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EVALUATION OF SPIRULINA ALGAE (SPIRULINA PLATENSIS) AS A FEED SUPPLEMENT FOR JAPANESE QUAIL: NUTIRITIONAL EFFECTS ON GROWTH PERFORMANCE, EGG PRODUCTION, EGG QUALITY, BLOOD METABOLITES, SPERM-EGG PENETRATION AND FERTILITY

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ABSTRACT: This study aimed to evaluate the nutritional impacts of Spirulina platensis supplementation in the feed and drinking water of the Japanese quail during the growing and laying periods. One-hundred-twenty Japanese quails (14 days old) were housed in twelve battery cages, which were randomly corresponded to three treatments: a basal mash diet (BMD) (control group), a BMD plus 1% Spirulina platensis, and a BMD plus 0.25% of Spirulina in the drinking water. The growth performance was evaluated between the 2nd and 6th week of age, then the egg production parameters and fertility rates were investigated during the following seven weeks. The Spirulina powder used in this study had 95.40% dry matter, 54.70% crude protein, 2.58% ether extract, and 1.58% crude fiber. During the growing period, the results showed that the birds provided with Spirulina powder at 1% in the feed (T1) and at 0.25% in the drinking water (T2) had higher ($P<0.05$) body weight (BW) and body weight gain (BWG) values than those of the control group. The total FI of T1 was higher ($P<0.05$) than those of the control and T2 (505.1 vs. 515.6 and 504.9 g). Besides, both of Spirulina treatments had better feed conversion ratios than that of the control group (3.3 and 3.3 versus 3.6 feed: gain). During the laying period, the Spirulina supplementation in feed or in water did not show significant ($P\geq0.05$) effects on the egg laying rate, egg weight, daily egg mass, feed intake, feed conversion (g feed: g egg) as compared with the control group. Finally, the birds supplemented with Spirulina treatments had lesser serum cholesterol and free fatty acid levels, and displayed higher fertility values ($P<0.05$) than that of the control group. In conclusion, the addition of Spirulina to the feed and/ or to the drinking water of the Japanese quail had beneficial effects on growth performance and fertility, while it did not show any significant ($P\geq0.05$) impact on the egg production, egg quality, or dressing percentage.

Key words: Blue microalgae; feed supplement; growth; quail production, egg quality.

INTRODUCTION

In poultry production, the conventional feedstuffs have a tremendous increase in prices; this is attributed to the insufficient supply and food-feed competition. Therefore, evaluating new energy and protein resources for poultry is having the major interest among researchers and producers as well (Danny et al. 2016). In this regard, the microalgae biomass represents a high potent feed option for animals; it was reported that around 30% of the world algal production is destined for animal feeding (Spolaore et al., 2006; and Zahroojian et al. 2013).

During the last ten years, the beneficial nutritional aspects of microalgae have been advertised extensively worldwide, and therefore the algae enterprises started to gain a clear interest among producers. The researchers, in turn, have conducted many studies recently focusing on investigating the potential contribution of Spirulina in poultry feeding (Zahroojian et al. 2013; Mariey et al., 2014; Świątkiewicz et al., 2015; Evans et al., 2015; Danny et al., 2016; and Kanagaraju and Omprakash 2016). The blue-green micro-algae Spirulina platensis, particularly, is high in protein content ranging from 50 to 65%, which containing all of the essential amino acids (Anusuya-Davy et al., 1981). Besides, it possesses a high energy content which estimated 2839 Kcal TMEn/kg (Evans et al. 2015), a high level of n-3 polyunsaturated fatty acids (Muhling et al., 2005), and considerable amounts of microelements, vitamins, antioxidants, and carotenoids (Brune, 1982; and Belay et al., 1996). Furthermore, Spirulina was reported to increase the poultry health, improve livability, and enhance the immune function (Qureshi et al. 1996; and Kanagaraju and Omprakash et al. 2016). In literature, there is a much controversy, where the previous studies showed non-decisive findings, which keep the feeding value of Spirulina for poultry in question. Spirulina was reported to replace a level of 5–10% of conventional proteins in poultry diet (Spolaore et al., 2006). In some reports, however, the excessive algal levels in poultry diets were found to be useless or may reduce the production profits (Spolaore et al., 2006; and Danny et al. 2016), where the algae biomass is still not available at low prices.

The nutrient profile of Spirulina, certainly, seems appealing and encouraging as a potent feed supplement for poultry. For better understanding of its nutritional value, it should be evaluated with the varied types of poultry involved in production. Quail production is gaining an increased interest because of its fast growth and high laying rate, which can contribute significantly in solving the animal protein gap in Egypt and developing countries. The quail meat and eggs are gaining a tremendous market demand and consumer acceptability. This study, therefore, was designed to evaluate the nutritional influences of supplementing the Japanese quail's water and/ or diet with the microalgae Spirulina platensis on the water and dietary supplementation with the microalgae Spirulina platensis on the growth performance, egg production, egg quality, dressing percentage, blood metabolites, internal organs, sperm-egg penetration, and fertility.

MATERIALS AND METHODS

Experiment site, birds and design

This study was carried out at the poultry research farm, Faculty of Agriculture, Assiut University, Egypt. One hundred and twenty Japanese quails (14 d old) were housed in twelve battery cages (40 x 40 x 30 cm), which were randomly corresponded to three treatments as follows:- a commercial basal mash diet (BMD) (control group), a BMD plus 1% Spirulina platensis, and a BMD plus 0.25% of Spirulina platensis in the drinking water. The growth performance was evaluated between the 2^{nd} and 6^{th} week of age of the unsexed birds, then the egg production parameters and fertility rates were investigated during the following seven weeks. During the laying period, the same regimens were applied, while the replicates were re-arranged to include two males and four females. The chemical composition of the control diet is shown in Table 1. Feed and water were provided ad libtum, a continuous lighting program was used during the growing period, while during the laying period they received 17 h light/ day.

Data collection procedure

Chemical analysis of Spirulina platensis and experimental diet:

The microalgae Spirulina platensis was purchased from the Algae Production Unit (APU), National Research Institute, Cairo, Egypt. The chemical analyses of the experimental diet (Table 1) and Spirulina platensis were determined following the standard methods of AOAC (2000).

Body weight and egg production measurements

All birds were wing banded before starting the experiment, and the individual birds were weighed weekly during the growing period from two to six weeks of age, then they were weighed after 7 weeks of the laying period. The added feed and refusals were recorded daily for each treatment replicate throughout the experiment period. The body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were calculated. During the laying period, the eggs were collected daily at 6 pm, counted and weighed individually. Thereafter, the averages of egg laying rate (ELR %), egg weight (EW), daily egg mass production (EM, g egg/hen/day) and feed conversion ratio (FCR, g feed: g egg) were calculated.

Egg quality measurements

In total, ninety eggs (thirty eggs/ treatment) were used to evaluate the egg quality parameters; including the yolk color (0- 15 grades Roche color fan), Haugh unit, yolk index (%), shell (%), yolk (%) and albumin (%).

Fertility Two-hundred-ten eggs, seventy from each treatment, were collected during the last two weeks of the experiment and stored at 14°C and 55-60% relative humidity until they were incubated. Only the fertility was evaluated in this trial; the hatchability was not possible to evaluate because of an unexpected error in the incubator, which caused the death of all embryos. Therefore, all eggs were cracked to calculate the fertility (%) = (Number of fertile eggs x 100/ total incubated eggs).

Sperm-egg penetration assay

The eggs used in the sperm penetration assay (total = 60 eggs; 20 random eggs per treatment) were stored at 15ºC until they were analyzed; the assay was performed within two weeks after collection (Bramwell et al. 1996). The protocol briefly included the removal of a portion (around 1 cm^2) of the ovum perivitelline membrane, which was then washed, straightened on a glass slide, fixed with 20% formalin, and stained with the Schiff's reagent (Sigma–Aldrich Co.). The number of sperm penetration holes in the whole germinal disc (SP holes/ GD) was counted by magnification x10 using a light microscope (Bramwell and Howarth 1997; and Abouelezz et al. 2015).

Carcass and internal organs

At the end of the experimental period, all birds used in the study were weighed individually, and slaughtered to evaluate the dressing percentage as well as the relative weights of internal organs. The lengths of caeca, small intestine and oviducts were measured.

Blood samples

The blood samples were collected from all birds at the end of experiment in non-heparinized tubes. The collected blood was centrifuged at 4000 RPM for 15 minutes to separate the serum. The collected blood serum samples were then kept on –20° C until analysis for total protein (TP), albumin (ALB), total antioxidant capacity (TAC), free fatty acids (FFA), cholesterol, and glucose. The globulin amount was calculated as the difference between the serum TP and ALB. Those serum parameters were analyzed using a colorimetric method (UV, visible spectrophotometer (Optizen Pop, Mecasys - Korea), 3 ml sealed quartz-glass cuvettes with a path length of 1 cm. The reagent kits were purchased from the Egyptian Company for Biotechnology (SPECTRUM. S.A.E, Cairo, Egypt: www.spectrum-diagnostics.com).

Statistical analyses

The collected data were subjected to ANOVA following the complete randomized design (Steel and Torrie, 1990). The data were statistically analyzed using the GLM – SAS software (SAS 2002), and the Duncan's multiple range test (Duncan, 1955) was used wherever significant differences were found. All values expressed in percentages were transformed to arcsine before analysis. Finally, the chi-squared test was used to assess the association between fertility rate and feeding treatment.

RESULTS

Analyses of the microalgae Spirulina platensis

The chemical analysis of the blue microalgae Spirulina platensis indicated 95.40% dry matter, 54.70% crude protein, 2.58% ether extract, and 1.58% crude fiber.

Growth performance

The results of growth performance parameters are shown in Table 2. The Japanese quail supplemented with Spirulina platensis in the feed (T1) and drinking water (T2) had higher ($P<0.05$) BW and BWG than those of the control group. The tested Spirulina treatments showed significant effects ($P<0.05$) on the FI during the fourth and sixth week with inconsisted trend. The total FI of birds fed T1 recorded the highest value ($P<0.05$) as compared with the others fed the control and T2 groups (515.6 vs. 505.1 and 504.9 g). With regard to the FCR, significant differences ($P<0.05$) were observed inconsistently during the fourth, fifth and sixth weeks. The overall FCR for quails of T1 and T2 were significantly ($P<0.05$) better than that of the control group (3.3 and 3.3 versus 3.6 g feed: g gain). The mortality did not show differences among treatments.

Egg production and egg quality

The egg production parameters and fertility are shown in Table 3. The final BW average of the birds in the control group was significantly lower ($P<0.05$) than those of the birds supplemented with Spirulina either in the feed or in the drinking water; which weighed 226.7 vs. 237.6 and 239.6 g, respectively. A similar pattern was obtained in the ELR and daily EM, while the differences did not reach to be significant (P>0.05). Besides, Spirulina treatments did not show significant effects on the FI, FCR, or EW values. The Spirulina treatments showed higher (P<0.05) fertility rates than that of the control group. Besides, the obtained sperm penetration counts in T1 and T2 were relatively higher (P>0.05) than the corresponding value in the control.

Carcass and internal organs

The dressing percentage and relative weights of internal organs are presented in Table 4. The feeding treatments did not show significant differences in the dressing percentage (%) or on the relative weights of internal organs; including the heart, gizzard, liver, abdominal fat, testes, spleen and ovary (%). Similarly, there were no significant (P>0.05) differences among treatments in the lengths of the caeca, small intestine, or oviduct.

Egg quality parameters

The tested Spirulina treatments did not show any significant (P>0.05) difference for any of the tested egg quality parameters (Table 5).

Blood metabolites

The results of serum parameters (Table 6) indicated that the cholesterol and FFA levels in birds received Sprulina treatments were significantly lesser (P<0.05) than those obtained in the control group, while the tested Spirulina treatments did not show any significant (P>0.05) effect on the quail serum glucose, TAC, TP, ALB or globulin.

DISCUSSION

The analysis of the blue microalgae Spirulina platensis showed a considerable protein content (54.7%), and low EE level (2.58%). These values were comparable to those reported in the previous studies, as 50 – 69% for the crude protein and 1.5 to 2.5 for the EE level (Mariey et al. 2012; Kanagaraju and Omprakash 2016; and Zeweil et al., 2016).

The results of the current study indicated that the addition of Spirulina platensis at 1% in the feed (T1) and 0.25% in drinking water (T2) of Japanese quail displayed higher (P<0.05) BW, BWG and better FCR values than those of the control group. These results were in agreement with the findings of Kanagaraju and Omprakash et al. (2016), which indicated that the Japanese quails fed a diet containing 1% Spirulina had a higher BW than that of control. The same response was also reported by Danny et al. (2016), where using 1, 2, and 4% of dietary spirulina led to an improved growth performance than that of the control, while using higher levels resulted in adverse effects. On the contrary, Venkataraman et al. (1994) found that using high levels of dietary spirulina 14– 17% did not affect broiler performance or meat quality. During the laying period, the Spirulina birds (T1 and T2) had higher final BWs than that of the control group. Our result was in consistency with that of Mariey et al. (2012), who found that the laying hens supplemented with 0.2% dietary Spirulina had a higher BW than that of the control group. Therefore, the tested spirulina levels in the present study were adequate and showed satisfactory for an improved growth performance.

Indeed, comparing between the two offering methods, adding Spirulina in the feed or in the drinking water, seems to be difficult. In literature, there was no information available on supplementing the bird's drinking water with alagae. The results of our study showed that the water supplementation with spirulina had several beneficial impacts on quail's growth performance versus those of the control group. However, through the experience with this trial, it could be suggested that this offering method was laboring to a high degree, which required daily mixing with the drinking water and additional cleaning of the drinkers of the previous day.

The cumulative feed consumption of quails provided with 1% Spirulina in feed (T1) was higher than that of the control group. A similar result was obtained by Danny et al. (2016), who found that the FI of Japanese quail increased significantly with the Spirulina treatment. On the contrary, Kanagaraju and Omprakash et al. (2016) found that the cumulative FI in the 1% Spirulina supplemented birds was lesser than that of the control group. Different from both results, Zahroojian et al. (2013) found that the FI of laying hens supplemented with 1.5, 2 and 2.5% Spirulina did not differ than the non-supplemented control group.

Another beneficial impact was recorded for the Spirulina treatments in the present study, which had better FCRs than that of the control group. This improved FCR was found to be consisted with the results of Kanagaraju and Omprakash et al. (2016), which indicated that the quails fed with Spirulina at 1, 2, and 3% of the diet had better FCRs than that of the control birds. Similarly, Danny (2014) obtained a positive response in FCR of the meat type Japanese quails fed 1, 2, and 4% dietary Spirulina.

The results of Kanagaraju and Omprakash et al. (2016) indicated that the livability of the Japanese quails fed with graded levels of (1%, 2%, or 3%) of Spirulina was not affected; while they had a higher livability than the control group (95.3, 95.7, 96.1 vs. 92.5%). The same results was reported by Danny et al., 2016, with quails fed 0, 1, 2, 4 and 8% dietary Spirulina. In this study, however, the birds of all groups showed a similar high livability rate.

Concerning the dressing percentage, the Spriulina birds (T1 and T2) had higher final body weights than those of the control group, and the dressing percentage was not affected by treatments. This implies a higher meat yield in spirulina groups than that of the control group. These results were found to be similar to those of Danny et al. (2016); and Toyomizu et al. (2001).

The tested treatments in the present study did not display significant changes in the serum TP, ALB, globulin, glucose, or TAC, while the free fatty acids and cholesterol levels in T1 were lower than those obtained in T2 and control groups (Table 6). The obtained averages of blood parameters in this study were comparable to those reported for the Japanese quail serum (Deka and Borah, 2008; and Kabir, 2013). Besides, the obtained cholesterol result was confirmed by the results of Kanagaraju and Omprakash et al. (2016) and Danny et al. (2016), who found that the quails fed with 1% Spirulina fed quails had significantly lower serum cholesterol level than that of the control group.

The supplementation of Spirulina at 0.25% in the drinking water and at 1% in the feed did not reveal any beneficial effect on the egg production traits (Table

3) or egg quality (Table 5). This could suggest the need to use higher levels of Spirulina with laying quails to initiate a beneficial effect. Our results were in accordance with those obtained by Zahroojian et al., 2013, who found that the laying hens fed with different levels of Spirulina (1.5, 2.0 and 2.5%) did not display any significant effect on the egg production, FI, FCR, Haugh unit, yolk index, or shell percentage. Besides, the latter authors concluded that the sole benefit of Spirulina addition was improving the yolk color concentration. In another study, Halle et al. (2009) observed a decrease in FI and no adverse effects on the overall egg production or egg quality with higher levels of algae.

The improved fertility rates, which were obtained in the birds of Spirulina treatments (Table 3), could be attributed to its rich content of several biologically active substances. While, Spirulina platensis was reported to contain considerable contents of the n-3 long chain polyunsaturated fatty (the docohexaenoic and eicosapentaenoic acid), protein, antioxidants, and vitamins; involving vitamin B and E in particular (Światkiewicz et al. 2015; Belay et al., 1996), which are required for producing high quality spermatozoa with an intact and normal structure.

CONCLUSION

The results of this study indicated that the supplementation of Spirulina powder at levels of 1% in the Japanese quail diet or at 0.25% in the drinking water sustained its quail's growth performance, improved the fertility, and decreased the serum cholesterol and free fatty acids, while it did not show any effect on egg production or egg quality.

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Table (1): Chemical composition of the experimental diet

Components	Value
Metabolizable energy (Kcal/kg)*	2850
Proximate analysis:	
Dry matter (DM) (%)	89.27
Moisture- (%)	10.73
Crude protein (CP) (%)	16.25
Ether extract (EE) (%)	5.78
Crude fiber (CF) (%)	5.27
Ash (%)	6.58
Nitrogen Free extract (%)	66.12
Calcium * (%)	2.5
Nonphytate phosphorus * (%)	0.35

*Calculated

Table (2): Growth performance of Japanese quails supplemented with Spirulina platensis

Parameters	Weeks	Treatments		
		Control	**T1**	**T2**
Body weight (g)	2	38.0±0.4	38.3±0.1	38.1±0.2
	3	75.7±3.3	77.6±1.2	78.8±0.3
	4	109.5±4.6^{B}	116.3±1.0^{A}	121.3±1.2^{A}
	5	145.7±5.4^{B}	155.4±5.4^{A}	161.8±1.4^{A}
	6	179.0±1.3^{B}	192.5±5.3^{A}	191.4±3.8^{A}
Body weight gain (g/bird/day)	2-3	5.4±0.5	5.6±0.2	5.8±0.0
	3-4	4.8±0.3^{B}	5.5±0.1^{A}	6.1±0.2^{A}
	4-5	5.2±0.3^{B}	5.6±0.7^{A}	5.8±0.3^{A}
	5-6	4.4±0.8^{B}	5.3±1.1^{A}	4.2±0.7^{B}
Total (g/ bird)		140.9±1.4^{B}	154.2±5.5^{A}	153.3±3.9^{A}
Feed intake (g/ bird/ day)	2-3	14.9±0.0	16.3±0.0	15.5±0.0
	3-4	15.9±0.7^{B}	16.1±0.1^{B}	17.2±0.6^{A}
	4-5	18.3±0.6	19.8±0.9	18.7±2.2
	5-6	23.1±1.6^{A}	21.5±2.6^{AB}	20.7±1.7^{B}
	Total	505.1±20.2^{B}	515.6±20.3^{A}	504.9±26.1^{B}
Feed Conversion (g Feed: g gain)	2-3	2.8±0.3	2.9±0.1	2.7±0.0
	3-4	3.3±0.2^{A}	2.9±0.1^{B}	2.8±0.0^{B}
	4-5	3.6±0.2^{A}	3.6±0.3^{A}	3.3±0.4^{B}
	5-6	5.7±1.3^{A}	4.3±0.6^{C}	5.1±0.5^{B}
	Overall	3.6±0.1^{A}	3.3±0.1^{B}	3.3±0.1^{B}
Mortality (No. of dead birds)	2-3	2	1	2
	3-4	1	1	1
	4-5	0	1	1
	5-6	0	1	0
	Total	3	4	4

Means ± SE within the same row with different superscripts are significantly different (P<0.05). Control: a basal diet; T1: fed a basal diet included 1% of Spirulina platensis. T2: fed a basal diet plus 0.25% Spirulina platensis in the drinking water.

Table (3): Laying performance and fertility of Japanese quails supplemented with Spirulina platensis

Parameters	Treatments		
	Control	T1	T2
Final body weight	226.7±4.7^{B}	237.6±11.7^{A}	239.6±4.0^{A}
Egg laying rate (%)	61.50±5.10	62.70±4.51	61.95±4.26
Egg weight (g)	11.19±0.26	11.20±0.40	11.25±0.04
Daily egg mass (g /d)	6.88±0.72	7.02±0.64	6.97±0.53
Feed intake (g/d)	24.44±0.67	24.60±0.72	25.06±1.50
Feed conversion (g feed: g egg)	3.55±0.24	3.50±0.19	3.60±0.24
Fertility (%)	87.14^{B}	91.43^{A}	92.29^{A}
Sperm penetration (Sperm holes/ germinal disc)	236.60 ± 147.98	253.64 ± 139.14	269.93 ± 130.63

Means ± SE within the same row with different superscripts are significantly different (P<0.05). Control: a basal diet; T1: fed a basal diet included 1% of Spirulina platensis. T2: fed a basal diet plus 0.25% Spirulina platensis in the drinking water.

Table (4): Dressing percentage and internal organs of Japanese quails supplemented with Spirulina platensis

Parameters		Treatments		
		C	T1	T2
Dressing percentage (%)		72.9±1.8	73.0±1.6	71.2±1.5
Relative weights	Heart (%)	0.9±0.0	0.8±0.0	0.9±0.0
	Gizzard (%)	1.1±0.2	1.1±0.7	1.1±0.5
	Liver (%)	2.3±0.2	2.4±0.3	2.3±0.2
	Abdominal fat%	1.1±0.2	1.0±0.3	1.3±0.3
	Testes w %	3.1±0.1	3.0±0.5	3.1±0.2
	Oviduct W %	3.8±0.3	3.8±0.1	3.9±0.5
Length (cm)	Caeca	17.0±1.1	17.6±1.3	17.2±0.9
	Small intestine	59.4±3.7	61.0±3.9	59.2±3.4
	Oviduct Length	37.2±2.0	38.8±1.4	38.5±1.9

Means ± SE within the same row with different superscripts are significantly different (P<0.05). Control: a basal diet; T1: fed a basal diet included 1% of Spirulina platensis. T2: fed a basal diet plus 0.25% Spirulina platensis in the drinking water.

Table (5): Egg quality of Japanese quail supplemented with Spirulina platensis

Parameters	Treatments		
	C	**T1**	**T2**
Yolk %	32.53±0.39	33.04±0.28	33.99±0.54
Albumin %	51.33±0.38	50.82±0.33	50.15±0.49
Shell %	18.52±0.26	18.56±0.32	18.23±0.12
Yolk color	5.58±0.21	5.81±0.24	5.89±0.31
Haugh unit	81.84±2.03	79.66±4.18	80.60±5.27
Yolk index (%)	40.48±0.86	39.29±3.04	41.60±1.76

Means ± SE within the same row with different superscripts are significantly different (P<0.05). Control: a basal diet; T1: fed a basal diet included 1% of Spirulina platensis. T2: fed a basal diet plus 0.25% Spirulina platensis in the drinking water.

Table (6): Blood parameters of Japanese quail supplemented with Spirulina platensis

Parameters	Treatments		
	Control	**T1**	**T2**
Glucose (mg/dl)	254.04±15.51	247.99±17.00	264.29±18.34
TAC (mmol/l)	0.95±0.07	0.93±0.12	1.00±0.01
Cholesterol (mg/dl)	222.57^{A} ±37.80	193.99^{B}±23.41	223.14^{A} ±32.23
FFA (mmol/l)	306.21^{A}±107.21	267.24^{B}±61.08	304.74^{A} ±130.31
TP (g/dl)	3.45±0.57	3.31±0.26	3.20±0.44
Albumin (g/dl)	2.15±0.21	2.29±0.12	2.08±0.25
Globulin (g/dl)	1.30±0.39	1.03±0.21	1.12±0.30

Means ± SE within the same row with different superscripts are significantly different (P<0.05). Control: a basal diet; T1: fed a basal diet included 1% of Spirulina platensis. T2: fed a basal diet plus 0.25% Spirulina platensis in the drinking water. TAC= Total Antioxidant Capacity; FFA= Free Fatty Acids; TP= Total Protein

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Blue microalgae; feed supplement; growth; quail production, egg quality.

الملخلص العربى

تقييم استخدام طحلب الاسبيرولينا كإضافة غذائيه للسمان اليابانى: التأثيرات الغذائيه على أداء النمو، إنتاج البيض، جودة البيض، مكونات الدم، إختراق الحيوان المنوى للبويضه، ونسبة الخصوبه.

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الملخص: هدفت هذه الدراسه الى تقييم التأثيرات الغذائيه لإضافة طحلب الإسبيرولينا الى العليقة أو إلى مياه الشرب على أداء السمان اليابانى خلال فترتى النمو وإنتاج البيض، ومدى تأثر مستوى بعض مكونات الدم، ونسبة الخصوبه، ومعدل إختراق الحيوانات المنويه لغشاء البويضه. فى هذه الدراسة، تم استخدام 120 طائر سمان، فى عمر اسبوعين، والتى تم إسكانها فى بطاريات مقسمة على 12 مكرره (40 x 40 x 30سم) ، بكل منها 10 طيور، وزعت عشوائيا على ثلاث معاملات: المجموعه الأولى غذيت على عليقة تجاريه ناعمة (مجموعة المقارنه)، والمجموعه الثانيه تغذت على عليقه ناعمه بها 1% اسبيرولينا، والمجموعه الثالثه غذيت على عليقه ناعمه مع إضافه الإسبيرولينا بتركيز 0.25 % فى مياه الشرب. خلال فترة إنتاج البيض، تم تعديل المكررات لتحتوى على ستة طيور (2 ذكر + 4 إناث). وقد تم تقييم صفات النمو خلال الفتره من 2 الى 6 أسابيع من العمر، كما تم تقييم صفات انتاج البيض خلال السبعة أسابيع التاليه.

وقد دلت النتائج على أن: 1. مسحوق الإسبيرولينا المستخدم يحتوى على 95.40 % رطوبه، و 54.70% بروتين خام. 2. وزن الجسم المسجل عند عمرستة أسابيع وإجمالى الزيادة فى وزن الجسم وكفاءة تحويل الغذاء فى الطيورالتى حصلت على الإسبيرولينا فى الغذاء او مياه الشرب أفضل معنويا (P<0.05) من القيم المتحصل عليها فى مجموعة المقارنه، وكانت كمية الغذاء المأكول الكلى فى المجموعه التى تغذت على الإسبيرولينا بنسبة 1% من العليقه الأعلى بالمقارنه ببقية المجاميع. 3. لم تسجل أى تأثيرات معنويه لمعاملات الإسبيرولينا فى العليقه او مياه الشرب على نسبة التصافى أو الوزن النسبى لأعضاء الجسم الداخليه، أو على أى من صفات إنتاج البيض أوصفات جودة البيض (P>0.05). 4. إنخفض مستوى الكوليسترول ومستوي الأحماض الدهنيه الحره فى سيرم الدم فى معاملتى الإسبيرولينا بالمقارنة بالكونترول (P<0.05). 5. تحسنت نسبة الخصوبة معنويا (P<0.05) فى معاملتى الإسبيرولينا فى الغذاء ومياه الشرب بالمقارنه بالكونترول (91.43% و 92.29% مقابل 87.14%، على التوالى)، بينما لم تتأثر معدلات اختراق الحيوانات المنويه لغشاء البويضه بين المعاملات المختلفه. دلت نتائج هذه الدراسه على أن إضافة طحلب الإسبيرولينا إلى عليقة السمان اليابانى بنسبة 1% أو بنسبة 0.25 % فى مياة الشرب أدى إلى تحسين معدل النمو ومعدل تحويل الغذاء خلال فترة النمو، وخلال فترة انتاج البيض تحسنت نسبة الخصوبه، بينما لم يكن لهذه المعاملات أى تأثير على صفات إنتاج وجودة البيض.