



## Influence of fennel (*Foeniculum vulgare*) seeds powder on welfare-related behaviors, growth performance, and serum biochemical indices in Japanese quails

Rand Rostam Mohammed\*

Department of Animal Production and Health, College of Agricultural Engineering Sciences, Salahaddin University-Erbil, Kurdistan Region, Iraq.

\*Corresponding author e-mail: [rand.mohammed@su.edu.krd](mailto:rand.mohammed@su.edu.krd).

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| <b>Received:</b><br>Jan. 22, 2026  | <b>Abstract</b><br>The study evaluated the effect of graded levels of fennel seeds powder ( <i>Foeniculum vulgare</i> ) on behavior, growth performance, lipid profile and blood biochemical parameters in quails. A total of 64 quails were divided into to four treatments with four replicates including (16 quails for each treatment). Birds in the first treatment were fed standard diet without fennel seeds powder (T1: control), while birds in the T2, T3 and T4 were fed standard diet supplemented with 4, 8 and 12 gram per kilogram (g/kg) fennel seeds powder (FSP) respectively. During 30 days, behavior traits of birds were recorded using erected cameras. Growth performance and blood parameters were measured. The results showed that the addition fennel powder were significantly improved behavioral characteristics including eating, drinking, and Wall & ground picking, Otherwise sitting, standing, and aggressiveness behavior among experimental treatments reduced significantly at study period compression with control diet. Additionally, were no significant differences observed in wing & leg spreading, preening, IBW, FBW, and BWG among experimental treatments. However, fennel seeds powder was significantly improved feed conversion ratio (FCR). Quails fed fennel powder had improved lipid profile than control. Regarding blood parameters glucose reduced significantly ( $P \leq 0.05$ ) in T4. It could be concluded, that fennel seeds up to 8 g/kg have stimulatory effect, improving behavior, feed conversion ratio, improved lipid profiles as well as some blood biochemical parameters on Japanese quails. However, the highest level of fennel seeds (12 g/kg) had similar results as at concentrations of 4 and 8 g/kg. |
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|                                    | <b>Keywords:</b> Fennel, behavior, cholesterol, glucose, welfare                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

### Introduction

Quails are frequently regarded as the ideal species for small-scale poultry production [1] and scientific research [2]. Japanese quail breeding has gained prominence and attracted the attention of breeders, as quail show rapid growth, early sexual maturity, high productivity, low feed consumption [3]. These birds are appropriate for

novice farmers and low-input production methods since they can be slaughtered as soon as at 5 weeks old and start laying eggs at about 6 weeks [4]. Their suitability for ornamental uses and urban backyard farming is also due to their docility and ease of handling (5), and there is resistance to diseases [6]. Besides providing meat and eggs, which are excellent sources of nutrients, particularly proteins [7].

Fennel has positive effects on poultry behavior, fear reaction, growth, general health, and economic efficiency as well as some serum biochemical indicators [8]. The positive effect of using various herbal preparations in feeding animals has been shown to safeguard their health and confirm good output [8]. They can also be utilized as natural growth promoter [9]. The use of phytogenic feed additives or herbal plants as antibiotic substitutes have recently attracted a lot of interest [10]. Phytogenic plants are natural products; their use in the diets of chickens is acceptable [11]. And have many properties mainly growth-promoting, antibacterial, anti-inflammation, and anti-oxidant [10, 11]. The bird's welfare must be given first priority by producers in order to sustain an effective and ethical industry as consumer demand for poultry products continues to expand [12]. Mainly poultry species are frequently commended for their effectiveness in turning feed into high-quality protein, the intensification of production methods has brought up serious issues with the birds' physical and mental health [12, 13].

The aim of this study's was to evaluate the influence of fennel (*Foeniculum vulgare*) seeds powder on welfare-related behaviors, growth performance, and serum biochemical indices in Japanese quails.

## **Materials and methods**

### **Birds management, diet and data collection**

This study was conducted at private field/Quail field Hall / Safin mountain Station, Erbil, Iraq from 29 / 10 / 2025 to 29/11 / 2025. A total of 64 Quails 15days-old-birds were selected and weighed and assigned randomly and equally to four dietary treatments divided throughout 16 cages. The cages, measuring 50 cm × 30 cm × 50 cm in length, width, and height (each), were built for optimal quail welfare and productivity. All quail chicks were raised under identical management and environmental circumstances until they reached the end of age. Each cage contained four quails, and each nutritional treatment was replicated four times, using the cages as the experimental units prepared in a completely randomized (CRD) design. During the experimental period, birds had unrestricted access to both feed and drinking water. All diets were formulated without the inclusion of antibiotic or probiotic supplements and were balanced to satisfy the nutritional requirements of Japanese quail, (Table 1) the ingredients and the chemical composition of basal diet.

The feed additive Fennel seed powder (*Foeniculum vulgare*) (FSP) used in the diets and treatments was prepared as follows; T1: Standard quail diet, no additions of fennel seeds powder (FSP) (Control); T2: Standard quail diet + 4g/kg of (FSP); T3: Standard quail diet + 8g/kg; T4: Standard quail diet + 12 g/kg (FP), which is combined



evenly. Feed was provided in the form of a mash table (1-3 mm), which displays the feed ingredients and their chemical makeup. From the local market of Erbil, fennel seeds were bought and ground into powder, and according to the research design, the feed has been mixed with fennel powder every week. Cameras were erected to control poultry behavior throughout 24 h a day. The temperature was remained at 20°C during the research period also the house was equipped with thermometer to measure the temperature and each cage fitted with single feeder and drinker. The birds from each replication were taken for final body weight, body weight gain, feed consumption, and feed conversion ratio and blood parameters index was recorded.

**Table (1):** Ingredients and Chemical Composition of Basal Diet

| Ingredients                       | Amount (kg) |
|-----------------------------------|-------------|
| Wheat                             | 449.75      |
| Soybean Meal 47%                  | 336         |
| Corn                              | 150         |
| Vegetable Oil                     | 15          |
| MCP <sup>1</sup>                  | 1 7         |
| Enzyme <sup>2</sup>               | 2 0.25      |
| Toxin binder                      | 2           |
| Premix 2.5% <sup>3</sup>          | 3 25        |
| TOTAL                             | 1000        |
| Chemical Composition <sup>4</sup> |             |
| Crude protein %                   | 23          |
| ME.Kcal/kg                        | 3000        |
| Available Ca %                    | 1.05        |
| Available P %                     | 0.5         |
| Na %                              | 0.21        |
| Lysine %                          | 1.46        |
| Methionine %                      | 0.6         |
| Fat %                             | 4.03        |
| Fiber %                           | 2.8         |

Dietary Supplementation of Fennel Seed Powder to the experimental diets according to its percentage in each treatment. <sup>1</sup>MCP: contains 16% calcium and 22.7 % phosphorous. <sup>2</sup>Enzyme: consists of a mixture of enzymes Xylanase, b-glucanase, Amylase, and Protease. <sup>3</sup>Premix 2.5% was used in the diets, which contain 16.7% protein, energy 3879 kcal/kg, %, lysine 8.1%, methionine 9.6 , Methionine + cysteine 9%, phosphorous available. <sup>4</sup>Chemical analysis of ingredients in the diet was carried out in the laboratory following the procedure of AOAC[14]

### Behavioral observations

Sixty-four quails were assigned to treatments and each treatment housed in four independent cages, with four birds per cage. Using an instantaneous scanning, behavioral observations were recorded for 30 minutes per a day (three days per a week) through the whole experimental period (30 days) [15]. To avoid upsetting the behavior

routines of quails, all observations were made with cameras were erected over each treatment to control and observe poultry behavior throughout 24 h a day. Behavior observation determined eating, drinking, wall & litter picking, wing & legs spreading, preening, sitting, standing, and aggressiveness of quails.

### **Growth performance**

The quails at starting day and end research day all birds per cages were weighed together and divided to their number to find out their average body weight. Their weights of day 30 at the end of study after subtracting weights of day 1 to determine body weight gain. The difference between the weight of the feed supplied and the residues was recorded as the feed intake (FI) for each cage. The average feed intake per bird was then calculated by dividing the average feed intake per cage by the number of birds. The feed conversion ratio (FCR) was calculated by the feed intake (g) distributing on body weight gain (g).

### **Blood collection and analysis**

At the conclusion of the experimental period, feed was withdrawn for three hours prior to slaughter. Following slaughter, approximately 2–4 mL of blood was collected from four quails per cage into sterile serum-separating gel tubes (SST). The samples were centrifuged at  $1,000 \times g$  for 15 minutes to obtain serum for biochemical analysis. Serum concentrations of cholesterol, triglycerides, low-density lipoprotein (LDL), high-density lipoprotein (HDL), very-low-density lipoprotein (VLDL), glucose, albumin, and globulin were determined using a commercial automated analyzer at a private diagnostic laboratory in Erbil, Kurdistan Region, Iraq (Shortawa Street, San Lab).

### **Statistical Analysis**

Data were analysed using the General Linear Model (GLM) technique within the Statistical Analysis System (SAS) software, Version 9.1.3 [16]. The statistical analysis was achieved using a completely randomized design for the study. [17] Duncan's multiple range tests were employed to examine changes between treatments ( $P \leq 0.05$ ).

## **Results and Discussion**

### **Behavioral observations**

Table 2 presents the data analysis of the impact of different dietary levels (*Foeniculum vulgare*) was used in the diets on quail's behavior characteristics comparisons with control which was used without additive to at 30 days. Quails reared in treatments when were significantly ( $P \leq 0.05$ ) increased eating in T2 comparison to T1, T3, and T4. However, drinking increased ( $P \leq 0.05$ ) significantly in feed additive treatments in compare to control. The wall & ground picking significantly ( $P \leq 0.05$ ) increased in T3 and T4 higher than T1 and T3. And there were insignificant difference between all treatments in wing & leg spread and preening. On the other hand, sitting, standing, and aggressiveness behaviors decreased significantly ( $P \leq 0.05$ ) in fennel additive treatments compared to control.



The results in this study, quails were fed the diet with 4g/kg of the fennel seed powder had more eating and drinking behavior compared to control and other level of fennel additive traits. The appetite-stimulating properties of fennel components like anethole and estragole may be the cause of the treatment groups' enhanced feed consumption [18]. That stimulates iron absorption, which helps to improve the appetite [19]. The chemical components of fennel may be connected to the improved comfort behavior as it is strengthen the immune system and lessen the impact of stress. The presence of trans-anethole oil, which has anti-testosterone qualities, could be other reason for the notable reduction in aggressive behavior in the fennel-treated groups [20]. These factors might have an impact on the comfort behavior and welfare of the birds. Antioxidants in fennel seed powder enhance the behavior of birds by lowering oxidative stress and consequently resulting in calmer, active birds with less aggressive behavior as indicated by reducing the sit and stand behavior significantly. However, there were no significant variations in wing and leg spread and preening behavior.

**Table (2):** Effect of Dietary Supplementation of Fennel Seed Powder on Japanese Quail Behavior Characteristics at 30 days.

| Traits                 | T1           | T2           | T3            | T4            |
|------------------------|--------------|--------------|---------------|---------------|
| Eating                 | 0.23 ± 0.03b | 0.36 ± 0.02a | 0.19 ± 0.04b  | 0.18 ± 0.02b  |
| Drinking               | 0.6 ± 0.00c  | 0.18 ± 0.02a | 0.14 ± 0.02ab | 0.11 ± 0.02b  |
| Wall & ground pick-ing | 0.44 ± 0.02a | 0.31 ± 0.02b | 0.45 ± 0.04a  | 0.52 ± 0.03a  |
| Wing & Leg spread      | 0.03 ± 0.01a | 0.04 ± 0.01a | 0.03 ± 0.01a  | 0.06 ± 0.02a  |
| Preening               | 0.08 ± 0.03a | 0.05 ± 0.02a | 0.10 ± 0.02a  | 0.09 ± 0.02a  |
| Sitting                | 0.06 ± 0.02a | 0.01 ± 0.01b | 0.01 ± 0.01b  | 0.03 ± 0.01ab |
| Standing               | 0.15 ± 0.03a | 0.05 ± 0.02b | 0.09 ± 0.02b  | 0.02 ± 0.01b  |
| Aggressiveness         | 0.03 ± 0.01a | 0.00 ± 0.00b | 0.00 ± 0.00b  | 0.00 ± 0.00b  |

T1 was the control diet, while T2, T3, and T4 were the diets supplemented with fennel seed powder at 4, 8, and 12 g/kg, respectively. Means with the same superscripts were not significantly different, whereas different superscripts indicated significant differences ( $P \leq 0.05$ ).

### Growth performance

Table (2) show IBW, FBW, and BWG did not differ significantly between treatments, but FI and FCR changed significantly among treatments. Gous and Morris [21] showed dietary FSP supplementation significantly increased the growth performance of quail chicks. enhanced digestibility and enriched antioxidants status. Fennel

also has strong antiviral, antimicrobial, and anti-inflammatory effects, which may improve gut health and eliminate pathogens. It was reported that the FSP is a rich source of essential oil (anethole, fenchone, methyl chavicol, limonene, phellandrene, camphene, pinene, anisic acid, and palmitic, oleic, linoleic, and petroselinic acids, volatile compounds, flavonoids, phenolics [21].

Improves the efficiency of lipid digestion and fatty acid metabolism and through increases the flow of digestive juice in the stomach and intestine. Additionally, they observed that the active ingredient in fennel seeds, anethole, had an impact on pathogen microorganisms improving the weight gain feed conversion ratio [23,24] found that in normal temperatures [25]. It was discovered that fennel seed supplementation has been shown to improvement in Japanese quails at various dosages and forms [26]. [27] Stated that dietary supplementation with fennel seed would be a useful nutritional strategy to enhance poultry production. It depends on the amount of using it to show the improvement in performance.

**Table (3):** Effect of Dietary Supplementation of Fennel Seed Powder on Growth Performance in Japanese Quail at 30 days.

| Traits              | T1              | T2               | T3              | T4               |
|---------------------|-----------------|------------------|-----------------|------------------|
| <b>IBW(g)</b>       | 75.25 ± 0.25a   | 75.28 ± 0.16a    | 75.50 ± 0.50a   | 75.25 ± 0.14a    |
| <b>FBW(g)</b>       | 201.50 ± 1.55a  | 193.50 ± 2.75a   | 197.98 ± 1.52a  | 202.50 ± 4.17a   |
| <b>BWG(g)</b>       | 126.25 ± 1.49a  | 118.23 ± 2.82a   | 122.48 ± 1.76a  | 127.25 ± 4.16a   |
| <b>FI(g /quail)</b> | 425.75 ± 17.80a | 357.50 ± 26.65ab | 337.50 ± 26.96b | 409.75 ± 23.48ab |
| <b>FCR (g / g)</b>  | 3.40 ± 0.15a    | 3.03 ± 0.23ab    | 2.75 ± 0.22b    | 3.20 ± 0.11ab    |

T1 was the control diet, while T2, T3, and T4 were diets supplemented with fennel seed powder at 4, 8, and 12 g/kg, respectively. IBW = initial body weight; FBW = final body weight; BWG = body weight gain; FI = feed intake; FCR = feed conversion ratio. Means with the same superscripts were not significantly different, whereas different superscripts indicated significant differences ( $P \leq 0.05$ )

### Blood Lipid profile and Glucose parameter

The results in table 4 showed at 30 days of study age serum lipids in quails has been tested, Cholesterol and LDL significantly ( $P \leq 0.05$ ) reduced in T2, T3 treatments, comparing with T1 and T4, HDL was significantly ( $P \leq 0.05$ ) increased in T4, and reduced in other treatments. However, Triglyceride and VLDL were significantly ( $P \leq 0.05$ ) dropped in all feed additive treatments in compare with control. While Glucose was significantly ( $P \leq 0.05$ ) increased in T2 and T3 and then reduced in T4 comparing with control. The current investigation indicates a considerable influence of FSP on the lipid profile. Our findings revealed a significant reduction in cholesterol, triglyceride, low-density lipoprotein, and very low-density lipoprotein levels and a rise

in high-density lipoprotein in the quails treated with increasing amounts of FSP. Similar findings were observed in prior research on broilers [28].

Furthermore, data showed that FS supplementation had significant effects on poultry lipid metabolism [29]. The increase the unsaturated fatty acids in FS additives might be the reason for the decrease in total cholesterol [30]. It was shown that the activity of 3-hydroxy-3-methyl-glutaryl coenzyme reductase, It accelerates cholesterol breakdown in the liver, which may be the reason for fennel seeds' hypolipidemic effect [22]. [31] It was proposed that the presence of polyphenols and flavonoids, as proven, would contribute to hypolipidemic action reducing LDL while improving HDL it should be noted that a bird's nutrition, genetics, sex, age, and conditions all have a significant impact on its blood serum cholesterol level, and elevated levels of cholesterol, glucose, and protein in the blood. [32] Was supported by increasing secretion of digestive enzymes of the gastrointestinal tract, which enhances the digestibility of carbohydrates and lipids. For glucose, in our study there was a statistically significant change, although there was an arithmetical rise and subsequently a mathematical decline.

**Table (4):** Effect of Dietary Supplementation of Fennel Seed Powder at Different Levels Lipid Profile and Glucose level in Japanese Quail at 30 days.

| Traits (mg/dL)      | T1                | T2                | T3             | T4             |
|---------------------|-------------------|-------------------|----------------|----------------|
| <b>Cholesterol</b>  | 215.33±1.03b      | 163.00±1.63c      | 144.25±0.63d   | 219.33±0.24a   |
| <b>Triglyceride</b> | 278.00±0.82a      | 191.67±1.03b      | 197.00±23.69b  | 168.00± 0.41b  |
| <b>HDL</b>          | 43.67±0.16b       | 41.82 ± 0.46c     | 43.81±0.07ab   | 44.54±0.04a    |
| <b>LDL</b>          | 116.10±0.79b      | 83.13± 1.07c      | 54.50± 0.65d   | 141.43±0.14a   |
| <b>VLDL</b>         | 55.50 ± 0.16a     | 38.27± 0.19c      | 46.13±0.06b    | 33.60± 0.08d   |
| <b>Glucose</b>      | 367.33 ±<br>1.43c | 387.75 ±<br>0.48a | 384.00 ± 1.08b | 366.50 ± 0.29c |

T1: basal diet, T2: basal diet with 4 g/kg of fennel seeds powder, T3: basal diet with 8 g/kg of fennel seeds powder, T4: basal diet with 12 g/kg % of fennel seeds powder. HDL: high density lipoprotein, LDL: low density lipoprotein, VLDL: very low density lipoprotein. Means with the same superscripts were not significantly different, whereas different superscripts indicated significant differences ( $P \leq 0.05$ ).

### **Blood Serum Albumin and Globulin parameters**

The results in table 5 showed at 30 days of study age albumin level was significantly ( $P \leq 0.05$ ) increased in T2 however, decreased in T3 and T4 in compare to T1, While, globulin was significantly ( $P \leq 0.05$ ) increased in T2 and T4 in compare to T3 with T1.

Albumin is the main protein contained in blood plasma which is responsible for osmotic pressure and as a transport agent for various small molecules in the blood such as fatty acids and bile pigments [33] Albumin and blood protein plays a major role in the deposition of protein into the meat. Liu, et al. [34] which states that albumin affects

the growth rate. It means low albumin will have an effect on total protein, consumption of less protein causes reduced blood albumin so that protein deposition into the meat will also decrease [35].

Globulin level has been used as indicator of immune responses and sources of antibody production [36]. The increase level of globulin concentration might confer immunity and higher disease resistance [37]. The positive effect of fennel seeds on bird's immunity which indicated by increasing globulin level might be due to the presence of essential oils that increase lymphocyte proliferation rate, phagocytosis and immunoglobulins secretion such as IgA and IgM in the blood of the birds [38].

**Table (5):** Effect of Dietary Supplementation of Fennel Seed Powder on Some Serum Biochemical Parameters in Japanese Quail at 30 days.

| Traits          | T1           | T2           | T3           | T4           |
|-----------------|--------------|--------------|--------------|--------------|
| Albumin (g/dL)  | 2.17 ± 0.02b | 3.10 ± 0.04a | 2.00 ± 0.00c | 1.80 ± 0.00d |
| Globulin (g/dL) | 1.80 ± 0.01b | 3.39 ± 0.12a | 1.71 ± 0.01b | 3.39 ± 0.04a |

T1: basal diet, T2: basal diet with 4g/kg of fennel seeds powder, T3: basal diet with 8 g/kg of fennel seeds powder, T4: basal diet with 12 g/kg of fennel seeds powder. Means within rows with different superscripts differ significantly at ( $P \leq 0.05$ ).

The Moderate dietary inclusion of fennel seed powder improved growth performance, behavior, and blood biochemical indices in Japanese quail, whereas higher levels offered no additional benefit. These results support fennel seed powder as a promising natural feed additive, with further research needed to confirm long-term and commercial applicability.

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