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Study the effect of Cordyceps militaris supplement in the diet on Physiological Performance and Quality of Eggs of Japanese Quail

Rhehab M. Asmir, Bahaa A. Alsereah, and Assad H. Essa

Department of Veterinary Public Health, Veterinary Medicine College, University of Basrah, Iraq.

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Abstract

This research aims to study the effect of the Cordyceps militaris supplement in the feed on the Physiological Performance and Quality of Eggs of Japanese Quail. This study used unsexed Japanese quail chicks, one day old and with an initial weight of 10.3 - 8.8 grams. They were randomly distributed into 4 treatments. Each treatment had three replicates, and each replicate had 15 chicks in cages containing a battery. The current study included an experimental period of (42-72) days for the chicks. The transactions were as follows: T1: Control treatment (without any addition), T2: Treatment of adding Cordyceps militaris 1 mg/kg feed, T3: Treatment of adding Cordyceps militaris 2 mg/kg feed. T4: Treatment of adding Cordyceps militaris 4 mg/kg feed. Blood samples were collected on day 42 of the field experiment to measure cellular blood characteristics represented by (RBC, WBC, Hb, PCV) and some biochemical blood characteristics such as (total protein, glucose, albumin, globulin, cholesterol, triglycerides, creatinine, insulin, Uric acid, liver enzymes ALT and AST, and thyroid hormones T4 and T3. The qualitative characteristics of eggs were also measured. The results of this study showed the following: The highest significant difference ($P \leq 0.05$) was obtained for adding the Cordyceps militaris fungus 4 mg/kg feed to the diets on the concentration of red blood cells, white blood cells, blood hemoglobin, and PCV, total protein, albumin, globulin, and triglycerides, creatine, T3, T4. All treatments and the control group did not record any significant difference in the qualitative.

Keywords*:* Blood, Egg, Crdycepes, Quails.

INTRODUCTION:

After the great development in the poultry industry and the increasing need for poultry meat, it has become the focus of attention of many as it is an important source of animal protein, which is considered essential in human nutrition which leads to contributing to achieving food security as a result of intensive breeding and its adoption as a method of raising poultry. As a result of low or high temperatures and the exposure of birds to stress and disease, antibiotics were used in bird feeds, which left a negative impact on the poultry as a result of their deposition in their meat, which made the consumer It is not widely accepted, so attention has turned to using safe food additives such as the Cordyceps mushroom, which enhances growth and immunity in birds (1,2). Cordyceps militaris is a type of fungus that was described for the first time by the Swedish scientist Car Linnaeus in 1753. In the year 1818, it was renamed and remains with this name until the present by the German scientist. Johann Heinrich Friedrich Link (3). Cordyceps mushroom is a medicinal plant product used as a nutritional supplement, as it works to strengthen the body's

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immunity as well as improve health in animals (4). It has been shown that Mushroom components include sugars, glycosides, alkaloids, volatile oils, and organic acids (5). In the field of animal production, especially poultry production, the Cordyceps militaris fungus has proven its effectiveness by adding it to rations as a nutritional supplement, as studies have shown. An improvement in production performance, Egg quality, cholesterol in the yolk, inhibition of lipid peroxidation, an increase in egg weight, and an increase in egg mass. A clear decrease in egg cholesterol (6). C. militaris It is considered a nutritional supplement that may be beneficial to bird nutrition in terms of enhancing the quality of eggs produced and reducing egg cholesterol (7). As a result of these reasons, we concluded that Cordyceps militaris can be used as a good nutritional supplement for bird feeds.

Materials & Methods

Birds Management:

The chicks were divided into four treatments randomly, and each treatment had three replicates (15 birds per replicate), based on Complete Random Design. When the birds reached the sixth week of age. The chicks were fed with two types of diets: a growth diet (1-45 days) containing 22.26% crude protein and 3049 calories/kg of assimilated energy. The other diet is a productive diet from the age of (45-70) days, which contains 18.38% crude protein and 2930 calories/kg of represented energy from the age of (45-70) days, as shown in Table (1).

Table (1): Feed Ingredients and chemical analysis (8)

Ingredients	Growth diet (%)(1-45)day	Productive diet (%) (45- end of the experiment)
Yellow corn	47	45
Wheat	13	24
Protein concentrated (50% protein)	5	8
Soybean meal (48% protein)	31	21
Limestone	1	1.5
Vegetable oil	1.5	-
The mixture of vitamins and minerals	1.5	0.5
Total	**100**	**100**
Metabolic energy (kcal/kg)	3049	2930
Protein (%)	22.26	18.38
Calcium (%)	0.8	1.95
methionine%	0.50	0.50
Phosphorus (%)	0.58	0.8

Design of Study:

The research used One hundred eighty Japanese quail chicks, one day old, unsexed, with a starting weight ranging between 8.8-10.3 gm. The chicks were randomly divided into 4 treatments (45 chicks) for each treatment, with three replicates (15 chicks per replicate). Cordyceps militaris was added as a nutritional supplement to the feed for 6 weeks as follows:

1- Diet with no Cordyceps militaris added (Control)

2- Diet supplemented with 1.0 mg/kg feed of Cordyceps militaris.

3- Diet supplemented 2.0 mg/kg feed of Cordyceps militaris.

4- Diet supplemented 4.0 mg/kg feed of Cordyceps militaris.

After the end of the sixth week, specifically on day 42, we collected blood samples to conduct cellular and biochemical tests. The birds were separated in the second experiment, which represents the productive period, in the same way as the first experiment, where the sex ratio was 2:1. The process of collecting eggs from birds was done to measure the following characteristics: eggshell breaking strength, and eggshell thickness. albumen height, Huagh unit, egg yolk width, yolk index, and yolk color.

Physiological Parameters:

Blood samples were collected from the wing veins of three male birds from each treatment at the age of 42 days using a syringe. The blood was then placed horizontally in tubes that did not contain an anticoagulant, and then the samples were transferred to a centrifuge at a speed of 4000 rpm for 15 minutes. The serum was stored in plastic tubes marked at a temperature of (-20)° C until tests were conducted.

Cellular Traits of Blood:

Hematological parameters analysis was done in Biovet veterinary laboratory by using the manual procedure as following:

Total number of Red Blood Cells (RBC)

Calculate the total number of red blood cells using a hemocytometer, depending on According to (9)

Total number of Red Blood Cells = Number of Red Blood Cells in 5 squares x 10,000

Total number of White Blood Cells (WBC)

The direct method was used to calculate the number of white blood cells using a hemocytometer. The blood was drawn to the mark of 0.5, then the volume was completed to the mark of 11 using the dilution solution, which diluted the blood 20 times. After mixing the blood solution, the dilution solution is mixed well, and then a drop of the diluted mixture is placed over the cavity of the blood ratio measuring device (Haemocytometer). Then the numbers of white blood cells stained by the dark blue method are counted, and they may appear in a granular shape, as the squares of white blood cells were used to extract the total number by examining them under the microscope, based on (10).

Number of White Blood Cells (1000 cells / mm^3) = Total Number of Cells in 9 squares + (10% of Total Number of White Blood Cells) x 20

Hemoglobin Concentration (Hb)

Based on (10) to calculate hemoglobin concentration, the method used, is a graduated glass tube. A 20 ml pipette and a standard colored bottle contain sections to calculate blood hemoglobin as a percentage, then read that color compared to the color of the standard bottle. By adding (HCL concentration 0.1).

Packed Cell Volume (PCV):

According to (10), blood was drawn using fine capillary tubes. The end of the capillary tube was closed with wax immediately after the blood was drawn from it and placed horizontally in a centrifuge

at a speed of 1200 rpm/5 minutes. Using a special hematocrit ruler, the readings were recorded.

Biochemical Traits:

Total Protein concentration:

As for the concentration of total protein in blood serum, it was measured using a kit prepared by the French company BIOLABO-SAS. The absorbance of the samples was measured in a spectrophotometer at a wavelength of (550 nm) according to the following equation:

Total Protein (g/100 ml) = Sample Absorbance/ Absorbance of standard solution x 6. (11)

Albumin concentration:

The absorbance of the samples and the standard solution was measured in a spectrophotometer at a wavelength of 630 nm, and then the absorbance of each sample was recorded to measure the concentration of albumin in blood serum, according to the method of work described by the French company Biolab and according to the following equation: -

Total Albumin (g/100 ml) = Sample Absorbance/ Absorbance of Standard Solution x 5. (11)

Globulin concentration:

Using the difference between total protein and albumin, the concentration of globulin in blood serum was calculated based on the following equation:

Globulin Concentration g/100 ml = Total Protein Concentration - Albumin Concentration. (11).

Glucose Concentration:

The absorbance of the samples was measured in a spectrophotometer at a wavelength of (505 nm) according to the instructions of the French company (BIOLABO-SAS).

Glucose Concentration mg/100 ml = Sample Absorbance / Absorbance of Standard Solution x 100. (11).

Cholesterol concentration

The absorbance of the samples was measured in a spectrophotometer at a wavelength of (500 nm) according to the instructions of the French company (BIOLABO-SAS).

Cholesterol Concentration mg/100 ml = Sample Absorbance / Absorbance of Standard Solution x 200. (11).

Triglyceride concentration

The absorbance of the samples was measured in a spectrophotometer at a wavelength of (540 nm) according to the instructions of the French company (BIOLABO-SAS).

Triglyceride concentration mg/100 ml = Sample Absorbance / Absorbance of Standard Solution x 200. (11).

Measurement of AST & ALT enzyme activity

AST& ALT activity (U/L) was extracted using a standard curve. The absorbance of the samples was measured in a spectrophotometer at a wavelength of (505 nm) according to the instructions of the French company (BIOLAB).

Insulin concentration

Based on the method of(12), Insulin concentration was measured by drawing a straight-line graph of the insulin level in the phosphate buffer (pH = 6), by taking a range of concentrations from L/µmole - 50 L/µmole 250 and the absorbance at UV nm was read 214 in a spectrophotometer.

Uric acid Concentration

Using a kit prepared by the British company Randox and using the method (13), The absorbance of the samples was measured in a spectrophotometer at a wavelength of (600 nm).

Uric acid Concentration mg/100 ml = Sample Absorbance / Absorbance of Standard Solution x 5.

Creatinine Concentration

Based on the colorimetric method with protein precipitation for (14), the concentration of creatinine

was measured. Creatinine is reacted with picric acid in a basic solution to form a colored complex.

Creatinine Concentration mg/ deciliter= Sample Absorbance / Absorbance of Standard Solution x 2

Triiodothyronine (T3) & Thyroxin (T4) concentration:

The concentration of triiodothyronine (T3) &(T4) in blood serum was extracted and measured using an ELISA device.

Qualitative Traits of Eggs

Qualitative egg characteristics were measured by taking 10 eggs for each replicate. They were kept in the refrigerator for 24 hours at the end of the experiment at 72 days of age. Place the eggs in the refrigerator to stabilize the contents of the egg and for the thick egg whites to take on their full gelatinous consistency to facilitate the process. Height measurement (15).

Egg Shell Thickness (mm)

Using a Vernier (thickness measuring machine), the egg was measured from the pointed end and the broad end of each egg (after removing the membranes), then the final average shell thickness of each egg was calculated according to the following equation:

Average thickness Shell= Tapered Shell thickness (mm) + Broad Shell thickness (mm) /2 (15).

Albumen & Yolk Height.

Using a metal ruler, two readings of the thick albumen of each egg were recorded for the area extending from the yolk to the outer edge of the thick albumen.

Albumin & Yolk Diameter

The diameter of the yolk and the diameter of the white were measured using an electronic Vernier caliper

Huagh Unit

As indicated by (16), the Haugh unit was calculated according to the following equation:

Haugh unit = 100 Log (H+7.57-1.7W0.37)

H: represents the height of whiteness (mm)

W: represents the weight of the egg (g)

7.57: a fixed number

Yolk Index

Based on the equation of (17) and to calculate the yolk index, which represents the product of the height of the yolk (mm) divided by its diameter (mm), the diameter of the yolk was measured using an electronic Vernier caliper.

Yolk Index= Height of Yolk (mm) / Diameter of Yolk(mm)

Statistical analysis:

The research data was analyzed using a completely randomized design (CRD) using the ready-made statistical program SPSS, (18). To test the significance of the differences between the studied means, (19) a multinomial test was used, at the level of significance ($p<0.05$), and the mathematical model was used in data analysis.

Results

Effect of Cordyceps militaries to the diets on Cellular traits of blood: -

Table (2) indicates the effect of adding *Cordyceps militaris* fungus in different concentrations to quail diets on the concentration of cellular blood characteristics. The results showed that there was a higher significant difference ($P\leq0.05$) in the concentration of the total number of Red Blood cells (RBC), the total number of White Blood Cell (WBC), Hemoglobin Concentration (Hb), and Packed Cell Volume (PCV) in the group to which *Cordyceps militaris* fungus was added. (4 mg/kg feed), reaching (3.71, 30.80, 17.01&45.17) respectively, compared to the other groups, the control group recorded the lowest significant difference reaching (3.28, 25.30, 14.32 &37.48) respectively in those qualities.

Effect of Cordyceps militaries to the diets on some biochemical traits of blood during the Growth period:

Table (3) indicates the effect of adding *Cordyceps militaris* fungus in different concentrations to quail diets on the concentration of biochemical blood characteristics. The results showed that there was a higher significant difference (P≤0.05) in the concentration of total protein, albumin & globulin in the group to which *Cordyceps militaris* was added (4 mg/kg feed) reaching (6.26, 2.99, 3.51) respectively, while triglycerides recorded least significant difference, reaching (104.93) Compared to other groups, while control group recorded least significant difference, reaching (4.52,1.87, 2.95) in the concentration of total protein, albumin & globulin, respectively, while highest significant difference was recorded in concentration of triglycerides, reaching (124.55). In the same table, glucose & cholesterol did not record any significant difference in all groups.

Effect of Cordyceps militaries to the diets on some biochemical traits of blood during the Growth period:

Table (4) shows the effect of adding the *Cordyceps militaris* fungus in different concentrations to quail diets on the concentration of biochemical characteristics in the blood. The results showed a higher significant difference (P≤0.05) in the concentrations of Creatinin and triiodothyronine. (T3) & Tetraiodothyronine (T4) in the group to which *Cordyceps militaris* fungus (4 mg/kg feed) was added, reached (2700, 2.36 & 10.35), respectively, while the control group recorded the least significant difference in these characteristics, as it reached (1367, 1.63 & 8.79) compared to the other groups., In the same table, AST, ALT, Insulin, and Uric Acid did not record any significant difference in all groups.

Effect of Cordyceps militaries on Quality traits of eggs during productive period:

Table (5) shows the effect of adding the Cordyceps militaris fungus in different concentrations to quail diets on the concentration of Quality traits of eggs. The results showed did not record any significant difference in all groups.

Table (2) Effect of Cordyceps militaries to the diets on cellular traits of the blood during the Growth period (Mean ± Standard Error)

Group / Week	Control	Cordyceps militaries Group			Sig. 0.05
		1mg/kg	2mg/kg	4mg/kg	
Total number of Red Blood Cell (RBC) cell×10^6/ml	3.28±0.12^{c}	3.52±0.06^{b}	3.59±0.03^{ab}	**3.71±0.04^{a}**	*
Total number of White Blood Cell (WBC) cell×10^6/ml	25.30±1.00^{c}	26.05±0.94^{c}	27.76±0.64^{b}	**30.80±0.65^{a}**	*
Hemoglobin Concentration (Hb) mg/dl	14.32±0.71^{b}	15.35±0.63^{b}	16.59±0.20^{a}	**17.01±0.50^{a}**	*
Packed Cell Volume (PCV)	37.48±0.63^{d}	39.40±0.55^{c}	41.86±0.77^{b}	**45.17±1.31^{a}**	*

Small letters referred to significant differences among groups at (p≤0.05). N.S. referred to no significant difference. * Referred to a significant difference

Table (3) Effect of Cordyceps militaries on the diets on some biochemical traits of blood during the growth period. (Mean ± Standard Error)

Group / Week	Control	Cordyceps militaries Group			Sig. 0.05
		1mg/kg	2mg/kg	4mg/kg	
Total protein	4.52±0.04^{d}	4.93±0.02^{c}	5.74±0.00^{b}	**6.26±0.07^{a}**	*
Albumin	1.87±0.02^{d}	2.19±0.04^{c}	2.74±0.09^{b}	**2.99±0.02^{a}**	*
Globulin	2.95±0.05^{d}	3.11±0.07^{c}	3.26±0.10^{b}	**3.51±0.05^{a}**	*
Glucose	155.3±15.91	159.04±12.72	161.89±9.42	173.02±20.17	N.S
Cholesterol	148.78±13.99	163.22±13.08	163.48±16.21	167.58±15.18	N.S
Triglyceride	124.55±2.10^{a}	100.96± 1.20^{b}	108.95± 2.24 ^{b}	**104.93± 0.50^{b}**	*

Small letters referred to significant differences among groups at (p≤0.05). N.S. referred to no significant difference. * referred to a significant difference

Table (4) Effect of Cordyceps militaries on the diets on some biochemical traits of blood during the growth period. (Mean ± Standard Error)

Group / Week	Control	Cordyceps militaries Group			Sig. 0.05
		1mg/kg	2mg/kg	4mg/kg	
AST	210.66±4.50	212.66±9.01	214.33±14.29	215.66±14.04	N.S
ALT	17.53±0.79	18.00±0.77	18.06±1.87	18.26±1.23	N.S
Insulin	36.88±1.53	38.72±1.34	39.51±1.84	40.35±1.60	N.S
Creatinin (mg/dl)	1367±0.02^{c}	2033±0.03^{b}	2100±0.01^{b}	**2700±0.00^{a}**	*
Uric Acid (mg/dl)	3.49±0.05	3.51±0.12	3.60±0.02	3.67±0.23	N.S
Triiodothyronine (T3) (ml/blood)	1.63±0.01^{d}	2.03±0.02^{c}	2.29±0.00^{b}	**2.36±0.03^{a}**	*
Tetraiodothyronine (T4) (ml/blood)	8.79±0.22^{d}	9.12±0.15^{c}	9.87±0.01^{b}	**10.35±0.06^{a}**	*

Small letters referred to significant differences among groups at (p≤0.05). N.S. referred to no significant difference. * referred to a significant difference

Table (5) Effect of Cordyceps militaries on Quality traits of eggs during the productive period (Mean ± Standard deviation)

Group / Week	Control	Cordyceps militaries Group			Sig. 0.05
		1mg/kg	2mg/kg	4mg/kg	
Egg Shell Thickness (mm)	2.33±0.28	2.33±0.00	2.50±0.28	2.50±0.00	N/S
Albumin Height	3.80±0.20	3.80±0.10	3.93±0.20	3.93±0.40	N/S
Yolk Height	13.00±0.57	13.33±0.57	13.33±0.00	13.66±0.57	N/S
Yolk Diameter	24.33±1.76	25.00±1.76	25.00±1.76	25.33±1.76	N/S
Albumin Diameter	55.00±7.63	55.00±5.00	56.66±5.00	60.00±5.00	N/S
Hough Unit	87.25±1.18	87.32±0.61	87.79±1.19	87.90±2.35	N/S
Yolk Index	0.52±0.04	0.53±0.04	0.53±0.05	0.56±0.03	N/S

Small letters referred to significant differences among groups at (p≤0.05). N.S. referred to no significant difference. * referred to a significant difference

Discussion

Effect of *Cordyceps militaris* on Cellular Blood Traits: -

Hematological indices are regarded as very important tools for an indication of the health of birds and clinical diagnosis in the present study. Table (2) indicates the effect of adding Cordyceps militaris fungus in different concentrations to quail diets on the concentration of cellular blood characteristics. The results showed that there was a higher significant difference (P≤0.05) in the concentration of the total number of Red Blood Cells (RBC), the total number of White Blood Cell (WBC), Hemoglobin Concentration (Hb), and Packed Cell Volume (PCV) in the group to which Cordyceps militaris fungus was added. (4 mg/kg feed), reaching (3.71, 30.80, 17.01&45.17) respectively, compared to the other groups, the control group recorded the lowest significant difference reaching (3.28, 25.30, 14.32 &37.48) respectively in those qualities. The reason for the significant increase may be due to the addition of cordyceps sinensis at high levels, of effectiveness and activity The polysaccharides contained in Cordyceps act as a mechanism for regulating and stimulating the work of immune cells at an increased rate. White blood cell count, such as the number of B and T lymphocytes (20). There may be another reason that may lead to an increase in the number of white blood cells as well as activates and stimulates the Secretion of immune cytokines, modification of intestinal flora, and increased numbers of probiotics (Lactobacillus bifid bacterium). Also reducing the number of harmful bacteria (Clostridium) Means that the Cordyceps fungus plays an important and essential role as an antibiotic because of its positive effect on the bird's health (21). There was a significant improvement and an increase in the number of white blood cells, which led to a decrease in the bird's physiological stress, while no significant difference was observed for (PCV), (Hb)

and (RBC) when adding the Cordyceps mushroom to the diet of broiler chickens (22).

5.4. Effect of *Cordyceps militaris* on some biochemicals blood traits: -

Regarding the concentration of biochemical characteristics in the blood when the Cordyceps militaris fungus was added in different concentrations to quail diets, the results of Table (3) showed that there was a higher significant difference ($P<0.05$) in the concentration of total protein, albumin, and globulin in the group to which Cordyceps militaris was added (4 mg/kg feed), which reached (6.26, 2.99, 3.51), respectively, while triglycerides recorded the least significant differences, reaching (104.93) compared to the other groups, while the control group recorded the least significant difference, reaching (4.52, 1.87, 2.95) in the concentration of total protein, albumin, and globulin, respectively, while the highest significant difference was recorded in the triglyceride group. The concentration of triglycerides reached (124.55). In the same table, glucose and cholesterol did not record any significant difference in all groups. The results of a study on adding Cordyceps sinensis and probiotics to the diet of broiler chickens showed a significant statistical increase in glucose, total protein, globulin, and triglycerides, the results also showed a clear improvement in cholesterol concentration (23). The increase in the concentration of globulin in the blood serum of the birds treated with Cordyceps militaris (4 mg) indicates a significant improvement in the health and immune status of the birds in that treatment, as there is a physiological importance for blood proteins, and they play an exceptional role when determining their concentration in the bird's body through its assessment of the health status for birds (24). Or due to the production of antibodies because of stimulating the immune system and increasing Gama globulin (25). The reason for the lower glucose content of the mushroom treatments may be due to the experimental conditions. Because, as we know, the percentage of glucose is supposed to increase due to the polysaccharides it contains and as a result of enzymatic hydrolysis into monosaccharides. Due to the processes of digestion and absorption, as a result, it leads to an increase in the level of blood glucose (26). As for the reason for the increase in the level of protein in blood serum in the aforementioned treatments. The reason may be attributed to the increase in the number of beneficial bacteria, which reduces the effect of stress on the percentage of total protein and globulin (27,28). The reason for low triglyceride (T.G) levels may be due to adding Cordyceps to the level of 4 mg/kg feed in the blood serum of quail birds to the microflora in the gastrointestinal tract. It inhibits the action of enzymes responsible for building fats in the liver, such as acetyl CoA. Carboxylase and glucose 6-phosphate 1 dehydrogenase (22). As for the reason for the decrease in cholesterol levels, it may be attributed to the disintegration of bile salts that are important in building cholesterol, as bile salts expel bile acids out of the body with the stool, or by changing the nature of the chemical when the food passes through the digestive tract, and as a result, it is not absorbed and is excreted with the stool (29,30). The results of Table (4) showed that there was a higher significant difference ($P<0.05$) in the concentrations of creatinine, triiodothyronine (T3), and tetraiodothyronine (T4) in the group to which the Cordyceps militaris fungus was added (4 mg/kg feed), amounting to (2700, 2.36, 10.35) respectively, while the control group recorded the least significant difference in these characteristics. It reached (1367, 1.63, 8.79) compared to the other groups. In the same table, AST, ALT, insulin, and uric acid did not record any significant difference in all groups. When dealing with the Cordyceps mushroom and the thyroid gland, it is necessary to know the importance of this gland, and that any defect in its functioning will affect the body and make it vulnerable to many diseases. Studies have shown that the Cordyceps mushroom improves the activity and function of the adrenal gland, which supports improving levels of thyroid hormones. Studies and research have also

proven that the Cordyceps mushroom helps use oxygen very efficiently to enhance cellular energy and combat adrenal fatigue (31- 35). In a study conducted by (36) to determine the effect of Cordyceps militaris extract, 50 mg/kg body weight, on improving glucoside in the blood serum of diabetic mice, the results showed a decrease in the concentration of creatinine in the blood serum. When talking about spirulina and the thyroid gland, it is necessary to know the importance of the thyroid gland, as it is considered one of the most important endocrine glands in the body, and any deficiency in its work affects the body with a variety of diseases and symptoms (36,37)

Effect of *Cordyceps militaris* on Quality of Eggs Traits: -

Table (5) shows the effect of adding the Cordyceps militaris fungus in different concentrations to quail diets on the concentration of Quality traits of eggs. The results showed did not record any significant difference in all groups. In a study conducted by (38) to determine the effects of nutritional supplementation of laying hens with Cordyceps militaris Polysaccharide (CMP) on egg production and quality. The results showed that nutritional supplements containing 100 and 200 mg of Cordyceps militaris /kg can improve the product performance of laying hens during the late egg-laying period. It also did not affect albumin height, shape index, Hoff units, eggshell-breaking strength, and eggshell thickness.

Conclusion

An improvement in egg characteristics occurred when adding Cordyceps militaris 4 mg from one to 72 days of age to quail diets. The results of the study showed a good effect on metabolic indicators, protein, and liver enzyme activity when adding Cordyceps militaris to quail diets.

Conflict of Interest:

All authors declare that they have no conflict of interest.

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