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Impact of Dietary Supplementation of Black Cumin Seed on Performance and Carcass Quality of Japanese Quail

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ABSTRACT

The study aims to evaluate the impact of dietary supplementation of different levels of black cumin seed on performance and carcass characteristics of Japanese quail. The study included six treatments, T_0 (basal diet), T_1 (basal diet + 0.5% black cumin seed), T_2 (basal diet + 1.0% black cumin seed), T_3 (basal diet + 1.5% black cumin seed), T_4 (basal diet + 2.0% black cumin seed), and T_5 (basal diet + 2.5% black cumin seed). The 450 experimental Japanese quails were then distributed to six treatments with five replications (15 birds/replication). The BW, BWG, FC, FCR, and DP of quail on different treatments was recorded. From the study, significant ($p<0.05$) differences were found in final FC among the dietary treatments. The final BWG also varied significantly ($p<0.05$) among the dietary treatments and significantly ($p<0.05$) higher BWG was observed in T_3 and T_4 groups. The improved FCR was observed with increasing of black cumin seed supplementation levels up to 2.0%. Moreover, significantly ($p<0.05$) higher DP was observed in T_5 (2.5% black cumin seed) than other dietary treatments. Carcass characteristics revealed that significant ($p<0.05$) differences were observed for breast and wing weight but non- significant ($p>0.05$) differences were detected in back, thigh, neck, heart, liver, and gizzard weight among the dietary treatments. Moreover, significantly ($p<0.05$) lower abdominal fat was found in black cumin seed supplemented groups and highest result was found in T_4 and T_5. It is concluded that dietary supplementation of black cumin seed in quail ration significantly ($p<0.05$) improved the growth performance and carcass features of Japanese quail and the best result was obtained when supplemented with 1.5-2.0% black cumin seed. Therefore, it is recommended that the use of 1.5-2.0% black cumin in quail diet resulted in improved growth performance and carcass yields in Japanese quail.

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Introduction

One of the most prosperous production sectors in the world that offers an animal protein with a high biological value is the poultry industry. According to Hanboonsong et al. (2013), the anticipated population rise is associated with new difficulties, such as the rising need for food and the 60% increase in food production projected for 2050. Because there are currently insufficient animal protein sources, there will also be fewer human protein sources. In the past, antibiotics had a significant influence on the sector and were frequently employed in broilers as growth promoters. Previously, antibiotics held a massive position in the industry, which were widely used in broilers as growth promoters. Nowadays, research efforts are being focused on reducing the use of antibiotics in livestock farming, especially in light of the bacterial resistance in human beings (Miles et al., 2006). Because of this, consumers and animal breeders are interested in feed and food that have significant bioactive components and improved health benefits (Cofrades et al., 2008). Antioxidants (natural or synthetic) that prevent the oxidation of lipids should be added to food products to retain their good quality (Capitani et al., 2013). Due to the presence of biologically active chemicals, aromatic plants are particularly important in animal feed (Asghar et al., 2021). Essential oils (Eos) support animal immunology, improve digestive enzymes, increase feed conversion ratio, and have antioxidant properties. According to Akram et al. (2021) using EOs in feed is a quick and easy technique to increase livestock output. Different plants, including garlic, ginger, oregano, black cumin, curcumin, cinnamon, rosemary etc. contain biologically active chemicals.

Black cumin (*Nigella sativa* L.) is an herbaceous plant with medicinal and aromatic properties and belongs to the Ranunculaceae family. It is grown each year and has a maximum height of 20 to 30 cm (Demirci et al., 2019). The phenolic chemicals it contains, the seed of black cumin is utilized in a variety of industries (food, medicine, cosmetics, etc.) and is grown in various climatic and geographic regions. Although black cumin seed (BCS) has a very faint aroma, Naz (2011) found that it aids in digestion and reduces stomach and intestinal gas. According to Shokri (2005), *Nigella sativa* contains a variety of pharmacologically bioactive substances, including thymoquinone, dithymoquinone, carvacrol, thymol, nigellicine-N-oxide, nigellidine, and hedrin. Antimicrobial and antioxidant properties can be revived by black cumin (Jaliljadeh et al., 2011). Other essential components of black cumin include sabinene, carvon, carveol, flavonoids, polysaccharides, coumarin, and cuminaldehyde, which have antifungal, antibacterial, antispasmodic, anti-inflammatory, and analgesic properties.

Black cumin seed contains 91.50-94.48% dry matter (DM), 34.49-41.60% fat, 16.00-26.70% protein, 24.90% nitrogen-free extract, 23.50-33.20% total carbohydrate, 7.94-8.40% cellulose, 3.77-4.86% ash, amino acids (glutamic acid, arginine, aspartic acid), minerals (Ca, P, Na, K, Fe, Cu, Zn, Se, Mg, Mn), and vitamins (A, C, thiamine, niacin, pyridoxine). BCS also contains 0.5-1.6% essential oils (thymoquinone, dithymoquinone, thymohydroquinone, nigellon, thymol, carvacrol, α and β pinene, d-limonene, pcymen), alkaloids, sterols (betasosterol, sychloeikolenol, sykloartenol, sterol esters, sterol glucosides), saponins, and quinones (Tufan et al., 2015a). According to Işk et al. (2019), BCS was high in fatty acids such oleic acid, linolenic acid, and palmitoleic acid; 0.5-1.6% yellowish volatile fatty acid, 28-42% fat, 23-37% protein, 4.41-4.86% ash, 33-40% total carbs, and other phytochemicals were discovered to be present in BCS, which was also reported to be an excellent source of protein, crude fat, cellulose, and macro minerals in another study (Kumar et al., 2017). According to Nehme et al. (2021), black cumin (*Nigella sativa*) has a very high concentration of carbs, protein, amino acids, lipids, calcium, potassium, phosphorus, and magnesium (Sultan et al., 2009). In Bangladesh, there is still a dearth of information about the quail's production and development capabilities and meat quality. Since black cumin has many traditional uses and has attracted a lot of scientific attention over the years, its active ingredients have been thoroughly investigated (Menounos et al., 1986; Atta-ur-Rahman et al., 1992; Al-Gaby, 1998; Ghosheh et al., 1999). To our knowledge, no research has been done on how ingestion of black cumin seeds affects quail performance in Bangladesh. Therefore, adding black cumin seed to the ration of quails may have a good effect on the amount and quality of the meat produced. In this study, we hypothesized

that the supplementation of black cumin seed to the ration of quail would enhance the growth performance and carcass quality of quail. The investigation's primary goal is to determine how black cumin powder affects the performance and carcass characteristics of Japanese quail.

Methodology

The present study was conducted at Sher-e-Bangla Agricultural University Poultry Farm to investigate the effect of supplementation of different levels of black cumin seed on the overall performance of Japanese quail. A total of 450 Japanese quail were used in the experiment, which were raised under a cage rearing system.

Experimental materials, birds and treatments

The experimental house was carefully prepared with proper ventilation to ensure good air circulation and reduce harmful gases, promoting the health of the quail. It was also thoroughly cleaned with detergent to create a suitable environment for studying the effects of dietary supplementation of black cumin seed on performance of Japanese quail.

A collection of 450 experimental quails (20-days old) embarked on a journey from Faridpur, enduring a lengthy 7–8 hours trudge to reach their destination at the Poultry farm of Sher-e-Bangla Agricultural University, Dhaka. Upon arrival, the quails were given a rest period of 15-20 minutes. Subsequently, the birds were randomly distributed into six dietary treatment groups, comprising 75 quails. The initial weight of the birds under different treatment is presented in Table 1.

The experimental treatments include T_0 = control (basal diet), T_1 = basal diet + 0.5% black cumin seed, T_2 = basal diet + 1.0% black cumin seed, T_3 = basal diet + 1.5% black cumin seed, T_4 = basal diet + 2.0% black cumin seed, and T_5 = basal diet + 2.5% black cumin seed. The experimental layout is given in the Table 2.

Table 1. Initial weight of the experimental birds (20-days old) in different treatments

Dietary Treatments	Initial Weight (g/bird)
T_0	89.93
T_1	91.51
T_2	89.84
T_3	90.82
T_4	89.62
T_5	92.89

Collection and preparation of black cumin seed

The black cumin seed was collected from Savar, Dhaka and also from Sher-e-Bangla Agricultural University mini market. In this study raw black cumin seed was used with ration. First, the black cumin seeds were left to dry in the sun. Lastly, the black cumin seed was stored in two airtight containers for later use.

Table 2. Layout of the experiment

Dietary Treatments	Arrangement of treatments	Replications					Total number of birds
		1	2	3	4	5	
T_0	Basal feed (Control)	.5 birds	15 birds	15 birds	15 birds	15 birds	75
T_1	Basal feed + 0.5% Black cumin seed	.5 birds	15 birds	15 birds	15 birds	15 birds	75
T_2	Basal feed + 1.0% Black cumin seed	.5 birds	15 birds	15 birds	15 birds	15 birds	75
T_3	Basal feed + 1.5 % Black cumin seed	.5 birds	15 birds	15 birds	15 birds	15 birds	75
T_4	Basal feed + 2.0 % Black cumin seed	.5 birds	15 birds	15 birds	15 birds	15 birds	75
T_5	Basal feed + 2.5 % Black cumin seed	.5 birds	15 birds	15 birds	15 birds	15 birds	75
Grand Total		**90**	**90**	**90**	**90**	**90**	**450**

Chemical composition of black cumin seed

The chemical composition of black cumin seed is stated in Table 3.

Table 3. Chemical composition of black cumin seed

Nutritional Parameter	Composition
Moisture content	5.52-8.50%
Crude protein	20-26.7%
Ash	3.77-4.86%
Total carbohydrates	23.5-33.2%
Ether-extractable lipid	34.49-38.72%

Source: Cheikh-Rouhou et al. (2007)

Managemental activities

Room temperature and relative humidity

During the experimental period, room temperature and relative humidity were meticulously monitored using a digital thermo-hygrometer. The recorded data revealed consistent conditions, with the average room temperature ranging between 26 to 30 °C and the relative humidity maintained within a narrow band of 55 to 60%.

Ration and feeding management

In this study, the Japanese quails were given broiler starter feed of Kazi Farms Limited and soyabean meal in a ratio of 9:1 to meet up the nutritional requirement of quail (Table 4). The chemical composition of broiler starter feed is shown in Table 5. Quails require a carefully managed feeding to ensure optimal health and productivity. Typically, quails aged around six months consume approximately 30-35 g of feed per day. Each bird was given 22 g of feed every day until they reached 5 weeks old (which is the 3rd week of rearing). After that, the amount of feed per bird was increased to 28 g/day until they reached 8 weeks old (which is the 5th week of rearing). The amount of feed consumed by the quails was measured regularly.

Table 4. Composition of experimental diet

Feed Items	Allocated Percentage
Broiler Starter	90
Soyabean Meal	10

Watering management

Watering management is crucial for maintaining the health and productivity of quail in a farming operation. Quails require constant access to clean water to stay hydrated and thrive. In this study every day, the birds were given 10 liters of water in total. For each specific treatment, they were given only 3 liters of water. No antibiotics or medicines were added to the water supply.

Table 5. Composition of broiler starter feed

Nutritional Parameters	Composition (%)
Moisture	12.0
Crude protein	21.5
Crude fat	5.0
Fiber	5.0
Ash	8.0
Methionine	0.64
Lysine	1.28

Source: Kazi Farms Ltd.; 50 Kg packet

Lighting management

Lighting management is crucial for optimizing the production and well-being of quail in both commercial and backyard settings. Proper lighting programs play a significant role in regulating the reproductive behavior, growth, and overall health of quail. In this study, 14-16 hours of lighting provided to ensure proper growth and development of the Japanese quails.

Debeaking

The procedure for debeaking of quail birds involves securely restraining the bird to minimize stress and movement, usually by holding its body gently but firmly. Next, an electric debeaking machine is utilized to carefully trim the tip of the beak, typically removing about one-third to one-half of its length. This process is performed swiftly and precisely to minimize pain and bleeding. After debeaking, the birds are monitored closely for any signs of discomfort or complications, and appropriate measures are taken to ensure their well-being.

Biosecurity measures and hygiene

In this study, a footbath set up used right by the entrance to stop any germs from getting in. Also, a disinfectant solution used in the footbath. Also kept everything clean and sanitized on the farm and around it. The dropping tray and the floor also cleaned with detergent. Hygiene was kept good during the whole experiment. The droppings tray was cleaned two times every week. Water containers were cleaned every day before filling them with water.

Ventilation system

In this study, a well ventilation system is maintained, promoting healthier quail birds and maximizing growth. In this experiment the shed took place facing south and had open sides, because of the wired grill allowing air to flow. It was easy to get rid of harmful gases from the farm.

Recorded parameters

The data was recorded for feed consumption (FC), live weight (LW), body weight gain (BWG), temperature, and humidity during the whole experimental period.

Data collection

FC

The amount of feed denied was subtracted from the total amount of feed supplied each replication to determine the amount of FC. Every day, the amount of feed that was accepted and rejected was weighed. Furthermore, the average and total amount of FC by each replication was recorded. The amount of FC in a replication was divided by the total number of birds in each replication to determine the FC.

$$FC\ (g/bird)\ = \frac{Total\ feed\ consumption\ in\ each\ replication}{Number\ of\ birds\ in\ each\ replication}$$

BWG

The initial BW and weekly BW of each replication were closely monitored throughout the study to determine the final BWG per quail. By subtracting the starting BW from the final BW of the birds, the average BWG of each replication was determined.

$$BWG\ =\ Final\ weight\ -\ Initial\ weight$$

Feed conversion ratio (FCR)

The practice of monitoring daily FC within each replication allows for the calculation of final FCR and the determination of total FC per bird. The entire amount of FC divided by the weight of birds in each replication was used to compute the FCR.

$$FCR\ = \frac{Average\ Feed\ intake\ (g)}{Average\ Body\ weight\ (g)}$$

Mortality of quail

The process described entails recording the instances of death in each replication, enabling the calculation of both survivability and mortality rates. Additionally, the mortality rate, derived from these death records, provides insights into the frequency or probability of death within the studied population or experimental conditions.

Determination of dressing percentage (DP)

At 35 days of age, three birds were randomly selected from each replication and slaughtered to determine the DP of quail. Using a knife and the halal procedure, all the birds were slaughtered. Prior to being slaughtered, each living bird was weighed. Using a sharp knife, the jugular vein, carotid artery, and trachea were severed in one cut to slaughter the birds, which were then allowed to bleed out completely for at least two minutes. Sharp scissors and a hand were used to remove the quails' outer skin. After that, the corpses

were thoroughly cleaned to get rid of any loose feathers and other foreign objects. The body was then dissected and eviscerated. The gall bladder was removed from the liver after the liver and heart were extracted from the remaining viscera. The gizzard was then extracted. Lastly, the dressing yield was computed by deducting the weight of the feathers, blood, head, shank, heart, liver, and digestive system.

$$Dressing\ yield = Live\ weight - (blood + feathers + shank + head + liver + heart + digestive\ system)$$

By deducting the head, neck, digestive system, blood, feathers, and shank from the live weight, the dressing yield was calculated. The neck, gizzard, liver, and heart were regarded as giblets. The following calculation was used to compute the DP of the bird.

$$DP = \frac{\text{Dressing yield (g)}}{\text{Live weight (g)}} \times 100$$

Dressing yield = Breast, thigh, drumstick, back, wing, giblet, abdominal fat weight

Statistical analysis

All of the data were gathered, summed, and examined in accordance with the study's goals. The preliminary data calculation was practiced using the Excel application. Using the Statistical Package for the Social Sciences (SPSS version 26.0) and one-way ANOVA, the acquired data was statistically analyzed in accordance with the completely randomized design (CRD) principles. The Duncan's multiple comparison test was used to compare mean differences, with a significance level of $p<0.05$.

Results and Discussion

The present study was performed to investigate the impact of dietary supplementation of different level of black cumin seed on the growth performance and carcass characteristics of Japanese quail. The growth performances of Japanese quail were evaluated by average LW, average BWG, average FC, FCR, weekly BWG, and survivability of the birds. Carcass characteristics were taken by DP, carcass weight, and relative weight of giblet organs. The results of this research with discussion are given below:

Effects of supplementation of different levels of black cumin seed on growth performance of Japanese quail

Effects on weekly FC

In the 1st week of rearing, T_0 (control/basal diet) bird consumed (g/bird) 18.80±13.00, T_1 (basal diet + 0.5% black cumin seed) bird consumed (g/bird) 16.22±15.27, T_2 (basal diet + 1.0% black cumin seed) bird consumed (g/bird) 17.00±8.66, T_3 (basal diet + 1.5% black cumin seed) consumed (g/bird) 16.93, T_4 (basal diet + 2.0% black cumin seed) consumed (g/bird) 17.13±3.60, and T_5 (basal diet + 2.5% black cumin seed) consumed (g/bird) 16.40 (Table 6). In the 2nd week of rearing, T_0 consumed (g/bird) 19.38±4.61, T_1 consumed (g/bird) 19.48±1.92, T_2 consumed (g/bird) 19.56±0.00 g, T_3 consumed (g/bird) 19.48±1.92, T_4 consumed (g/bird) 19.56±0.00 g, and T_5 consumed (g/bird) 19.56±0.00 (Table 6). During the 3rd week of rearing, T_0 consumed (g/bird) 25.04±7.50, T_1 consumed (g/bird) 21.38±27.68, T_2 consumed (g/bird) 21.42±18.71, T_3 consumed (g/bird) 22.27±14.93, T_4 consumed (g/bird) 21.75±4.04, and T_5 consumed (g/bird) 19.98±17.89 (Table 6). Then, in the 4th week of rearing, T_0 consumed (g/bird) 27.04±3.21, T_1 consumed (g/bird) 23.20±52.84, T_2 consumed (g/bird) 25.40 ±39.84, T_3 consumed (g/bird) 26.38±24.82, T_4 consumed (g/bird) 26.22±27.15, and T_5 consumed (g/bird) 25.87±32.92 (Table 6). Lastly, in the 5th week of rearing, T_0 consumed (g/bird) 26.53±3.46, T_1 consumed (g/bird) 22.71±30.73, T_2 consumed (g/bird) 24.73±9.64, T_3 consumed

(g/bird) 25.51±9.07, T_4 consumed 25.44±13.79, and T_5 consumed 23.73±43.26 (Table 6). Statistical analysis revealed that significant differences ($p<0.05$) in FC among the dietary six treatments in 1st, 3rd and 5th week of rearing. There were no significant differences ($p>0.05$) observed among the dietary treatments for the 2nd and 4th week of rearing. The impact of various black cumin concentrations (1.0%, 2.0%, or 4.0%), and it was found that Japanese quail fed 2.0% black cumin powder had the maximum FC and BWG (Boka et al., 2014). Throughout the entire five weeks of the trial, Asghar et al., (2022) observed no change in the weekly FC in relation to black cumin seed powder. A discernible positive correlation between the inclusion of black cumin at a rate of 5 gm/kg in the broiler diets and enhanced FC over the specified periods, underscoring the potential of black cumin as a beneficial dietary supplement for poultry (Laudadio et al., 2022). Over the entire trial period, the total FC/bird varied slightly, with averages of 4.467±0.01 kg, 4.496±0.01 kg, 4.613±0.01 kg, and 4.613±0.01 kg for feed formulations containing 1.0%, 2.0%, 3.0% of black cumin powder, respectively (Devi et al., 2022a). Therefore, the addition of black cumin in quail diet increases the weekly FC of Japanese quail.

Table 6. Effect of supplementation of different levels of black cumin seed on weekly feed consumption (g/bird) of Japanese quail

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week
T_0	18.80^{b} ±13.00	19.38±4.61	25.04^{c} ±7.50	27.04±3.21	26.53^{b} ±3.46
T_1	16.22^{a} ±15.27	19.48±1.92	21.38^{ab} ±27.68	23.20±52.84	22.71^{a} ±30.73
T_2	17.00^{a} ±8.66	19.56±.00	21.42^{ab} ±18.71	25.40±39.84	24.73^{ab} ±9.64
T_3	16.93^{a} ±3.60	19.48±1.92	22.27^{b} ±14.93	26.38±24.82	25.51^{ab} ±9.07
T_4	17.13^{a} ±1.73	19.56±.00	21.76^{ab} ±4.04	26.22±27.15	25.44^{ab} ±13.79
T_5	16.40^{a} ±13.89	19.56±.00	19.98^{a} ±17.89	25.87±32.92	23.73^{ab} ±43.26
Level of Significance	*	NS	*	NS	*

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). NS= Non-significant ($p>0.05$). ^{abc}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on total FC

The total FC of the Japanese quail was determined to know the effect of feeding different level of black cumin seed on FC of the Japanese quail. The final FC per bird (Figure 1) varied significantly ($p<0.05$) across the different dietary treatments. The average of total FC (g/bird) of Japanese quail at the end of the experiment in the dietary group T_0, T_1, T_2, T_3, T_4, and T_5 were 817.60, 720.95, 756.78, 773.99, 770.78 and 738.73 respectively (Figure 1). Adding BCS to the quail feed was determined to be ineffective in terms of FC of the quails and FCR compared to the control group. Moreover, increasing the amount of BCS added to the feed was found to decrease the FC and improve the FCR. In 1.0 and 2.0% BCS supplementation decreased the FC compared to 0.50% BCS supplementation and FCR improved only in 1.0% BCS (Ghasemi et al., 2014). There were similar studies in the literature reporting that adding BCS or BCS oil to the quail feed not only reduces the FC (Attia and Al-Harthi, 2015) but also improves the FCR (Arif et al., 2018; Szczerbińska et al., 2020). Therefore, the supplementation of black cumin seed in quail diet decreases the final FC of the Japanese quail.

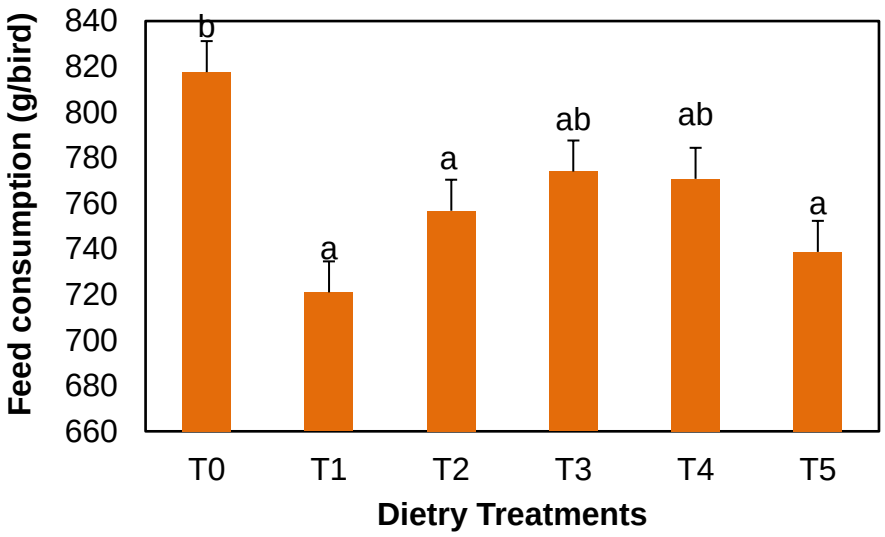

Figure 1. Effect of supplementation of different levels of black cumin seed on total feed consumption (g/bird) of Japanese quail

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE, one-way ANOVA (SPSS, Duncan method). Bar represents the standard error of the means (n=75). ab: Values bearing different letters above bar differ significantly at the level of $p<0.05$.

Effects on weekly LW

The Table 7 displays a notable significant ($p<0.05$) difference in the week's weight across the six dietary treatments. In the 1st week of rearing, T_0 (control/basal diet) had a weight (g/bird) of 118.06±1.00, T_1 (basal diet+ 0.5% black cumin seed) was 115.86±0.99, T_2 (basal diet + 1.0% black cumin seed) recorded 118.02±1.80, T_3 (basal diet + 1.5% black cumin seed) showed 121.71±1.77, T_4 (basal diet + 2.0% black cumin seed) was 121.50±1.56, and T_5 (basal diet+ 2.5% black cumin seed) had a weight (g/bird) of 117.64±1.56. In the 2nd week of rearing, the weights (g/bird) were 135.67±1.66 for T_0, 132.04±1.00 for T_1, 136.80±1.82 for T_2, 138.31±1.88 for T_3, 136.29±2.03 for T_4, and 132.71±1.33 for T_5. During the 3rd week of rearing, T_0 recorded 147.20±1.66, T_1 was 152.58±2.11, T_2 had 158.22±2.13, T_3 showed 165.29±1.88, T_4 was 161.71±1.70, and T_5 recorded 153.89±1.92. In the 4th week of rearing, T_0 weighted (g/bird) 157.67±1.88, T_1 was 156.07±1.50, T_2 recorded 166.77±1.67, T_3 showed 172.87±1.37, T_4 was 170.11±1.28, and T_5 had 160.38±1.78. Finally, in the 5th week of rearing, T_0 recorded a weight (g/bird) of 164.44±1.76, T_1 was 159.30±1.99, T_2 had 170.56±2.05, T_3 showed 179.33±2.01, T_4 was 176.93±1.95, and T_5 had a weight (g/bird) of 168.09±2.35. Providing Japanese quails with a diet containing 0.80% black cumin seed resulted in a body weight (g/bird) of 173.30, whereas a diet containing 1.60% black cumin seed led to a higher weight (g/bird) gain of 207.89 (Kesab et al., 2023). Feeding Japanese quails 500 mg of cumin oil and black seed per kilogram of body weight resulted in a significant gain of 215.26 g in week five and in week three and four it consume 108.47 g and 155.39 g (Al-Ardhi et al., 2020). It was observed that Japanese quail given 3.0% black cumin seed relative to their BW experienced notable weight over successive weeks. In the fourth week, the average weight was 145.89 g, increasing to 191.15 g in the fifth week, and further to 225.44 g in the sixth week (Abdou and Rashed, 2015). Giving 1.0% of black seed resulted body weight of 200.8 g, whereas feeding them 1.5% of black seed their body weight led to a weight gain of 198.9 g (Tahan and Bayram, 2011). Therefore, the supplementation of black cumin seed in quail diet increases the weekly live weight and a significantly increased weight is observed when black cumin 1.0-1.5% level added.

Table 7. Effect of supplementation of different levels of black cumin seed on weekly live weight (g/bird) of Japanese quail

Dietary Treatments	1st Week weight (g)	2nd Week weight (g)	3rd Week weight (g)	4th Week weight (g)	5th Week weight (g)
T_0	118.06^{ab}±1.00	135.67^{ab}±1.66	147.20^{a}±1.66	157.67^{a}±1.88	164.44^{ab}±1.76
T_1	115.86^{a}±0.99	132.04^{a}±1.00	152.58^{ab}±2.11	156.07^{a}±1.50	159.30^{a}±1.99
T_2	118.02^{ab}±1.80	136.80^{ab}±1.82	158.22^{bd}±2.13	166.77^{ac}±1.67	170.56^{bd}±2.05
T_3	121.71^{b}±1.77	138.31^{b}±1.88	165.29^{d}±1.88	172.87^{c}±1.37	179.33^{d}±2.01
T_4	121.50^{b}±1.56	136.29^{ab}±2.03	161.71^{cd}±1.70	170.11^{bc}±1.28	176.93^{cd}±1.95
T_5	117.64^{ab}±1.56	132.71^{ab}±1.33	153.89^{ac}±1.92	160.38^{ab}±1.78	168.09^{ac}±2.35
Level of Significance	*	*	*	*	*

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). ^{abcd}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on weekly BWG

The weekly weight gain (g/bird) of Japanese quail subjected to different treatments presented in Table 8. In the 1st week of rearing, the quail in the T_4 group, which received a diet with 2.0% black cumin seed, exhibited the highest weight (g/bird) gain at 31.89±2.30. This was followed by the T_3 group (1.5% black cumin seed) with 30.53±0.94, the control group T_0 (28.67±2.13), T_2 group (1.0% black cumin seed) with 28.18±1.16, T_5 group (2.5% black cumin seed) with 24.76±1.96, and the T_1 group (0.5% black cumin seed) with the lowest gain of 24.35±1.18. During 2nd the week of rearing, the T_2 group showed the highest gain (g/bird) (18.78±0.45), followed by T_3 (16.96±1.21), T_0 (17.07±2.35), T_1 (16.18±0.16), T_5 (15.07±0.81), and T_4 with the least gain (g/bird) (14.78±0.85). In 3rd week of rearing, the T_3 group again led with 26.98±2.49, closely followed by T_4 (25.42±1.85), T_2 (21.42±1.47), T_5 (21.18±3.65), T_1 (20.53±0.15), and the control group T_0 with a significant ($p<0.05$) drop to 11.53±5.66. During the 4th of rearing, results showed T_0 achieving the highest weight (g/bird) gain (11.02±3.12), followed by T_3 (7.58±3.26), T_5 (6.49±0.52), T_2 (5.22±2.62), T_4 (8.40±1.10), and T_1 with the lowest at 3.48±4.62. In the 5th week of rearing, T_5 recorded the highest gain (g/bird) (7.71±1.43), followed by T_2 (7.11±0.40), T_4 (6.82±2.38), T_3 (6.47±1.40), T_1 (6.96±1.75), and T_0 (6.22±1.16). Week 1st and 3rd shows a significant ($p<0.05$) difference of weight gain among the treatments other hand 2nd, 4th and 5th week shows no significant ($p>0.05$) differences between the treatments respectively. With the exception of the 1st week, adding BCS to the quail meal had no effect on the BW of the quails in comparison to the control group. Nonetheless, notable distinctions were seen between the BCS groups with regard to LW and LW increase. When compared to 2.0% BCS, the LW of quails in 0.50% BCS increased dramatically. Stated differently, LW and LW increase were adversely influenced by adding more BCS to the meal. Similarly, some research in the literature contends that adding more BCS to the feed either improves or negatively impacts LW, while others claim that it has no effect on LW (Karadağoğlu et al., 2019; Kumar and Patra, 2017). Even while the results of this study showed that adding BCS to quail diet did not substantially alter the LW of quails when compared to the control group, one could argue that LW of quails, especially those in the 0.50 and 1.00% BCS groups, tend to increase (Abd El-Hack et al., 2018; Tufan et al., 2015a). This improvement could result from BCS's beneficial effects on the digestive tract, which include boosting food digestion and having anti-bacterial properties (Abd El-Hack et al., 2016; Srinivasan, 2018). Therefore, in this study supplementation of different level of black cumin seed in the diet is evident that weekly BWG significantly increase in Japanese quail.

Table 8. Effect of supplementation of different levels of black cumin seed on weekly weight gain (g/bird) of Japanese quail

Dietary Treatments	1st Week weight gain (g/bird) (Mean± SE)	2nd Week weight gain (g/bird) (Mean± SE)	3rd Week weight gain (g/bird) (Mean± SE)	4th Week weight gain (g/bird) (Mean± SE)	5th Week weight gain (g/bird) (Mean± SE)
T_0	28.67^{ab}±2.13	17.07±2.35	11.53^{a}±5.66	11.02±3.12	6.22±1.16
T_1	24.35^{a}±1.18	16.18±0.16	20.53^{ab}±0.15	3.48±4.62	6.96±1.75
T_2	28.18^{ab}±1.16	18.78±0.45	21.42^{ab}±1.47	5.22±2.62	7.11±0.40
T_3	30.53^{b}±0.94	16.96±1.21	26.98^{b}±2.49	7.58±3.26	6.47±1.40
T_4	31.89^{b}±2.30	14.78±0.85	25.42^{b}±1.85	8.40±1.10	6.82±2.38
T_5	24.76^{a}±1.96	15.07±0.81	21.18^{ab}±3.65	6.49±0.52	7.71±1.43
Level of Significance	*	NS	*	NS	NS

T_0 = Control (basal diet), T_1 = Basal diet +0.5% black cumin seed, T_2 = Basal diet +1.0% black cumin seed, T_3 = Basal diet +1.5% black cumin seed, T_4 = Basal diet +2.0% black cumin seed, T_5 = Basal diet +2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). ^{ab}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on BWG

The BWG of the Japanese quail was determined to know the effect of feeding different level of black cumin seed on BWG of the Japanese quail. The relative total BWG (g/bird) of Japanese quail in the dietary group T_0, T_1, T_2, T_3, T_4 and T_5 were 74.51, 71.51, 80.71, 88.51, 87.31 and 75.73 respectively (Figure 2). The results showed that there were significant differences ($p<0.05$) were found among the dietary treatments for BWG. According to Seidavi et al. (2020), adding BCP oil (2.0% and 0.5%) to quail meals improved performance (growth and egg production) and decreased the number of harmful bacteria in the gut. Abbas and Ahmed's (2010) shows that the birds fed a meal enhanced with 1.0% or 2.0% black cumin had significantly ($p<0.05$) lower BWG and unchanged FCR, which is in contrast to our findings. The BWG, FC, FCR, and weight of various body organs (breast and thigh) were all impacted by the black cumin addition, according to Naula et al. (2019). Therefore, the supplementation of black cumin in quail diet increases the final BWG and a significantly increased BWG is observed when black cumin seed is added cat 1.5-2.0% level.

Effects on FCR

For the various dietary treatment groups T_0, T_1, T_2, T_3, T_4 and T_5, the corresponding FCR values were 10.97, 10.08, 9.38, 8.74, 8.83, and 9.82 respectively (Figure 3). There was significant ($p<0.05$) difference observed for FCR among the dietary treatments. The group T_2 (1.0% black cumin seed), T_3 (1.5% black cumin seed) and T_4 (2.0% black cumin seed) groups shows significantly ($p<0.05$) better FCR than the other groups including control. Abbas and Ahmed (2010) reported that the FCR of birds fed a meal supplemented with 1.0% or 2.0% black cumin was significantly unaffected, which is in contrast to our findings. According to Asghar et al. (2022), the group that followed a diet containing 2.0% BCP had a considerably higher ($p<0.05$) FCR than the other groups. In this study, better FCR is obtained may be due to the better intensive management, lower mortality rate and the positive effect of black cumin in the ration. Hence, the present study concluded that dietary supplementation of 1.0-2.0% black cumin seed in quail ration ameliorate the FCR of Japanese quail.

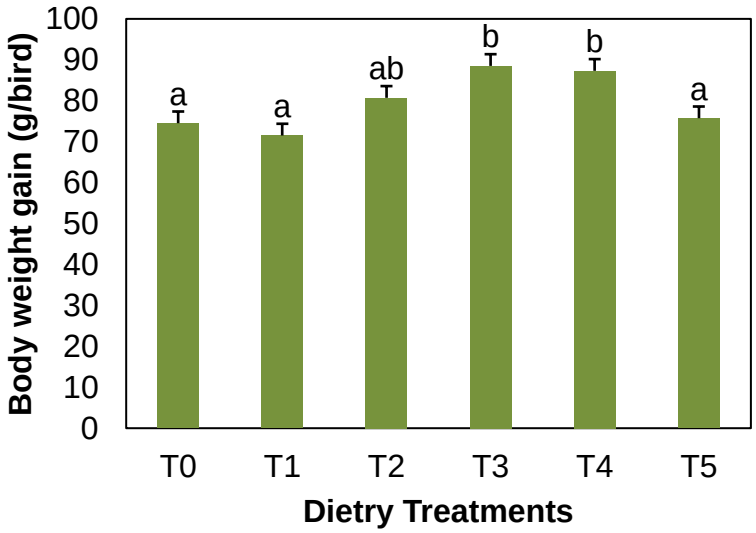

Figure 2. Effect of supplementation of different levels of black cumin seed on body weight gain (g/bird) of Japanese quail

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet +1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE, one-way ANOVA (SPSS, Duncan method). Bar represents the standard error of the means (n=75). ab: Values bearing different letters above bar differ significantly at the level of p<0.05.

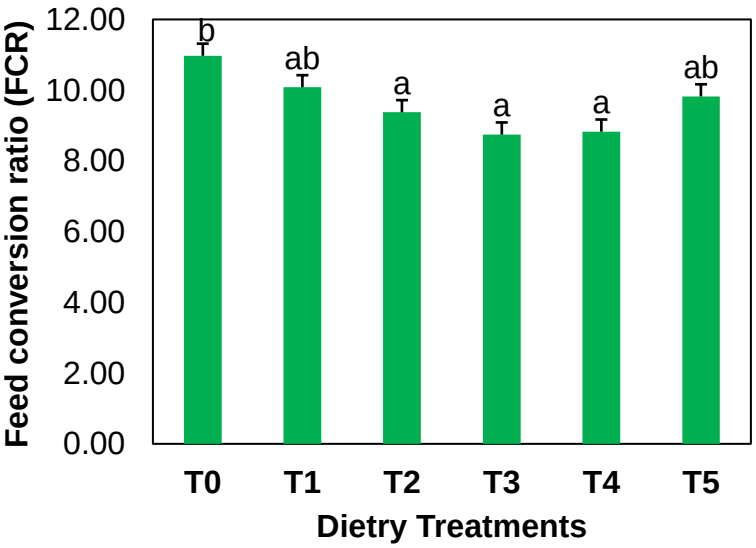

Figure 3. Effect of supplementation of different levels of black cumin seed on FCR of Japanese quail

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE, one-way ANOVA (SPSS, Duncan method). Bar represents the standard error of the means (n=75). ab: Values bearing different letters above bar differ significantly at the level of p<0.05.

Effects on LW and eviscerated weight (EW)

The highest recorded LW (g/bird) was observed in T_3, comprising 1.5% black cumin seed along with the basal diet, reaching a maximum of 183.74±3.41 (Table 9). Conversely, the lowest LW (g/bird) was documented in T_2, where 1.0% black cumin seed was combined with the control, with a minimum of 159.66±7.53 (Table 9). The other treatment groups displayed intermediate LW (g/bird), with T_0 at 177.26±6.61, T_1 at 160.69±4.18, T_4 at 178.95±3.06, and T_5 at 177.83±9.76 (Table 9). In terms of LW, the study revealed a significant ($p<0.05$) difference among the six dietary treatments ($p<0.05$) (Table 9). In case of EW (g/bird), the values for T_0, T_1, T_2, T_3, T_4 and T_5 were 105.50±4.60, 100.40±4.48, 99.83±3.97, 113.74±0.29, 110.80±3.80, and 114.26±4.60 respectively. There were significant ($p<0.05$) differences observed for EW among the different dietary treatments. The group with the 2.0% BCP diet had a significant higher LW in Japanese quail (Asghar et al., 2022). Furthermore, administering black cumin seed at a rate of 0.50% of the average LW resulted with an average recorded weight of 349.80 g (Taleb et al., 2023). Comparably, some research in the literature contend that adding more BCS to the feed has a negative impact on LW (Shewita and Taha, 2011; Talebi et al., 2021), has no effect on LW (Karadağoğlu et al., 2019; Kumar and Patra et al., 2017), or either positively enhances LW. Therefore, it's evident that the dietary supplementation of different level of black cumin seed significantly increases the LW and EW of Japanese quail.

Table 9. Effect of supplementation of different levels of black cumin seed on live weight and eviscerated weight of Japanese quail

Dietary Treatments	Live Weight (g/bird) (Mean± SE)	Eviscerated Weight (g/bird) (Mean± SE)
T_0	177.26^{ab}±6.61	105.50^{ab}±4.60
T_1	160.69^{a}±4.18	100.40^{a}±4.48
T_2	159.66^{a}±7.53	99.83^{a}±3.97
T_3	183.74^{b}±3.41	113.74^{b}±0.29
T_4	178.95^{ab}±3.06	110.80^{ab}±3.80
T_5	177.83^{ab}±9.76	114.26^{b}±4.60
Level of Significance	*	*

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). ^{ab}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on DP

The Figure 4 shows the DP of Japanese quail under different treatments involving varying levels of black cumin seed supplementation in their diet. In the dietary treatment T_0 (basal diet) had a DP of 59.49%, T_1 (basal diet + 0.5% black cumin seed) had a DP of 62.42%, T_2 (basal diet + 1.0% black cumin seed) had a DP of 62.58%, T_3 (basal diet + 1.5% black cumin seed) had a DP of 61.94%, T_4 (basal diet + 2.0% black cumin seed) had a DP of 61.89%, and T_5 (basal diet + 2.5% black cumin seed) had a DP of 67.77%. There were a significant ($p<0.05$) differences witnessed among the six dietary treatments and highest performance was perceived when black cumin seed added at 2.5% level. According to Khan et al., (2012); Schemmer et al. (2020) and Tufan et al. (2015b), BCP supplementation had no impact on the quail DP values. Quails fed a diet supplemented with BCP exhibited greater breast and thigh weights as well as a higher DP as compared to the

control group, as reported by Kumar et al. (2018). These results support of Khan et al. (2012), who discovered that the highest fed BCP addition group had higher DP values. Moreover, Jahan et al. (2015) found that the DP was not significantly ($p>0.05$) affected by the addition of the BCP extract (100–300 mg/kg). In a similar manner, dietary factors had no effect on the DP Seidavi et al. (2020). Therefore, the addition of black cumin in Japanese quail diet can significantly progresses the DP of Japanese quail at 2.5% level.

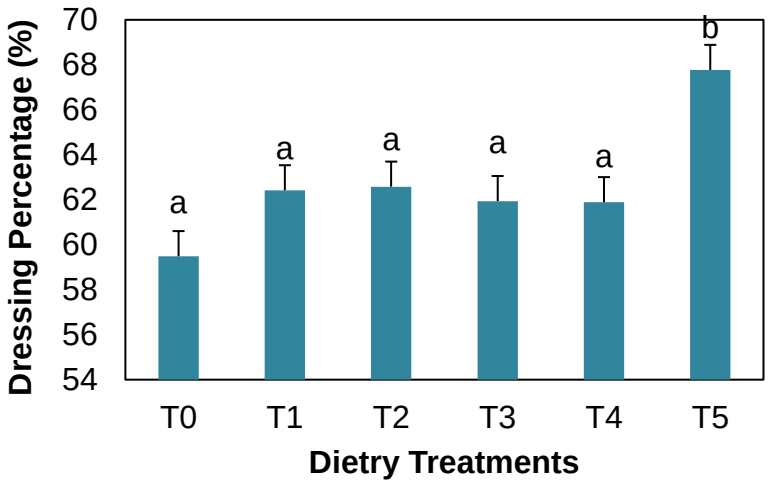

Figure 4. Effect of supplementation of different levels of lack cumin seed on dressing percentage (%) of the Japanese quails

T_0 = Control (basal diet), T_1 = Basal diet +0.5% black cumin seed, T_2 = Basal diet +1.0% black cumin seed, T_3 = Basal diet +1.5% black cumin seed, T_4 = Basal diet +2.0% black cumin seed, T_5 = Basal diet +2.5% black cumin seed, Values are mean ± SE, one-way ANOVA (SPSS, Duncan method). Bar represents the standard error of the means (n=75). ab: Values bearing different letters above bar differ significantly at the level of $p<0.05$.

Effects of supplementation of different levels of black cumin seed on carcass characteristics of Japanese quail

Effects on breast weight

The highest breast weight (%/bird) was observed in T_1 (basal diet + 0.5% black cumin seed), with a mean of 42.71±0.50, closely followed by T_4 (basal diet + 2.0% black cumin seed) with 41.89±0.67. The lowest breast weight (%) was recorded in T_0 (basal diet) at 38.23±0.38. Other treatments showed intermediate values i.e., T_3 (basal diet + 1.5% black cumin seed) at 4.51±0.89, T_5 (control) at 39.84±1.19, and T_2 (basal diet + 1.0% black cumin seed) at 38.85±0.21 respectively (Table 10). In terms of breast weight, a significant ($p<0.05$) difference among the six treatments was observed but the carcass weight in the treatment T_4 group was better than in any other treatment group. The weight of the carcass, breast, and thigh at 28 and 42 days of age were not impacted by the black cumin therapy (Shokrollahi and Sharifi, 2018). Higher breast percentages may result from the beneficial dietary effects of herbal plants on protein metabolism and nutrition utilization, according to a theory put out by Abd El-Hack et al., (2016). Therefore, the present study suggested that the supplementation of different level of black cumin seed in quail diet improve the breast weight in Japanese quail.

Effects on back weight

The highest back weight (%/bird) found in T_4 (basal diet + 2.0% black cumin seed) at 20.69±0.92 to the lowest in T_5 (basal diet + 2.5% black cumin seed) at 19.22±1.23. The other treatments exhibited back weights as follows T_3 (basal diet + 1.5% black cumin seed) at 18.91±1.44, T_2 (basal diet + 1.0% black cumin seed) at 19.84±1.34, T_0 (control) at 18.94±0.39, and T_1 (basal diet + 0.5% black cumin seed) at 18.58±0.41, indicating some variability in the effect of black cumin seed supplementation across different concentrations and also there no significant ($p>0.05$) difference was found between the dietary treatment groups (Table 10). Studies found that the higher outputs of carcasses and organs also found that poultry birds fed diets containing black cumin seed had improved growth performance (Durrani et al., 2007; Guler et al., 2006; Kumar et al., 2018). It was found by Abaza et al. (2008) that adding BC powder to quail feed greatly enhanced the carcass characteristics. Therefore, the present study suggested that the addition of black cumin seed in quail diet advance the back weight in Japanese quail.

Table 10. Effect of supplementation of different levels of black cumin seed on thigh, back, wing, breast and neck weight of Japanese quail based on carcass weight

Dietary Treatments	Breast (%/bird) (Mean± SE)	Back (%/bird) (Mean± SE)	Thigh (%/bird) (Mean± SE)	Wings (%/bird) (Mean± SE)	Neck (%/bird) (Mean± SE)
T_0	38.23^{a}±0.38	18.94±0.39	17.13±0.83	6.45^{b}±0.23	4.78±0.34
T_1	42.71^{b}±0.50	18.58±0.41	14.21±0.79	5.92^{ab}±0.22	4.73±0.25
T_2	38.86^{a}±0.21	19.84±1.34	15.08±0.81	6.52^{ab}±0.20	4.63±0.15
T_3	40.51^{a}±0.89	18.91±1.44	16.13±1.17	6.02^{ab}±0.22	4.17±0.25
T_4	41.89^{b}±0.67	20.69±0.92	14.65±0.54	5.871^{ab}±0.26	4.53±0.13
T_5	39.84^{a}±1.19	19.22±1.23	14.82±0.89	6.00^{a}±0.32	4.62±0.28
Level of Significance	*	NS	NS	*	NS

T_0 = Control (basal diet), T_1 = Basal diet + 0.5% black cumin seed, T_2 = Basal diet + 1.0% black cumin seed, T_3 = Basal diet + 1.5% black cumin seed, T_4 = Basal diet + 2.0% black cumin seed, T_5 = Basal diet + 2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). ^{ab}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on thigh weight

The highest thigh weight (%/bird) was found in T_0 (control) at 17.13±0.83, followed closely by T_3 (basal diet + 1.5% black cumin seed) at 16.13±1.17. The lowest value was recorded in T_1 (basal diet + 0.5% black cumin seed) at 14.21±0.79. Other treatments showed the following values T_2 (basal diet + 1.0% black cumin seed) at 15.08±0.81, T_4 (basal diet + 2.0% black cumin seed) at 14.65±0.54, and T_5 (basal diet + 2.5% black cumin seed) at 14.82±0.89 (Table 10). No significant ($p<0.05$) differences were observed between the dietary treatment groups. Naula et al. (2019) showed an impact of the black cumin additive on the BWG, FC, FCR, and weight of different body organs (breast and thigh). According to Kumar et al. (2018) quails given a feed enhanced with BCP had larger breast and thigh weights as well as a higher dressing percentage compared to the control. Therefore, the present study suggested that the addition of black cumin seed in quail diet develop the thigh weight in Japanese quail.

Effects on wings weight

The highest wing weight (%/bird) was observed in T_0 (control) at 6.45±0.23. The lowest was in T_4 (basal diet + 2.0% black cumin seed) at 5.871±0.26. The other treatment values included T_2 (basal diet + 1.0% black cumin seed) at 6.52±0.20, T_3 (basal diet + 1.5% black cumin seed) at 6.02±0.22, T_5 (basal diet + 2.0% black cumin) at 6.00±0.32, and T_1 (basal diet + 0.5% black cumin) at 5.92±0.22 (Table 10). In terms of wings weight, a significant ($p<0.05$) difference among the six dietary treatments was detected. Therefore, the present study suggested that the supplementation of black cumin seed in quail diet significantly improve the wings weight in Japanese quail.

Effects on neck weight

The highest neck weight (%/bird) was observed in T_0 (control) at 4.78±0.34, while the lowest was in T_3 (basal diet + 2.5% black cumin seed) at 4.17±0.25. Other treatments showed the following values T_1 (basal diet + 0.5% black cumin seed) at 4.73±0.25, T_5 (basal diet + 2.5% black cumin seed) at 4.62±0.28, T_4 (basal diet + 2.0% black cumin seed) at 4.53±0.13, T_2 (basal diet + 1.0% black cumin seed) at 4.63±0.15 (Table 10) and indicating no significant ($p>0.05$) differences among the dietary treatments. Data demonstrated from Table 10 implied that the treatment groups' carcass weights were superior to those of the T_4 group, which contained basal diet + 2.0% black cumin seed. The dressed wings, breast, and thigh showed substantial effects in the dietary treatment groups. According to the results of the slaughter characteristics, the only thing that was substantially impacted by 1.0% and 1.5% black cumin seed at 42 days was the relative weight of quail. The weight of the carcass, breast, thigh at 28 and 42 days of age were not impacted by the black cumin therapy (Shokrollahi and Sharifi, 2018). Therefore, the present study suggested that the addition of black cumin seed in quail diet develop the neck weight in Japanese quail.

Effects of supplementation different levels of black cumin seed on internal organs weight of Japanese quail

Effects on heart

The heart weight (%/bird) of Japanese quail showed no statistically significant ($p>0.05$) differences among the dietary treatments. For the heart weight (%/bird), the treatments show the following values, T_0 (control/basal diet) has 1.82±0.08, T_1 (basal diet + 0.5% black cumin seed) has 1.52±0.09%, T_2 (basal diet + 1.0% black cumin seed) has 1.71±0.16, T_3 (basal diet + 1.5% black cumin seed) has 1.55±0.15, T_4 (basal diet + 2.0% black cumin seed) has 1.52±0.01, and T_5 (basal diet + 2.5% black cumin) has 1.85±0.09 (Table 11). When BCS supplementation was used, Jahan et al. (2015) found variations in breast meat, drumstick meat, skin, and abdominal fat, but not in average heart, gizzard, or liver weight. Therefore, the present study suggested that the addition of black cumin seed in quail diet progress the heart weight in Japanese quail.

Effects on liver

The liver weight (%/bird) of Japanese quail also did not show statistically significant ($p>0.05$) differences among the dietary treatments. For the liver weight (%/bird), the treatments show the following values, T_0 (control) has 5.00±0.72, T_1 (basal diet + 0.5% black cumin seed) has 4.66±0.20, T_2 (basal diet + 1.0% black cumin seed) has 4.53±0.93, T_3 (basal diet + 1.5% black cumin seed) has 4.26±0.06, T_4 (basal diet + 2.0% black cumin seed) has 3.89±0.19, and T_5 (basal diet + 2.5% black cumin seed) has 6.73±0.50 (Table 11). According to Guler et al. (2006), the feed containing 1.0% BCS and antibiotics had a substantial impact on the weights of the liver. It has been shown by Erener et al. (2010) that dietary BCS increases carcass weight. With BCS feeding, Saleh (2014) observed a significant ($p<0.05$) rise in the weight of the breast muscle but no change in the weight of the liver. When BCS supplementation was used, Jahan et al. (2015) found variations in breast, drumstick, skin, and abdominal fat, but not in average heart, gizzard, or liver weight. Therefore, the present study advocated that the supplementation of black cumin seed in quail ration influences the liver weight in Japanese quail.

Table 11. Effect of supplementation of different levels of black cumin seed on internal organs of Japanese quail

Dietary Treatments	Heart (%/bird) (Mean± SE)	Liver (%/bird) (Mean± SE)	Gizzard (%/bird) (Mean± SE)	Abdominal Fat (%/bird) (Mean± SE)
T_0	1.82±0.08	5.00±0.72	3.49±0.68	3.13^{a}±0.18
T_1	1.52±0.09	4.66±0.20	3.20±0.88	4.46^{b}±0.46
T_2	1.71±0.16	4.53±0.93	4.37±0.23	4.14^{b}±0.43
T_3	1.55±0.15	4.26±0.06	3.79±1.05	4.66^{b}±0.4
T_4	1.52±0.01	3.89±0.19	3.29±0.74	3.68^{ab}±1.38
T_5	1.85±0.09	6.73±0.50	3.22±0.13	3.70^{ab}±0.17
Level of Significance	**NS**	**NS**	**NS**	*****

T_0 = Control (basal diet), T_1 = Basal diet +0.5% black cumin seed, T_2 = Basal diet +1.0% black cumin seed, T_3 = Basal diet +1.5% black cumin seed, T_4 = Basal diet +2.0% black cumin seed, T_5 = Basal diet +2.5% black cumin seed, Values are mean ± SE (n=75), one-way ANOVA (SPSS, Duncan method). SE= Standard Error. *= Significant difference ($p<0.05$). ^{ab}: Values bearing different letters within each column differ significantly at the level of $p<0.05$.

Effects on gizzard

For the gizzard weight (%/bird) of Japanese quail, no statistically significant ($p>0.05$) differences were noted among the dietary treatments. For the gizzard weight (%/bird), the treatments show the following values, T_0 (control) has 3.49±0.68, T_1 (basal diet + 0.5% black cumin seed) has 3.20±0.88, T_2 (basal diet + 1.0% black cumin seed) has 4.37±0.23, T_3 (basal diet + 1.5% black cumin seed) has 3.79±1.05, T_4 (basal diet + 2.0% black cumin seed) has 3.29±0.74, and T_5 (basal diet + 2.5% black cumin seed) has 3.22±0.13 (Table 11). When BCS was added to the diet, Khalaji et al. (2011) saw an increase in the relative weight of the gizzard, but no other changes were observed in the carcass characteristics. Therefore, this study recommended that the addition of black cumin seed in quail ration improves the gizzard weight in Japanese quail.

Effects on abdominal fat

The abdominal fat weight (%/bird) of Japanese quail showed statistically significant ($p<0.05$) differences among the dietary treatments. For the abdominal fat (%/bird), the treatments show the following values, T_0 (control) has 3.13±0.18, T_1 (basal diet + 0.5% black cumin seed) has 4.46±0.46, T_2 (basal diet + 1.0% black cumin seed) has 4.14±0.43, T_3 (basal diet + 1.5% black cumin seed) has 4.66±0.42, T_4 (basal diet + 2.0% black cumin seed) has 3.68±1.38, and T_5 (basal diet + 2.5% black cumin seed) has 3.70±0.17 (Table 11). Supplementing with BCS has been shown to increase weight in a number of trials including weight in the thigh, breast, edible internal organs, and abdominal fat (Kumar et al., 2018; Saleh, 2014). However, Ghasemi et al. (2014) found no evidence of a substantial impact of BCS on the percentage of the carcass, the weight of the internal organs, or the amount of fat in the abdomen. Dietary BCS had no discernible effects on dressing percentage, edible internal parts, abdominal fat, complete gut weight, or gut length (Ismail, 2011). Therefore, the existent study proposed that the addition of black cumin seed in quail diet significantly reduces the abdominal fat percentage in Japanese quail.

Conclusions

The study concluded that the addition of different levels of black cumin seed to quail rations led to a significant ($p<0.05$) improvement in production performance, including enhanced body weight, carcass characteristics, feed conversion ratio (FCR), and dressing percentage. The most notable improvements were observed with the inclusion of 1.5-2.0% black cumin seed with the feed. Therefore, the addition of 1.5-2.0% black cumin seed in quail diets is recommended to enhance the overall performance of meat quail.

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Conflict of interest

The authors stated that there are no conflicting interests.

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