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EFFECT OF SUPPLEMENTING DIET WITH SPIRULINA PLATENSIS ALGAE OR TURMERIC ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF GOLDEN MONTAZAH LAYERS

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ABSTRACT The objective of this study was to investigate the effect of Spirulina Platensis algae (SP) or Turmeric Powder (TP) on some antioxidants, interferon proteins, immune response and its relationship to productive performances. A total number of 150 Golden Montazah (GM) laying hens and 15 cocks were kept individually in layer's cages and distributed randomly (divided equally into 5 treatment groups) during laying period from 29 to 40 weeks of age. The 1st group (T1) was fed the basal diet and served as a control group (without supplementation). The 2nd and 3rd groups were fed the basal diet supplemented with 2 or 3 g SP/kg diet, respectively. However, the 4th and 5th groups were fed the basal diet supplemented with 4 or 6 g TP/kg diet, respectively.

The obtained results indicated that supplementing layer diet with 2, 3g Sp/kg and 6 g TP/kg significantly improved feed conversion ratio (FC) compared to the control group during the whole period (29 to 40 weeks old). Hens received diet supplemented with 3 g SP/kg or 6 TP/kg had significantly higher egg number (EN), egg weight (EW) and egg mass (EM) during the whole period than those of the control group. Feeding GM layers on diets supplemented with 3 g SP/kg or 6 g TP/kg significantly increased shell weight percentage compared to the control group. Supplementing layers diets with either SP or TP at each tested levels significantly decreased blood cholesterol, total lipids and low density lipoprotein (LDL). While 3 g SP/kg or 6 g TP/kg groups recorded significantly higher values of high density lipoprotein (HDL), total antioxidant capacity (TAOC) and glutathione peroxidase (GPX), and some immunological parameters and such as antibody titers against Newcastle Disease Virus (NDV), Avian Influenza (AI), antibody against sheep red blood cells (SRBC) and Interferon proteins (IFN-γ) concentration) compared to the control group. The averages of fertility and hatchability percentage of total eggs were significantly increased for the hens received diet supplemented with 3 g SP/kg compared to all other groups.

Conclusively, it could be recommended to supply layer diets with SP or TP for better productive and reproductive performance as well as improved immune responses during the laying period.

Keywords: Spirulina – Turmeric – antioxidant – interferon - immune response.

INTRODUCTION

Antibiotics have been used to treat and control diseases in livestock and poultry for more than 50 years. Low levels of antibiotics are used as feed supplements for their ability to enhance animal health and improve both growth rate and feed conversion efficiency. It worthy to note that using antibiotics and chemicals over a long period of time has resulted in emergence of pathogens that become resistant to such treatments. Therefore, the European Union and Egypt banned antibiotics growth promoters in poultry nutrition since 2006. Many alternatives have been investigated to incorporate antimicrobials in poultry diets without any adverse effect on both productivity and health. One possible solution to solve this problem is using SP. In this respect, Spirulina is edible blue green alga that belongs to the lynobactria group and it is a source of phycocyanobilin (Al-Batshan et al. 2001). Khan et al. (2005) reported that SP is rich in nutrients such as vitamins, amino acids, linoleic acid, tocopherols, chlorophyll and β-carotenes. Spirulina is rich in protein, vitamins such as B12 and provitamin A (-carotenes), minerals such as iron, calcium, sodium, potassium, copper, magnesium, phosphorus and selenium. It also contains other phytochemicals that makes microalgae suitable for all higher organisms as food and forage raw material (Kistanova, et al., 2009).

Spirulina platensis posses some promising biological activities such as antitumor, antimicrobial, antiviral, anti-inflammatory, hypocholesterolemic, radio protective and metalloprotective effects (Mayada Farag, et al., 2016). In this respect, Qureshi, et al., (1994) found that SP has been shown to enhance immune function, reproduction and increase growth, less than 10 g SP /kg chicken diets have been found to enhance the defense systems by increasing antigen processing and greater T-cell activity. Another comparable alternative is natural sources of herbs and medicinal plants which later known as phytobiotics. These alternatives are used to stimulate digestive system and enhance growth performance.

It was found that TP belongs to such as class of medical plant and may be an alternative to antibiotics in poultry nutrition. The active components of TP consist of volatiles and non-volatiles constituents. The major active substances in non-volatile are rich source of phenolic compounds such as curcumin (Roughley and Whiting, 1973). Araújo and Leon (2001) summarized the biological properties of curcumin and other phytochemicals as antibacterial, antiviral antioxidant and antiinflammatory. Nowadays, alternative feed supplements enhancing bird health are sought by poultry producers. Among different herbs and supplements, TP which contains bioactive secondary metabolites as curcuminoids, has been successfully used as a suitable feed supplement for poultry. It induces a wide range of positive actions in birds, namely: 1. improvement of several haematological and biochemical indicators, 2. increase of antibody titers after vaccination (e.g., against Newcastle disease), 3. diminishment of heat stress by different mechanisms, 4. prevention bad effects of aflatoxins consumed together with diet, 5. increase of antioxidant activity of several organs (e.g., spleen), 6 decrease in some potentially pathogenic bacteria counts, i.e. Escherichia coli, in the ileal content of

the farmed laying hens (Guil-Guerreroet et al., 2017). Radwan et al., (2008) showed that dietary supplementation with turmeric meal increased egg weight, egg mass and egg production of laying hens.

Little researches had been focused on the effect of supplementing laying hens diets with SP (Nilay and Nurten, 2014, Ashgn et al., 2015 and Zeweil et al. 2016) or TP (Chen et al., 2010, Abeer Mohammed 2014 and Guil-Guerreroet et al., 2017) on immune response, interferon proteins and some virus like NDV and influenza virus. Therefore, the aim of this work is to study the effects of dietary SP or TP as a feed supplement on these traits and laying hens performance.

MATERIALS AND METHOD

Experimental additives:

Spirulina platensis (SP) was obtained from Alga Biotechnology Unit, National Research Center, Dokki, Egypt. However, Turmeric powder (TP was purchased from local markets. active composition of SP and TP is summarized in Table 1, these materials were analyzed for their active components at Central Laboratory of Food and feed, Agricultural Research Center, Ministry of Agriculture, Egypt.

Experimental design, birds and diets:

The current study was carried out at Sids Poultry Research Farm, Animal Production Research Institute, Egypt, during the period from November 2016 to January 2017 by using 150 Golden Montazah hens and 15 cocks, housed individual cages (20 × 40 × 40 cm), randomly distributed into 5 groups (30 females and 3 males/each treatment) during laying period from 29 to 40 weeks of age. The 1st group (T_1) was fed the basal diet (Table 2) and served as the control group (without supplementation). The 2nd and 3rd groups were fed the basal diet supplemented with 2 or 3 g Spirulina platensis (SP)/kg diet, respectively. While, the 4th and 5th groups were fed the basal diet supplemented with TP at level of 4 or 6 g/kg diet, respectively. Sixteen hour constant lighting and continuous ventilation were provided and all birds were kept under the same managerial condition throughout the experiment period.

Egg number (EN) egg weight (EW) and egg mass (EM), body weight gain of hens and cocks, feed intake (FI), feed conversion ratio (FC), were calculated at different intervals of laying (29-32 weeks, 33-36 weeks and 37-40 weeks) besides to the whole period (29-40 weeks). Feed intake was recorded for each treatment and FC was calculated as (g feed/g egg). Egg mass (EM) was calculated by multiplying EN (egg/hen/day) × average EW.

Egg quality measurements:

A total number of 225 eggs (45 eggs/treatment) were taken at 40 weeks of age to determine the egg quality parameters. Egg were weighed individually then broken and the inner contents were placed on a leveled glass surface to determine the inner egg quality. Shell weight %, albumen weight %, Yolk weight %, Yolk index and shell thickness (mm) including membranes. Measurements were done by using a micrometer at three locations on the egg (air cell, equator and sharp end). Yolk index was calculated according to Tilki and Saatci (2004) as shown in the following equation:

Yolk index (%) = Yolk height (mm) / Yolk diameter × 100

Blood samples:

Blood samples were collected randomly from brachial vein of 3 hens from each treatment on the last day of the (in the morning between 8 and 10 O'clock before

feeding). Blood serum was separated by centrifugation of blood at 3000 rpm for 15 min and was stored frozen at-20°C until analyzed. Aspartic aminotransferase (AST), Alanine aminotransferase (ALT) and total antioxidant capacity (TAOC) were determined by using Antioxidant method (Reitman and Frankel 1957). However, cholesterol, total lipids, low density lipoprotein (LDL) and high density lipoprotein (HDL) were determined by spectrophotometer using available commercial kits, while glutathione peroxidase (GPX) was determined by sing UV method.

Immunological response:

Whole blood samples were taken from 4 hens/treatment at the age of 40 wks. These samples were used to examine the immune response to Newcastle Disease virus (NDV) and Avian Influenza H5NI (AI) by Manual of Diagnostic Tests Vaccines for Terrestrial Animals DIE (Edition 2014 and 2012), respectively. These examinations were carried out in Reference Laboratory for Veterinary Quality Control on Poultry Production, Egypt. To determine the antibody against sheep red blood cells (SRBC's), hens were injected with 0.2 ml of 9% SRBC's in the 7^{th} day of every infusion to decide hostile to SRBC's primary antibody titers separately. Immune response creation was measured by an agglutination test using the micro titer strategy (Trout et al., 1996), while interferon proteins (IFN-Y) were determined by using GSI chicken IFN-Y ELISA kit Data sheet method (McLaren and Ramji, 2009).

Fertility and hatchability tests:

A total number of 24 hens and 3 cocks from each treatment (in 3 replicates) were used, these birds were placed in floor pens measuring 185 × 320 cm and supplied with the same treatments. Eggs were daily collected from each treatment (15 eggs) during the last week and incubated to determine fertility and hatchability percentages.

Statistical analysis:

Data were statistically analyzed using the General Linear Model procedure of analysis (SAS, 2001). Duncan's multiple range test (Duncan, 1955) was used to test differences within means of treatments while level of significances was set typically at minimum ($P \leq 0.05$). The statistical model for analysis data was as following:

$Y_{ij} = \mu + T_i + e_{ij}$

Where:

Y_{ij} = the observation

μ = the overall mean.

Ti = the effect of treatment groups (i = 1, 2, … and 5)

eij = random error

RESULTS AND DISCUSSION

Egg Productions:

The average values of egg number (EN), egg weight (EW) and egg mass (EM) during the different periods of age of GM laying hens affected by using SP or TP in diets are presented in Table (3). It could be noticed that hens received diet, supplemented with 3 g SP/kg or 6 g TP/kg diet had higher ($P \leq 0.01$) EN value (55.54 and 57.46 vs 53.33 eggs is that the control group) at the whole period from 29 to 40 wks, EW (45.63 and 46.00 vs 43.53g.) during the third period from 37 to 40 wks, at the whole period (43.22 and 43.89 vs 42.32 g.), EM (2400 and 2522 vs 2257 g.), respectively and at the whole period than those of the control group. Nevertheless, there were insignificant differences among all groups in EN during the first, second and third periods. Also, different groups did not show any significant variation in both EW and EM during the first and second periods.

It is noticeable that EN, EW and EM values were significantly increased with supplementing hen diets with SP or TP at different levels during laying periods. These obtained result, are in good agreement with those reported by (Nikodemusz et al., 2010 and Marrieyet al, 2012) who found that inclusion SP in hen diets improved egg production, egg weight and daily egg mass. Al-Batshan et al. (2001) found that the major active substance in SP is phycocyanin. Also, the covalently linked chromophore with phycocyanobilin, is involved in the antioxidant and radical scavenging activity of phycocyanin.

Concerning the effect of different levels of TP, these results agreed with those reported by Radwan et al., (2008) who showed that dietary supplementation with turmeric stimulated egg production of laying hens, supplementation of 5.0 g/kg TP in layer diets increased egg production, weight and egg mass. Basically, egg production is determined by deposition of the yolk components into the development follicle, and it depends on the liver function in which most of the components are synthesized (Rahardja et al., 2015). Consequently, TP contains active compounds as such curcumin that beneficially stimulate bile secretion and bile flow which can support health of the liver. (Emadi and Kermanshahi 2007 and Saraswati et al., 2014).

Productive performance:

Effect of dietary Spirulina Platensis (SP) or Turmeric Powder (TP) supplementation to Golden Montazah (GM) laying hen diets on change body weight, feed intake (FI) and feed conversion (FC) are summarized in Table (4). The data declare that all treatments did not show any significant change in hens or cocks weight gain. The present results agree with those reported by (Ross et al., 1994 and Mariey et al., 2012) who found that there was no change due to feeding dietary SP in final body weight.

Feeding GM laying hens on diets containing SP or TP at each tested levels during the first period (29-32 wks) and second period (33-36 wks) did not affect significantly the average feed intake. While the hens fed diets containing SP at level of 3 g/kg diet or TP at a level of 6 g/kg diet recorded lower FI than the other groups. On the other hand, the values of FC only improved ($P \leq 0.05$) with laying hens fed diet containing 6 g TP (3.06 vs 3.73) during the third period and whole period (3.69 vs 4.18) compared to the control group.

Generally, FC improved ($P \leq 0.01$) throughout the whole experiment period (29-40 wks) with feeding laying layers on diets supplemented with SP or TP at each tested level except 4 g TP/kg diet. The results were supported by those reported by Nikodemusz et al, (2010) and Mariey et al. (2012) who noticed that feeding SP containing diets gave a beneficial effect on FC of laying hens. The significant improvement in FC may be due to that SP improve absorption of minerals, protect from diarrhea and optimize nutrient digestion processes (Gruzauskas et al., 2004). Besides, SP has an excellent nutritional profile (high carotenoids, high quality protein and rich in minerals and vitamins (Ross and Dominy, 1990). Feeding Spirulina containing diets may enhance the absorbability of dietary vitamins (Tsuchihashi et al., 1987 and Mariey et al., 2012). On the other hand, Malekizadeh et al., (2012) observed that hens fed diet with 1% Curcuma had improved FI as compared with the control diet. However, (Kumeri, et al., 1994 and Namagirilakshmi, 2005) found that

supplementation of TP in chicken diet showed better FC. These results may be as an indicator of dietary supplementation of TP caused a significant ($P<0.05$) increase in Lactobacillus count compared with the control group (Hanan Al-Mashhadani 2015).

Egg quality:

Results presented in Table (5) show that hens fed diets containing SP at level of 3 g/kg diet or TP at a level of 6 g/kg diet recorded higher percentage of shell weight (15.97 and 15.76 %), respectively, while hens group fed the control diet or that group fed dietary 2 g SP/kg achieved the best ($P\leq0.01$) albumin weight percentage (54.34 and 54.34 %) than the other groups SP at level of 3 g/kg diet or TP at a level of 4 and 6 g/kg diet (51.21, 51.90 and 50.73 %), respectively. Conversely, there were insignificant differences among all groups in yolk weight, yolk index and shell thickness. These results are similar line with those obtained by Dogan et al. (2016) who reported that, egg shell increased ($P\leq0.05$) with increasing supplementation level of SP from 5 to 20 g/kg diet. This increase may be due to the high calcium content in SP (Tokusoglu and Unal, 2003) and Williamson and Burkitt, 2014). On the other hand, Radwan et al, (2008) suggested that supplementing layer diets with TP at a level of 5 g/kg diet improved the environment in the uterus (specifically the site of calcium deposition) and consequently increased shell weight. While, there were insignificant differences among all groups in shell thickness.

In contrast, some studies found no effect of dietary supplementation with TP (5 g/kg diet) on egg shell weight (Riasi et al., 2008 and Radwan et al., 2008). The variance in effect of TP in laying hen diets among the different studies might be attributed to the differences in the concentration levels of TP supplementation, age and strains of laying hens, TP sources, stability of active compounds and experimental methods used.

Serum parameters:

Results in Table (6) summarize the supplementation effect of SP and TP in diets on some serum parameters of GM laying hens. The obtained results showed that feeding birds on diets supplemented with SP or TP at each tested level did not affect significantly AST and ALT values. Whereas, the results indicated that cholesterol, total lipids, and LDL decreased ($P\leq0.01$), while, HDL was significantly increased with supplementing hen diets with 3 g SP/kg diet (157, 410, 84.2 and 38) or 6 g TP/kg diet (139, 333, 77.6 and 47) compared with control group (178, 448, 99.2 and 29.2 mg/dI), respectively. However, there were no significant effects among groups of T2, T4 and control groups (T1) in HDL serum concentration.

Supplementing hen diets with 3 g SP/kg diet or 6 g TP/kg diet resulted in a significant increase ($P\leq0.01$) in TAOC (0.452 and 0.482 mU/L) and GPX concentration in serum (49.6 and 50.69 U/mg) compared to the control group (0.415m U/L and 47.4 U/mg), respectively. Likewise, the NDV and SRBC's values improved ($P\leq0.01$) with increasing the SP and TP levels compared to the control group. However, hen groups fed diets containing 2 or 3 g SP/kg were significantly ($P\leq0.01$) higher in AI values (4.57 and 5.16) than control group (3.19 $\log^2$). Concerning interferon proteins (IFN-Y), the results showed that hens fed diets containing 3 g SP/kg diet was the best group in IFN-y (5.65)

followed by those fed 6 g TP/kg (5.01) and 2 g SP/kg diet (4.34) compared to the control group (3.75 Pg/ml). Moreover, hens groups fed diet supplemented with 3 g SP/kg diet recorded the highest ($P \leq 0.01$) value in immune response compared to the other tested groups.

These results are in harmony with those reported by (Nilay and Nurten, 2014 and Zeweil et al. (2016) who stated that dietary SP supplementation (5 or 10 g/kg diet) did not have significant effect on AST and ALT values in rabbits or Gimmizah local strain. Also, these are in good agreement with those reported by (Nilay and Nurten, 2014, Ashgan et al., 2015 and Abdel-Daim et al., 2013) who reported that HDL, TAOC and GPX concentration in serum improved as addition of SP. Nevertheless, LDL reduced by the dietary SP supplementation in the diets compared to the control group.

Furthermore, (Tsuchihashi et al., 1987 and Mariey et al., 2012) found significant reduction of cholesterol concentration of broiler chickens fed dietary SP. They attributed this reduction to lower absorption and/or synthesis of cholesterol in the gastro-intestinal tract by increase population Lactobacillus in intestine (Surono, 2003), thereby preventing them from acting as precursors in cholesterol synthesis (Abdulrahim et al., 1996). Blinkova et al., (2001) found that SP affected hemopoiesis, stimulating the production of antibodies, cytokines, also, T and B cells are activated. Spirulina enhanced Natural killer cells functions by IFN gamma production and cytolysis (Hirahashi et al., 2002). On the other hand, Chen et al., (2010) reported that curcumin had a direct effect on viral particle infectivity that was reflected by the inhibition of haemagglutination; this effect was observed in H1N1as well as in H6N1 subtype. In contrast to amantadine, viruses did not develop resistance to curcumin. Furthermore, by comparison of the antiviral activity of structural analogues, the methoxyl groups of curcumin do not play a significant role in the haemagglutinin interaction. Abeer Mohammed (2014) found that significant increase ($P<0.05$) in the values of both of interleukin-2 and interferon gamma INF-γ concentration in blood serum of both mice groups treated with two concentration of TP 1 and 5 mg/kg body weight in comparison with control group. Interferons (IFN) are cytokines that are responsible for the activity of the immune system. Moreover, they are small proteins belonging to the group cytokines. They have effect on immune system and inhibit the tumor growth. They provide signaling to the immune system during viral infections. They amplify the antigen presentation to T cells. They increase the ability of the uninfected host to resist the new viral infection. They also activate the macrophages, B cells and alter the T cells and promote apoptosis. They are involved in various immune interactions as inducers, regulators and effectors of both innate immunity and acquired immunity during the viral infections (Priyanka and Muralidharan 2014).

Fertility and hatchability%:

Results in Table (7) summarize the effect of supplementation SP or TP in diets on fertility and hatchability percentage of laying hens at 40 weeks of age. It could be noticed that feeding layer groups on diets supplemented with high SP level (3 g/kg diet) resulted significantly ($P \leq 0.01$) increase in fertility percentage (94.4 %) to those fed the other treated groups including the control.

On the other hand, supplementing hen diets with 3 or 2 g SP/kg diet resulted in a significant increase ($P \leq 0.01$) in hatchability percentage from total eggs (84.2 and 82.8 vs 80.6 %) compared to the control group, respectively.

The current results are in line with those obtained by Manafi, (2011) and Mariey et al., (2012) who reported that percentages of fertility and hatchability of eggs produced by the birds fed SP diets were significantly ($P \leq 0.01$) higher than those of the control group. Such increase may be due to the high contents of tocopherols in SP. In this respect, El-Khimsawy, (1985) reported that tocopherols had a vital role in fertility and hatchability of poultry. Also, Inborr, (1998) reported that the improvement of egg fertility for broiler breeders was recorded when SP incorporated into their diets reflected a 5% improvement in hatchability rates.

In conclusion,, the present study indicated that SP supplementation to the diets during laying period from 29 to 40 weeks of age could be modulate and optimize the productive traits, powerful antioxidant molecule, immune effect, increase interferon protein and may be active against several enveloped virus including NDV and influenza virus. Likewise, the dietary supplementation of TP and SP can improve reproductive performance of GM laying hens.

Table (1): Chemical composition (%) of Spirulina platensis (SP) and Turmeric powder (TP).

Spirulina platensis (SP)		**Turmeric powder (TP).**	
Items	**%**	**Items**	**%**
α-Bisabolol	0.48	5-Hydroxy-7-methoxy-2-methyl-3-phenyl-4-chromenone	0.39
Orientin	0.43	9-cis-Retinal	0.24
Colchicine	0.33	Cholecalciferol	0.24
Ledol	0.40	9-cis-Retinoic acid	0.21
α-Cubebene	0.53	3,4-Dimethoxycinnamic acid	0.25
(--)Zingiberene	0.38	Caryophyllene	0.26
Himachalene	0.41	Cis-β-Farnesene	0.98
Cis- β-Farnesene	0.53	HIMACHALENE-γ	0.28
(+) -α-Tocopherol	0.36	Guaiene-β	0.33
(±)-trans-Nuciferol	2.17	Curcumene-α	9.43
Retinal	0.76	Zingberene	2.59
Squalene	0.46	Patchoulene-γ	10.27
Geranyl-α -terpinene	0.34	Humulene-β	3.58
Phytol	0.41	Sesquiphellandrene-β	2.16
Cymarin	0.67	6-Neoclavene	11.51
Zearalenone	0.98	Lanceol, cis	0.92
α-Santonin	4.63	Z)-Bergamotol-trans-α	1.51
β-Citronellol	1.68	Ylangene	1.22
(±)-Lavandulol	1.34	Cuparene	18.55
Elaidic acid	0.38	Arachidonic acid	15.34
Cholecalciferol	0.64	geranyle-ineneterp-α	12.05
Resveratol	1.33	Shyobunone	1.97
n-Hexadecanoic acid	3.26	Zerumbone	4.07
Thebaine	0.92	(+)-Tocopherol-α	0.91
7,8-Dihydro-ionone-α	0.55		
Ricinoleic acid	1.49		
Octadecanedioic acid	0.85		
9-cis-Retinoic acid	0.90		
Quinine	0.65		
Arachidic acid	3.31		
Methoprene	28.12		
Pentadecanoic acid	3.69		
Hexestrol	0.45		
Heptacosane	12.19		

According to Edition 2014 and 2012.

Table (2): Composition and calculate analysis of the basal diet.

Ingredients	**%**
Yellow corn	63.60
Soybean meal44%	24.60
Wheat bran	1.50
Di-calcium phosphate	1.50
Limestone	8.00
Salt (NaCl)	0.40
DL-Methionine	0.10
*Vit.and Min. Mixture	0. 30
Total	**100.00**
Calculated analysis**:	
Metabolizable energy (Kcal / Kg)	2700
Crude protein%	16.00
Calcium %	3.37
Available P%	0.41
Lysine%	0.89
Methionine%	0.39
Met + cystine%	0.66

*Supplied per kg diet: Vit A, 10000IU., Vit D3, 2000 IU., Vit E, 10 mg., Vit K3, 1 mg., Vit B1, 1 mg., Vit B2, 5mg., Vit B6, 1.5 mg., Vit B12, 10 mcg., Niacin, 30 mg., Pantothenic acid,10 mg., Folic acid,1 mg., Biotin, 50 mcg., Choline, 260 mg., Copper,4 mg., Iron, 30 mg., manganese, 60 mg., Zinc, 50 mg., Iodine, 0.3 mg., Selenium, 0.1mg., Cobalt,0.1mg.

According to Feed composition Tables for animal and poultry feedstuffs used in Egypt (2001).

Table (3): Effect of Spirulina platensis or Turmeric powder supplementation on egg number (EN), egg weight (EW) and egg mass (EM) of Golden Montazah laying hens at different ages.

Items	Treatments					SE	Sig
	Control	SP levels		TP levels			
		(2 g/kg)	(3 g/kg)	(4 g/kg)	(6 g/kg)		
Egg number (egg/hen/4 weeks): (1)							
EN 1	14.93	15.06	16.07	15.57	15.83	±0.14	NS
EN 2	18.60	18.93	19.37	18.63	19.10	±0.18	NS
EN 3	19.80	19.90	20.10	19.83	22.53	±0.37	NS
EN 4	53.33 b	53.89 ab	55.54 a	54.03ab	57.46 a	±0.43	**
Egg weight (g/hen/day): (1)							
EW 1	40.83	40.97	41.00	41.60	42.10	±0.18	NS
EW 2	42.60	42.97	43.03	43.37	43.57	±0.21	NS
EW 3	43.53b	44.10b	45.63a	44.27b	46.00a	±0.28	**
EW 4	42.32b	42.68b	43.22a	43.08b	43.89a	±0.21	**
Egg mass (egg number × egg weight (g)): (1)							
EM 1	609.6	617.0	658.9	647.7	666.4	±11.91	NS
EM 2	792.4	813.4	833.5	808.0	832.2	±21.15	NS
EM3	861.9 b	877.6 b	917.2 b	877.9 b	1036.4 a	±29.98	*
EM 4	2257 c	2300 b	2400 b	2328 bc	2522 a	±24.05	**

Means having different letters at the same row are differ significantly.*= (P<0.05),** = (P<0.01) and NS= Not significant. SE: Standard error.

(1) EN, EW and EM 1, 2, 3 and 4 were periods of age (29-32, 33-36, 37-40 and whole period 29-40 Wks of age, respectively).

Table (4): Effect of Spirulina platensis or Turmeric powder supplementation on change body weight gain, feed intake (FI) and feed conversion ratio (FC) of Golden Montazah chicken at different ages.

Items	Treatments					SE	Sig
	Control	SP levels		TP levels			
		(2 g/kg)	(3 g/kg)	(4 g/kg)	(6 g/kg)		
Body weight gain (grams):							
Hens	254	230	220	231	250	±10.94	NS
Cocks	475	484	463	477	458	±7.29	NS
Feed intake FI (g/hen/4 wks): (1)							
FI_1	3048	3050	3022	3024	3022	±10.474	NS
FI_2	3161	3160	3143	3145	3124	±11.499	NS
FI_3	3218 ^{a}	3181 ^{b}	3170 ^{b}	3200 ^{a}	3171 ^{b}	±6.136	**
FI_4	9427 ^{a}	9391 ^{ab}	9335 ^{bc}	9369 ^{abc}	9317 ^{c}	±20.082	*
Feed conversion ratio FC (g feed /g egg): (1)							
FC_1	5.00	4.94	4.59	4.67	4.53	±0.085	NS
FC_2	3.99	3.88	3.77	3.89	3.75	±0.107	NS
FC_3	3.73 ^{a}	3.62 ^{a}	3.46 ^{a}	3.65^{a}	3.06 ^{b}	±0.119	*
FC_4	4.18 ^{a}	4.08 ^{b}	3.89 ^{b}	4.02 ^{ab}	3.69 ^{c}	±0.042	**

Means having different letters at the same row are differ significantly.*= (P<0.05),** = (P<0.01) and NS= Not significant. SE: Standard error.

(1) FI and FC 1, 2, 3 and 4 were periods of age (29-32, 33-36, 37-40 and whole period 29-40 wks of age, respectively).

Table (5): Effect of Spirulina platensis and Curcuma powder supplementation on egg quality of Golden Montazah laying hens at 40 wks of ages.

Items	Treatments					SE	Sig
	Control	SP levels		TP levels			
		(2 g/kg)	(3 g/kg)	(4 g/kg)	(6 g/kg)		
Shell weight%	14.07 ^{b}	14.29 ^{b}	15.97 ^{a}	14.63 ^{b}	15.76 ^{a}	±0.283	**
Albumen weight%	54.34 ^{a}	54.34 ^{a}	51.21 ^{b}	51.90 ^{b}	50.73 ^{b}	±0.613	**
Yolk weight%	31.37	31.59	32.82	33.47	33.51	±0.695	NS
Yolk index	47.44	46.63	47.03	48.28	49.76	±1.169	NS
Shell thickness (mm)	0.450	0.442	0.452	0.457	0.445	±0.012	NS

Means having different letters at the same row are differ significantly.

*= (P<0.05),** = (P<0.01) and NS= Not significant. SE: Standard error,

Control = (without supplementation)

Table (6): Effect of Spirulina platensis or Curcuma powder supplementation on some serum blood constituents of Golden Montazah laying hens at 40 wks of ages (Means ± SE).

Items	Treatments						
	Control	SP levels		TP levels		SE	Sig
		(2 g/kg)	(3 g/kg)	(4 g/kg)	(6 g/kg)		
Plasma measurements:							
AST (U/L)	11.80	11.23	13.10	11.67	12.60	±0.359	NS
ALT (U/L)	43.0	42.5	42.1	42.0	41.7	±0.401	NS
Cholesterol (mg/dl)	178 ^{a}	168 ^{b}	157 ^{b}	157 ^{b}	139 ^{c}	±3.731	*
Total lipids (mg/dl)	448 ^{a}	423 ^{b}	410 ^{bc}	394 ^{c}	333 ^{d}	±10.80	**
LDL(mg/dl)	99.2^{a}	92.6^{b}	84.2^{c}	89.3^{bc}	77.6^{d}	±2.064	**
HDL (mg/dl)	29.2 ^{c}	30.6 ^{c}	38.0 ^{b}	35.2 ^{bc}	47.0 ^{a}	±1.912	**
TAOC (mU/L)	0.415 ^{c}	0.423 ^{c}	0.452^{b}	0.431^{c}	0.482^{a}	±0.007	**
GPX (U/mg)	47.4 ^{c}	47.5 ^{c}	49.6 ^{ab}	47.99^{bc}	50.69^{a}	±0.421	*
Immunological responses (whole blood):							
NDV (log) ^{2}	3.17^{c}	3.17 ^{c}	4.25^{a}	3.44 ^{bc}	3.78 ^{ab}	±0.126	**
AI (log) ^{2}	3.19^{b}	4.57^{a}	5.16^{a}	3.19 ^{b}	3.76 ^{b}	±0.221	**
SRBC 3(log) ^{2}	3.64^{c}	4.09^{c}	4.85^{ab}	4.28^{bc}	5.15^{a}	±0.166	**
IFN-γ (Pg/ml)	3.75^{d}	4.34^{c}	5.65 ^{a}	3.97 ^{bc}	5.01^{b}	±0.198	**

Means having different letters at the same row are differ significantly.
*= (P<0.05),** = (P<0.01) and NS= Not significant. SE: Standard error.
NS = not significant, SE: Standard error, Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), low density lipoprotein (LDL) and high density lipoprotein (HDL), Total Antioxidant Capacity (TAOC), glutathione peroxidase (GPX), Newcastle Disease Virus (NDV), Avian Influenza H5N1 (AI), Sheep red blood cell (SRBC) and interferon proteins (IFN-γ), Control (without supplementation)

Table (7): Effect of Spirulina platensis or Curcuma powder supplementation on fertility and hatchability percentages of Golden Montazah laying hens at 40 wks of ages.

Items	Treatments						
	Control	SP levels		TP levels		SE	Sig
		(2 g/kg)	(3 g/kg)	(4 g/kg)	(6 g/kg)		
Fertility %	89.5 ^{b}	90.4 ^{b}	94.4 ^{a}	90.1 ^{b}	89.9 ^{b}	±0.294	**
Hatchability% from total eggs	80.6 ^{c}	82.8 ^{b}	84.2 ^{a}	80.5 ^{c}	81.2 ^{c}	±0.331	**

Means having different letters at the same row are differ significantly.
*= (P<0.05), ** = (P<0.01) and NS= Not significant. SE: Standard error.
Control (without supplementation)

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الملخص العربى

تأثير أضافة سبرولينا أو الكركم فى العلف على الأداء الأنتاجى والتناسلى فى دجاج المنتزة الذهبى

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قسم بحوث تغذية الدواجن1 ، قسم بحوث تربية الدواجن2

أجريت هذه التجربة لدراسة تأثير أضافة طحلب سبرولينا والكركم على بعض مضادات الأكسدة وبروتينات الأنترفيرون والأستجابة المناعية وعلاقة ذلك بالأداء الأنتاجى. أستخدم فى هذ التجربة 150 دجاجة و 45 ديك من سلالة دجاج المنتزة الذهبى، تم تربية الدجاجات فى أقفاص بيض ثم وزعت عليقة مقارنة عشوائيا الى خمسة مجموعات متساوية خلال فترة أنتاج البيض (من عمر 29 وحتى 40 أسبوع من عمر الطيور). غذيت المجموعة الأولى على العليقة الأساسية بدون أضافة ، بينما غذيت المجموعتان الثانية والثالثة على العليقة الاساسية مضاف اليها 2 ، 3 جرام سبيرولينا على الترتيب بينما المجموعة الرابعة والخامسة غذيت على العليقة الاساسية مضاف لها 4 ، 6 جرام كركم على الترتيب.

وكانت أهم النتائج المتحصل عليها:

- أوضحت النتائج المتحصل عليها أن إمداد علائق الدجاج البياض بمستوى 2 ، 3 جرام سبيرولينا/كجم عليقة أو إمداد العلائق بمستوى 6 جرام كركم/كجم عليقة أدى لتحسن معنوى فى معدل التحول الغذائى مقارنة بالعليقة الكنترول وذلك اثناء فترة التجربة الكلية (من 29 إلى 40 أسبوع من عمر الدجاج).
- أوضحت النتائج أيضاً أن الدجاج البياض المغذى على عليقة 3 جم سبيرولينا/ كجم عليقة أو 6جم كركم/كجم عليقة أعطى أعلى عدد ووزن وكتلة بيض اثناء فترة التجربة الكلية مقارنة بالمجموعة الكنترول.
- أدى تغذية الدجاج البياض على علائق مضاف إليها 3جم اسبيرولينا/كجم أو 6 جم كركم/كجم عليقة الى زيادة معنوية فى النسبة المئوية لوزن قشرة البيض مقارنة بالمجموعة الكنترول.
- أضافة طحلب الاسبيرولينا أو الكركم الى علائق الدجاج البياض عند كل مستوى مختبر خفض معنويا تركيز كلا من الكوليسترول، الدهون الكلية والبروتين الدهنى منخفض الكثافة (LDL) بالدم. بينما سجلت المجاميع التى تغذت على علائق بها 3 جم سبيرولينا/كجم أو 6 جم كركم/كجم عليقة قيم أعلى معنوياً لكلً من البروتين الدهنى مرتفع الكثافة (HDL) مضادات الأكسدة ومقاييس المناعة مقارنة بالمجموعة الكنترول.
- المجموعة التى تغذت على عليقة بها 3 جم سبيرولينا/كجم عليقة كانت أعلى قيم معنوية فى نسبتى الخصوبة والفقس مقارنة بالمجموعة الكنترول.

التوصية:

يستنتج من هذه الدراسة بأنه يوصى بإمداد علائق الدجاج البياض بطحلب الاسبيرولينا أو الكركم لرفع الأداء الانتاجى والتناسلى ولا سيما استجابات المناعة اثناء فترة إنتاج البيض.