g)	Shell Weight (%)
T1 PC (HVF 1%)	0.422 ± 0.002 c	5.59 ± 0.142 c	9.21 ± 0.169
T2 NC (Tallow 1%)	0.430 ± 0.004 c	5.77 ± 0.051 c	9.18 ± 0.064
T3 NC + (FV 0.25%)	0.445 ± 0.008 b	6.03 ± 0.074 b	9.41 ± 0.096
T4 NC + (FV 0.50%)	0.447 ± 0.002 b	6.10 ± 0.015 ab	9.34 ± 0.044
T5 NC + (FV 0.75%)	0.462 ± 0.004 a	6.20 ± 0.060 ab	9.40 ± 0.107
T6 NC + (FV 1%)	0.472 ± 0.004 a	6.34 ± 0.055 a	9.55 ± 0.215
P-value	<.0001	<.0001	NS**
*The different letters within the same columns are significant differences at ($P < 0.05$).			
**NS: Non-Significant			
***PC: positive control, NC: negative control, HVF: hydrogenated vegetable fat, FV: <i>Foeniculum vulgare</i> .			

Albumen Quality: Percentage of Albumen Weight: Table 3 shows how the percentage of Albumen weight changed when different amounts of Fennel seeds powder were added to the diets of laying hens during the experiment. The percentage of Albumen weight was different between the experimental treatments in a way that was clear from

the results. The percentage of albumen weight in treatment T6 was 68%, which didn't differ much from treatment T5 67.4% compared to the other treatments. We also observed that treatment T5 was significantly better ($P \leq 0.05$) than treatments T1, T2, and T3 in percentage of albumen weight, but it didn't differ much from treatment T6.

The present results are in agreement with the findings of (1 and 14) who reported that adding Fennel seeds or extracts to the diets of laying hens resulted in significant variations in the percentage of Albumen weight. While there were no studies that contradicted the current findings regarding the percentage of albumen weight when adding Fennel seeds or extracts to the diets of laying hens.

(17) indicated that the high percentage of Albumen weight may be attributed to the ability of the active compounds in the Fennel seeds to remove the toxicity of some substances by converting lipophilic and hydrophobic compounds to become more soluble in water (hydrophilic), which facilitates their metabolism in the liver or kidneys. On the other hand, the active compounds in the Fennel can lead to an increase in the size of the oviduct and thus increase its activity to supply albumin proteins. (34) reported that the increase in Albumen weight may be due to some of the compounds possessed by the Fennel seeds, which are known as phyto-estrogens because of their critical role in increasing the level of estrogen in the blood, this increase in estrogen stimulates bone growth and increases the activity of the oviduct, which leads to an increase in the amount of substances added to the egg during the stages of deposition of albumin proteins and shell membranes.

Albumen Weight: The results of the statistical analysis indicate, that there are significant differences between the experimental treatments in the weight of Albumen Table 3. the egg albumen weight from treatments fed fennel seed were higher ($P > 0.05$) than positive and negative control. A significant superiority was observed in the weight of Albumen weight from treatment T6 the table showed that the eggs albumin weight were significantly higher in T4, T5 and T6 when compared to T3. However, the albumin weight of treatment T6 was higher than T4.

The present results are in agreement with the findings of (14 and 30), who indicated that there were significant differences in Albumen weight when adding of Fennel seeds powder or extracts to poultry diets. While, (10 and 27) stated that there were no significant differences when adding Fennel seeds and extracts to laying hens' diets.

Albumen Index: Table 3 As shown in Table 3, there were significant differences $P < 0.05$ between the experimental treatments in the trait of albumen index. A significant superiority ($P < 0.05$) was observed in the albumen index in favor of treatments T6 and T5, whose values of albumen index reached 59.1 and 60.4 % respectively compared to treatments T1, T2 and T3. In the same table, we also observed that treatment T4 57.1% is significantly ($P \leq 0.05$) superior to treatments T1 and T2 in terms of the characteristic Albumen index, and that treatment T3 54.6% is significantly ($P \leq 0.05$) superior to treatment T1 in terms of the mean General Guide to Albumen index.

The current results for the characteristic of Albumen index are in agreement with the findings of (1) they found that there were significant differences in the characteristic of Albumen index after adding 0.5 % of fennel seeds powder in the diets of laying hens

(Lohmann Brown). In contrast to our findings that were obtained by (6), who indicated that there were no significant differences in the trait of Albumen index when adding three levels 0.3, 0.6 and 0.9% of Fennel seeds to the diets of quail birds.

The high value of Albumen index for eggs produced by laying hens fed diets containing a high concentration of fennel seeds powder may be attributable to the improvement in the quality of the Albumen, as indicated by the increase in Albumen height resulting from the increase in Albumen weight. The increase in the Albumen index may be largely attributed to the increase in thickness of Albumen resulting from the increase in the proportion of Ovomucin protein, which causes a gel-like structure in Albumen egg (16).

Haugh Units: Table 3 indicates the effect of adding different percentages of Fennel seeds powder to laying hens' diets on Haugh unit. The results that there are significant differences ($P \leq 0.05$) between the experiment's coefficients in Haugh unit, a significant superiority ($P \leq 0.05$) was observed in Haugh unit in favor of the supplementation treatment T6, as the value of Haugh unit 88.8% compared to T1, T2 and T3 84.9, 85.6 and 86.8% respectively which did not differ significantly with treatment T4 and T5 87.3 and 87.9%, respectively, we also note that there is a significant superiority ($P \leq 0.05$) of treatment T5 over treatments T1 and T2 in the same characteristic, which did not differ significantly ($P \leq 0.05$) with treatment T4, we also note that there is a significant superiority ($P \leq 0.05$) of treatment T4 and T3 over treatment T1 in the characteristic of Haugh unit.

The present results are in agreement with the results obtained by (1, 14 and 22) who reported were significant differences when adding Fennel extracts or seeds to laying hens' diets. While the current results do not agree with results obtained by (6, 10, 18 and 27), who reported were no significant differences in Haugh unit values when adding seeds or Fennel extracts to the diets of laying hens.

(32) indicated high values of Haugh unit may be due to Fennel compounds that led to an increase in efficiency of liver by increasing the metabolism of nutrients, which may provide more egg albumin formation, on other hand, herbal extracts may lead to an increase in the metabolism of nutrients within the liver, which provides the high content of (Ovomucin) protein and high content of these proteins that enter the composition of egg albumin increases the structure and quality of albumin and thus reflected on high values of Haugh unit.

Table 3 Effect of adding *Foeniculum vulgare* to laying hens diets on quality of egg Albumen.

Treatments	Egg Albumen qualities			
	Albumen Weight (%)	Albumen Weight (g)	Albumen Index (%)	Haugh Units (%)
T1 PC (HVF 1%)	63.2 ± 0.367 d	38.3 ± 0.694 e	47.5 ± 1.46 d	84.9 ± 0.344 d
T2 NC (Tallow 1%)	63.5 ± 0.137 d	39.9 ± 0.179 de	51.4 ± 0.977 c	85.6 ± 0.786 cd
T3 NC + (FV 0.25%)	65.0 ± 0.306 c	41.7 ± 0.572 cd	54.6 ± 1.37 bc	86.8 ± 0.440 bc
T4 NC + (FV 0.50%)	66.3 ± 0.487 b	43.4 ± 0.568 bc	57.1 ± 1.74 ab	87.3 ± 0.980 abc
T5 NC + (FV 0.75%)	67.4 ± 0.274 ab	44.7 ± 0.215 ab	59.1 ± 0.647 a	87.9 ± 0.434 ab
T6 NC + (FV 1%)	68.0 ± 0.723 a	45.3 ± 0.929 a	60.4 ± 1.42 a	88.8 ± 0.360 a
P-value	<.0001	<.0001	<.0001	0.0022

* The different letters within the same columns are significant differences at (P<0.05).

Chemical Analysis of Egg Yolk: Table 4 shows the effect of adding different percentages of Fennel seeds powder to laying hens' diets on percentages of yolk components. The results of chemical analysis of egg yolk showed a significant (P≤0.05) superiority (P≤0.05) in favor of treatment T6 in the percentages of yolk components (moisture, protein and carbohydrates) And a significant decrease (P≤0.05) percentage in yolk fat compared with rest of experimental treatments, while treatments T3, T4, T5 and T6 were significantly (P≤0.05) superior in percentage of ash compared to the control treatments T1 and T2.

Table 4 Effect of adding *Foeniculum vulgare* to laying hens diets on Chemical analysis of egg yolk.

Treatments	Parameters				
	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrates (%)
T1 PC (HVF 1%)	48.36 ± 0.008 b	0.903 ± 0.003 b	33.7 ± 0.005 b	16.3 ± 0.006 e	0.663 ± 0.003 e
T2 NC (Tallow 1%)	48.09 ± 0.109 c	0.900 ± 0.005 b	34.2 ± 0.120 a	16.1 ± 0.020 f	0.623 ± 0.008 f
T3 NC + (FV 0.25%)	48.44 ± 0.011 b	0.923 ± 0.003 a	33.4 ± 0.042 c	16.4 ± 0.032 d	0.703 ± 0.012 d
T4 NC + (FV 0.50%)	48.45 ± 0.006 ab	0.923 ± 0.003 a	33.2 ± 0.025 d	16.6 ± 0.012 c	0.743 ± 0.012 c
T5 NC + (FV 0.75%)	48.50 ± 0.008 ab	0.916 ± 0.003 a	33.0 ± 0.017 e	16.7 ± 0.008 b	0.816 ± 0.008 b
T6 NC + (FV 1%)	48.60 ± 0.031 a	0.916 ± 0.003 a	32.6 ± 0.032 f	16.8 ± 0.020 a	0.906 ± 0.006 a
P-value	0.0001	0.0033	<.0001	<.0001	<.0001

* The different letters within the same columns are significant differences at (P<0.05).

Yolk Quality: Percentage of Yolk Weight: Table 5 showed effect of adding different percentages of Fennel seeds powder to diets of (Lohmann brown) laying hens on percentage of yolk weight (%), as it is noted that there are significant differences (P≤0.05) between experiment treatments in percentage of yolk weight, it is noticed from the table a significant decrease (P≤0.05) in percentage of yolk weight in favor of

treatment T5 and T6 compared to the rest of the experimental treatments, which recorded a percentage of yolk weight of (23.1 and 22.3%) respectively, also note there was a significant decrease ($P \leq 0.05$) for treatment T4 (24.3%) compared to treatments T1, T2 and T3 (27.5, 27.3 and 25.5%) sequentially in the percentage of yolk weight%, and treatment T3 recorded a significant decrease ($P \leq 0.05$) for Treatment T1 and T2 in the percentage of yolk weight%.

The present results agreement with the findings of (1), who indicated that there was a significant difference when adding 0.5% of Fennel seeds powder to laying hens diets (Lohmann Brown). While the current results not agreement with (14 and 31), who reported were no significant differences in percentage of yolk weight when adding Fennel seeds or extracts to laying hens' diets.

The reason for the decrease in weight of yolk can be attributed to the fact that it is known that the yolk is the most part of the egg that contains fat, and since the increase in the amount of Fennel in the diet negatively affects the amount of fat in the egg, especially the yolk, so the percentage of yolk weight will decrease with a decrease in the percentage of fat in the yolk, this is what was shown by the results of the chemical analysis of egg yolk in Table 4, which indicates a decrease in the percentage of fat in the yolk with an increase in the percentage of Fennel seeds powder (15).

Yolk Weight: Table 5 showed the effect of adding different percentages of Fennel seeds powder to laying hens' diets on weight of yolk, as the results were significant ($P \leq 0.05$) differences in weight of yolk between the different treatments, it was observed that there was a significant decrease in weight of yolk in favor of treatment T6, as the weight of the yolk was 14.7 g, which did not differ significantly with treatment T5 15.3 g when compared with the rest of the experiment treatments.

It was also noticed that there was a significant decrease ($P \leq 0.05$) for treatment T5 compared to treatments T1, T2 and T3 (16.7, 17.1 and 16.4 g) sequentially in egg yolk weight, which did not differ significantly with treatment T4 (15.8 g), the table indicates that there was a significant decrease ($P \leq 0.05$) treatment T4 when compared with T1 and T2 in the same trait, and treatment T3 did not have a significant difference ($P \leq 0.05$) compared with treatment T1 and T2, which did not differ significantly in egg yolk weight.

The present results are in agreement with (30 and 31), who indicated were significant differences in egg yolk weight when adding Fennel seeds powder and extracts to laying hens diets. While the current results do not agreement with (10, 14 and 27) who reported were no significant differences in yolk weight when adding Fennel seeds and extracts to laying hens' diets.

The decrease in the amount of fat in the yolk negatively affected the weight of the yolk. Table 4 displays the results of the chemical analysis of the yolk, which demonstrates a decrease in the percentage of fat in the yolk by increasing the percentage of Fennel seeds powder added to the diet, and thus the decrease in the amount of fat deposited in the yolk, which may be due to the active compounds found in Fennel seeds powder (5).

Yolk Index: The results of the statistical analysis indicated in Table 4, which represents the effect of adding different percentages of Fennel seeds powder to laying hens diets

in yolk index, a significant superiority ($P \leq 0.05$) was observed in yolk index in favor of treatment T6 compared to the rest of the experimental treatments, which recorded the value of yolk index amounted to 45.5%, also note that there is a significant superiority ($P \leq 0.05$) for treatment T5, T3 and T4 (44.2, 43.9 and 43.8%) sequentially over treatment T1 42.7% in the yolk index trait.

The current results for the yolk index trait are in agreement with the findings of (1), who indicated were significant differences in yolk index trait when adding 0.5% of Fennel seeds powder to laying hens diets (Lohmann Brown). While the current results evidence do not agreement with (6, 18, 27, 30 and 32), who reported were no significant differences in add seeds and extracts of the Fennel to the diets of laying hens.

The yolk index is an indicator of the quality of the yolk and they are directly related, and a high yolk index value is an indicator of the durability of the yolk membrane. The high value of yolk index is a positive indicator for this trait, so high value of yolk index is due to the increase in the height of the yolk and the small diameter of the yolk, and this is considered a positive indicator of the quality of the yolk for consumers. As the surface of the yolk membrane consists of thin fibers that are attached to the thick inner layer (Chalaziferous layer). These fibers are responsible for giving strength to the yolk membrane that prevents water from entering the yolk, on the other hand, if the strength of the yolk membrane decreases, the velocity of water entry increases and thus leads to the yolk flattening, i.e. a larger diameter and a lower height (8). It is believed that the increase in the percentage of Fennel in the diets contributed to strengthening the surface of the yolk membrane with fibers, which increased the durability of the membrane by reducing the speed of water entering the yolk and thus keeping the yolk in a spherical, (12) indicated that the increase in the yolk index value is due to the antioxidant properties of *Echinacea purpurea*, a widely used medicinal herb. This antioxidant activity can protect the yolk membrane from oxidation and damage, this increases the quality of the egg yolk.

Table 5 Effect of adding *Foeniculum vulgare* to laying hens diets on quality of egg yolk.

Treatments	Egg Yolk Qualities		
	Yolk Weight (%)	Yolk Weight (g)	Yolk Index (%)
T1 PC (HVF 1%)	27.5 ± 0.298 a	16.7 ± 0.253 a	42.7 ± 0.261 c
T2 NC (Tallow 1%)	27.3 ± 0.095 a	17.1 ± 0.130 a	43.6 ± 0.231 bc
T3 NC + (FV 0.25%)	25.5 ± 0.287 b	16.4 ± 0.139 ab	43.9 ± 0.344 b
T4 NC + (FV 0.50%)	24.3 ± 0.450 c	15.8 ± 0.205 bc	43.8 ± 0.385 b
T5 NC + (FV 0.75%)	23.1 ± 0.207 d	15.3 ± 0.150 cd	44.2 ± 0.266 b
T6 NC + (FV 1%)	22.3 ± 0.685 d	14.7 ± 0.435 d	45.5 ± 0.263 a
P-value	<.0001	<.0001	0.0002

* The different letters within the same columns are significant differences at ($P < 0.05$)

Conclusion: We concluded from the results current study that adding 0.75 and 1% of Fennel seeds powder to laying hens' diets improved the qualitative characteristics of the eggshell and the qualitative properties of the yolk and Albumen.

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