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Effect of replacing black soldier fly larvae powder with soybean meal in the ration on some egg quality traits in laying hens

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Abstract

This experiment was conducted in a private farm (Al-Amer Poultry Company) in Al-Mahawil District of Babil Governorate for the period from 29-9-2020 to 18-1-2021 (16 weeks) to investigate the effect of Replacing Black Soldier Fly Larvae Powder With Soybean Meal in the Ration on some egg quality traits in laying hens by using 60 Lohmann brown hens, 55 weeks of age. Birds were randomly assigned to five treatments, 16 hens per treatment, and each treatment constituted of four replicates, with 4 hens per replicate. The experiment's treatments were as follows: (T1): control, (T2): BSF larval meal was partially replaced by 25% in the place of Soybean meal, (T3): BSF larval meal was partially replaced by 50% in the place of Soybean meal, (T4): Partially replace 75% BSF larval powder in soybean meal, (T5): completely replace 100% BSF larvae powder. The results indicated that the replacement of soybean meal by larvae BSF produce a significant improvement during the total period (56–71 weeks) of the experiment in: shell thickness, shell weight, shell weight relative, albumen weight relative, albumen height, yolk weight, yolk weight relative, yolk height, and yolk index. It is concluded from the experiment that replacing black soldier fly larvae powder with soybean meal led to an improvement in some qualitative characteristics of eggs produced from these hens. Thus, BSF larvae can be used as a successful and economical alternative in laying hens diets to improve some egg quality characteristics.

Keywords: black soldier fly powder (BSF), soybean meal, hen, egg quality

Introduction

The continuous increase in food prices has placed more emphasis on taking advantage of alternative sources of protein not only in Iraq but all over the world, and as a result of the expansion of the poultry industry and the scarcity of feed materials and their high prices, efforts have recently been directed to finding safe, low-cost and balanced feed alternatives in their nutritional content with Seeking to exploit these alternatives not only to reduce feed costs, but also to improve production efficiency [1]. In the same direction, [2] explained that the feed industry consumes three quarters of the

arable land in the world, meaning that animals consume the production of three quarters of the arable land, while humans consume a quarter. There is a tendency at the present time to establish factories to breed the larvae of the black soldier fly that feed on organic residues, and then to dry these larvae and market them as feed for fish and poultry, and market the by-products of this process as odorless fertilizers for farms and gardens [3]. The larvae of the black soldier fly are rich in protein and fat, and the amount of protein and fat in the larvae is estimated according to the food source on which they feed. In general, the percentage of protein and fat from the dry weight of the larvae is 42-44% and 31-35%, respectively, and this is a very high percentage when compared with Protein ratios in the most important feed sources included in the formation of animal rations, the most important of which is soybean meal, which contains 44% protein and is considered the most important source of vegetable protein in poultry and farm animal rations [4]. The larvae of the black soldier fly are rich in essential and non-essential amino acids, as they contain all the amino acids that the animal's body cannot manufacture and in large quantities such as arginine, histidine, lysine and methionine, as well as rich in the amino acid cysteine [5].

Materials and Methods

This experiment was conducted in a private field (Al-Amer Poultry Company) in Al-Mahawil District of Babil Governorate. The duration of the experiment was 16 weeks, from 29-9-2020 to 18-1-2021 to know the effect of replacing the powder of black soldier fly larvae in the ration of soybean meal On the quality characteristics of eggs for laying hens, In the experiment, 60 chickens at 55-week-old of the (LOHMANN BROWN-CLASSIC) strain were used. The birds received administrative and veterinary care. The birds were raised in wire mesh cages. The birds were individually weighed and randomly distributed to five treatments, 12 chickens per treatment. Each treatment consisted of of four replicates and 3 chickens per replicate, The experimental treatments were the following: The first treatment (T1): the control group, the second treatment (T2): BSF larval meal was partially replaced by 25% in the place of Soybean meal, the third treatment (T3): BSF larval meal was partially replaced by 50% in the place of Soybean meal, the fourth treatment (T4): Partially replace 75% BSF larval powder in soybean meal. Fifth treatment (T5): completely replace 100% of the larval powder (BSF) in the place of the soybean meal. Powder of black soldier fly larvae was added to the diet two weeks before the beginning of the experiment until the end of the experiment period. The birds were fed on a diet that contained all the required nutrients and according to the recommendations of the company producing this strain (Table 2). The chemical analysis of larvae powder imported from China was carried out at (Erbil Feed) Company for Feed Industry and General Trading Co., Ltd. located in Erbil Governorate, northern Iraq, and table (1) shows the chemical analysis calculated for larval powder of the black soldier fly (BSF).

Table (1): Chemical Analysis of Black Soldier Fly Larvae Powder (BSF)

chemical composition	result
protein %	40.8
fat %	25.7
Ash %	13.6
fiber %	7.8
Humidity %	4.32
Metabolizable energy (kilocalories/kg)	4195
Calcium %	2.94
Phosphorous %	0.80
Lysine %	2.52
methionine %	0.69
methionine + cysteine %	1.24

Table (2): The diet provided to laying hens at 55 weeks of age used in the experiment

the components	T1 (control) kg	T2 25% (BSF) kg	T3 50% (BSF) kg	T4 75% (BSF) kg	T5 100% (BSF) Kg
yellow corn	57.75	50.75	49.4	40.7	38.7
Barley	-	3	3.3	9.75	8
wheat bran	-	4	6.25	8.5	15
soybean meal 48%	24	18	12	6	-
protein concentrate	5	5	5	5	5
Larvae powder (BSF)	-	6	12	18	24
vegetable oil	2.2	2.2	1	1	-
D.C.P	0.5	0.5	0.5	0.5	0.5
Limestone	10.25	10.25	10.25	10.25	8.5
salt	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100
Computed chemical analysis					
crude protein %	18.3	18.3	18.1	18.1	18.3
Metabolizable energy (kilo calories / kg of feed)	2824	2826	2816	2829	2815
Calcium	4.26	4.42	4.58	4.75	4.25
Phosphorous	0.43	0.47	0.51	0.55	0.59
Methionine	0.41	0.41	0.41	0.42	0.43
Lysine	1.00	1.00	1.00	1.00	1.00

methionine + cysteine	0.43	0.47	0.51	0.55	0.60

All appropriate conditions for raising laying hens in the hall were provided from lighting (16 hours of light: 8 hours of darkness / day), ventilation and appropriate temperature throughout the duration of the experiment, and the humidity ranged between 50-60%. Egg samples were taken for testing every two weeks and 4 eggs were taken from each treatment, and the following characteristics were calculated: egg weight, shell thickness, shell weight, shell weight relative, albumen weight, albumen weight relative, albumen height, Haugh Unit, yolk weight, yolk weight relative, yolk height, and yolk index and based on what was indicated [6].

Completely randomized design CRD (Completely Randomized Design) was used to study the effect of different treatments on the studied traits, and the significant differences between means were compared with Duncan's test (1955) [7] and the SAS (2012) [8] statistical program was used to analyze the data.

Results and Discussion

Regarding the average weight of eggs for the qualitative examinations of eggs, Table (3) shows that there were no significant differences between the experimental treatments in the total period (56-71 weeks), as the T3 and T4 recorded 67.65 and 65.80 g, respectively, with the highest egg weight compared to the T1, T2 and T5. which recorded 65.54, 65.21 and 65.51 g, respectively. The results that were reached were in agreement with [9, 10, 11] who did not notice significant differences in egg weight traits when BSF larvae replaced soybean meal in laying hens' diets and japanese quail. As for the average thickness of the eggshell during the total period (56-71 weeks), it is noted in Table (3) that the T2 and T4 were highly significant compared to the control treatment, Where the replacement treatments recorded an average eggshell thickness of 0.65, 0.57, 0.61 and 0.60 mm for the T2, T3, T4 and T5, respectively, compared with the T1, which recorded the lowest average shell thickness (0.55 mm). This result is in agreement with the findings of [10, 12, 13, 14] who observed a significant increase in eggshell thickness for treatments of replacing BSF larvae for soybean meal in laying hens' diets Compared to the control treatment. It is noted from Table (3) that there are highly significant differences between the treatments during the total period (56-71 weeks) in the average egg shell weight, where the T3 was significantly superior with the average shell weight of 7.45 g compared to the T1, T2, T4 and T5 which recorded 6.21, 6.80, 6.40 and 6.63 g, respectively. The results are in agreement with [11, 14] who noticed a significant superiority of treatments for replacing BSF larvae for soybean meal in Japanese quail and laying hens diets in shell weight trait compared to the control treatment. The results shown in Table (3) showed the effect of replacing BSF larvae powder for soybean meal in laying hen rations on the relative weight of the shell during the total period to the highly significant superiority of the T3, T2 and T5, which scored 11.01, 10.44 and 10.15% respectively compared to the control treatment. Which

recorded 9.47% relative weight of the shell, and no significant differences were observed between the T4, which recorded 9.75% compared to the control treatment. The results were in agreement with what was found by [11] that there were significant differences in the treatments of replacing BSF larvae for soybean meal in Japanese quail diets in the characteristics of the relative weight of the shell compared to the control treatment.

Table (3): Effect of replacing soybean meal with BSF larval powder in laying hen rations on egg shell specifications (mean ± standard error).

treatments	period (age in weeks) Total period (56 - 71)			
	average egg weight (g)	average shell thickness (mm)	Average weight of the shell (g)	relative weight of the shell (%)
T1	65.54 ± 2.76	0.55 ± 0.02c	6.21 ± 0.30b	9.47 ± 0.07d
T2	65.21 ± 0.85	0.65 ± 0.01a	6.80 ± 0.22b	10.44 ± 0.29ab
T3	67.65 ± 0.50	0.57 ± 0.02bc	7.45 ± 0.12a	11.01 ± 0.12a
T4	65.80 ± 1.24	0.61 ± 0.01ab	6.40 ± 0.12b	9.75 ± 0.17cd
T5	65.51 ± 1.02	0.60 ± 0.01abc	6.63 ± 0.12b	10.15 ± 0.21bc
Significant	N.S	**	**	**

• T1: control diet, T2, T3, T4 and T5: BSF larval powder replaced the soybean meal at 25, 50, 75 and 100%, respectively.
• N.S. There are no significant differences between the treatments.
• ** There are significant differences between the treatments at the 0.01 probability level.

Table (4) indicates the effect of replacing BSF larvae for soybean meal in laying hens' diets on the average egg albumen weight. It is noted during the total period that the T4 recorded the highest weight of albumen (44.17 g) compared to the rest of the treatments, which recorded 43.98, 42.48, 43.23 and 42.20 g for each of the T1, T2, T3 and T5, respectively. These results were in agreement with [12] who showed that there were significant differences for larval replacement treatments in the trait of albumen weight compared to the control treatment. Regarding the relative weight of egg albumen, the T4 and T1 were significantly superior, which recorded 67.05 and 67.04%, respectively, compared to the T3 and T5, which recorded 63.86 and 64.34%, respectively, while there were no significant differences between the experimental treatments with the T2 (65.03%). As for the Albumen high during the total period, there were significant differences for the T3 which recorded 9.14 mm compared to the T1, T2 and T5, which recorded (8.38, 8.33 and 8.45 mm), respectively, while the T4 recorded 8.74 mm, which did not differ significantly compared to the other treatments. The results were in agreement with [12] who found a significant increase in the treatments of adding BSF larvae to the laying hens' diets compared to the control treatment in the trait of high Albumen. As for the effect of replacing BSF larvae powder with soybean meal in laying hens' diets at a Haugh Unit during the total period (56-71 weeks), there were no significant differences between treatments, as the treatments T1, T2, T3, T4 and T5

(81.13) were recorded. , 82.26, 81.95, 83.11 and 82.46) respectively. The results were in agreement with [15, 16] that there was no significant effect between treatments of replacing BSF larvae with soybean meal in laying hens diets and the control treatment in Haugh Unit.

Table (4): Effect of replacing soybean meal with BSF larvae powder in laying hens' diets on egg Albumen specifications (mean ± standard error).

treatments	period (age in weeks) Total period (56 - 71)			
	egg Albumen weight (g)	Relative weight of Albumen (%)	Albumen high (mm)	Haugh Unit
T1	43.98 ± 1.87	67.04 ± 0.25a	8.38 ± 0.11b	81.13 ± 0.83
T2	42.48 ± 1.01	65.03 ± 1.09ab	8.33 ± 0.27b	82.26 ± 1.77
T3	43.23 ± 0.60	63.86 ± 0.44b	9.14 ± 0.15a	81.95 ± 0.56
T4	44.17 ± 1.03	67.05 ± 0.73a	8.74 ± 0.24ab	83.11 ± 0.87
T5	42.20 ± 0.85	64.34 ± 0.48b	8.45 ± 0.16b	82.46 ± 1.28
Significant	N.S	**	*	N.S

• T1: control diet, T2, T3, T4 and T5: BSF larval powder replaced the soybean meal at 25, 50, 75 and 100%, respectively.
• N.S. There are no significant differences between the treatments.
• * There are significant differences between the treatments at the 0.05 probability level.
• ** There are significant differences between the treatments at the 0.01 probability level.

Table (5) shows the effect of replacing BSF larvae powder with soybean meal in laying hens' diets on the average yolk weight, with a significant superiority during the total period of the T3, where the highest yolk weight was recorded at 16.98 g compared to the control treatment, which recorded 15.35 g. Regarding the relative weight of the yolk and during the total period (56-71 weeks), the T5 was significantly superior, which scored 25.52% compared to the control treatment, which recorded 23.50% in the characteristic of the relative weight of the yolk. As for the yolk height, the T5 recorded the highest value of the average yolk height, recording 20.25 mm, with a significant difference compared to the T1 and T2, which recorded 19.52 and 19.41 mm, respectively, while the T3 and T4 recorded 19.80 and 19.94 mm, respectively, did not differ significantly with the T1. During the total period (56-71 weeks) of the experiment. Regarding the yolk index during the total period, there were highly significant differences for the T4, which recorded 0.485, compared to the T2 and T3, which recorded 0.475 and 0.458, respectively, while it did not differ significantly with the T1 and T5, which recorded 0.478 and 0.478, respectively.

Table (5): Effect of replacing BSF larvae powder in soybean meal in laying hens' diets on egg yolk specifications (mean ± standard error).

treatments	period (age in weeks) Total period (56 - 71)			
	yolk weight (g)	Relative weight of yolk (%)	yolk high (mm)	yolk index
T1	15.35 ± 0.61bc	23.50 ± 0.22bc	19.52 ± 0.11bc	0.478 ± 0.003ab
T2	15.94 ± 0.48abc	24.53 ± 0.86abc	19.41 ± 0.21c	0.475 ± 0.003b
T3	16.98 ± 0.21a	25.13 ± 0.45ab	19.80 ± 0.15abc	0.458 ± 0.003c
T4	15.23 ± 0.53c	23.21 ± 0.76c	19.94 ± 0.15ab	0.485 ± 0.003a
T5	16.69 ± 0.22ab	25.52 ± 0.30a	20.25 ± 0.09a	0.478 ± 0.003ab
Significant	*	*	**	**

• T1: control diet, T2, T3, T4 and T5: BSF larval powder replaced the soybean meal at 25, 50, 75 and 100%, respectively.
• * There are significant differences between the treatments at the 0.05 probability level.
• ** There are significant differences between the treatments at the 0.01 probability level.

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