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INFLUENCE OF DITARY TRYPTOPHAN SUPPLEMENTAL ON PRODUCTIVE PERFORMANCE OF SINAI BEDOUIN LAYER HENS

M. E. Soltan and Eman A. Hussein

Poultry and Fish Prod. Dept, Fac. of Agric., Menoufia Univ., Shebin El-Kom, Egypt.

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SUMMARY

This experiment was conducted in the Poultry Research Farm and the Poultry Nutrition Laboratory, Faculty of Agriculture, Minufia University, Shebin El-kom, in order to investigate the effect of dietary tryptophan (Trp) supplementation on Production performance, egg quality traits and some blood constituents of Sinai Bedouin layer hens were fed on supplementation during the period of 26 to 38 wks of age were determined. Economic efficiency and phonetic correlation between some productive parameters at the different levels of tryptophan supplementation were calculated. Results showed that final body weight and weight gain were significantly ($P \leq 0.05$) higher by increasing of tryptophan level. Hen–day production percentage, egg number, egg weight and egg mass were significantly improved as the level of dietary tryptophan increased. Feed conversion ratio was significantly ($P \leq 0.05$) improved. Pronounced effects on egg shell percentage and thickness were significantly noted. Albumen, yolk and Haugh units were improved by adding tryptophan at the level of 0.23% of laying diets. Other traits of egg quality were not significantly affected by higher tryptophan levels. High positive phenotypic correlations between some productive parameters and final body weight was noticed by increasing tryptophan levels. Significant phenotypic correlation between egg weights and some egg quality traits by increasing tryptophan levels was recorded. There was a significant increase in plasma total protein, globulin concentration resulted from dietary tryptophan. No significant differences were determined in transaminase enzymes (ALT and AST) plasma blood concentration between all treatments significantly reduced the levels of total cholesterol and triglycerides concentrations. Finally, it could be concluded that dietary tryptophan might have positive effects on productive performance, economic efficiency and health status of layer hens. In respect of Sinai Bedouin laying hens diets 0.23% tryptophan could be recommended for improve most of economic traits.

Keywords: *tryptophan, performance, egg quality, blood constituents, economical efficiency, sinai bedouin, layer hens*

INTRODUCTION

Amino acids play important roles as components of proteins; they are essential for maintenance and production and have a paramount function in many metabolic processes. The current practice to reduce the cost with feeding is based on the incorporation of industrial amino acids, since they replace the traditional protein sources (Varela, 2009). Pinto *et al.* (2003) pointed out that this practice allows the formulation of cheaper diets with lower crude protein levels than those recommended by the tables of nutritional requirements, in addition to meeting the requirements of essential amino acids. Therefore, protein deposition depends on amino acid supplementation in both quantity and quality as well as in biological values of dietary protein (Stringhini *et al.,* 2005 and Carvalho *et al.,* 2009).

L-tryptophan 98% is produced by the fermentation of raw materials of agricultural origin, such as beet molasses or hydrolyzed starch. It consists of white and light yellow crystals with 98% tryptophan and 100% digestibility (Ajinomoto, 2010) The absolute requirements of amino acids of the birds are largely influenced by genetic factors, the rate of production and environmental factors. However, the ratios between them are much less influenced (Bregendah *et al.,* 2008), so it is more important to determine the ideal ratios between amino acids rather than the absolute requirement of the birds for each amino acid. Furthermore, the ideal profile of amino acids for commercial laying hens is not well established in the literatur

Tryptophan is significant in the formulation of feeds with a reduced content of protein in the nutrition of laying hens because it is considered the third limiting amino acid (Peganova and Eder (2003). Tryptophan plays a significant role in the use of crude protein-reduced rations in laying hen nutrition because it is considered the third limiting amino acid in diets based on corn and soybean meal for laying hens (Peganova *et al.,* 2003 and Deponti *et al.,* 2007). High levels of tryptophan had positive effects on systemic immune response and growth performance in birds (Emadi *et al.,* 2010). Tryptophan is also important to alleviate the depression of weight gain and feed intake caused by niacin deficiency in poultry (Xie *et al.* 2014). Tryptophan is the forerunner of serotonin and melatonin syntheses, and reduces aggressiveness in birds, which, with no doubt, eases the daily management of the birds and, in a way, contributes to a more efficient egg production, since the number of damaged eggs is reduced in this situation. Tryptophan deficiency provokes a reduction in feed intake (Peganova and Eder, 2002) and its requirement can be influenced by long-chain neutral amino acids present in the diet of laying hens, such as isoleucine, valine, leucine, phenylalanine, tyrosine, methionine and histidine, and even more by the protein in the diet. Unlike the recommendations for lysine, tryptophan is usually evaluated based on the ratio with lysine, that is, aside from the individual levels of the amino acid, the ratio with lysine is currently one of the major allies of researchers in determining the best level of tryptophan. So, for birds in the laying stage, the recommendations are very diverse. Wethli and Morris (1978) investigated the Trp requirement for three different strains of laying pullets, and from these data developed a method to calculate the optimum Trp intake using the marginal cost of Trp and the value of eggs.

Jensen *et al.* (1990) suggest that supplemental L-tryptophan improves the egg production rate in laying hens. In general, cereal feedstuffs such as corn, wheat and barley are relatively low in tryptophan Ryozo and Makoto (2007). Harms and Russell (2000) showed that egg weight increased as dietary Trp increased. Likewise, the increase in the levels of dietary digestible tryptophan linearly enhanced the feed intake, digestible tryptophan intake, egg production, egg mass, feed conversion per egg mass (Lima *et al.,* 2012). Preedaa *et al.* (2017) indicated that increasing tryptophan levels at 0.18 and 0.20 % had significantly ($P\leq0.01$) decreased plasma cholesterol and increased total protein and albumin levels, whereas plasma glucose levels did not vary due to tryptophan levels. El-Slamoney *et al.* (2010) reported that addition of level 0.21% tryptophan had positive effects on performance, Economic efficiency and health status of the laying hens. Bregendahl *et al.* (2008) and Costa *et al.* (2010) concluded that the tryptophan: digestible lysine ratio of 24% was sufficient for better performance of the birds. Dong and Zou, (2017) showed that Laying rate, average egg weight, and feed conversion ratio were significantly increased by Trp levels from 0.19 to 0.23%. Dietary Trp from 0.17 to 0.19% increased egg internal quality.

Mousavi *et al.,* (2018) indicated that the minimum requirement of the standardized ileal digestible (SID) Trp:Lys ratio from for laying hens (30–36 wk) ranged from 17.5 to 29 based on the positive effects in egg production, egg mass, feed intake, feed conversion ratio and body weight. This study was carried out to investigate the effect of feeding different levels of tryptophan supplementation on the productive performance, egg quality, some plasma blood constituents and economical efficiency of Sinai Bedouin laying hens.

MATERIALS AND METHODS

A total of one hundred and fifty Sinai Bedouin layer hens at 26 weeks of age of nearly body weight (1162 kg) were used in the experiment. Flock history of Sinai Bedouin fowl is one of the Egyptian local strains were briefly presented and summarized by Soltan *et al.,* 2009 and Soltan and Eman Hussein (2017). Birds were distributed at random into five dietary treatments of 30 hens and divided into 3 replicates of 10 hens each in a completely randomized design. Layers were housed in individual cages and kept under similar management conditions during the experimental periods. The composition of the basal diets is given in Table (1). The basal corn – soybean meal diet used contained 17%crude protein (CP) and ME 2760 Kcal/Kg diet and Tryptophan was added to the basal diets (control) formatted to contain 0.14% Trp. The second, third, fourth and fifth experimental treatments were supplemented with 0.17, 0.20, 0.23 and 0.26% tryptophan, respectively.

Feed and water were provided *ad libitum* during the experimental periods. Artificial light was used beside the normal day light to provide 16 hours photo period. Hens were individually weighted at the beginning of the experiment (26 weeks of age) and the end of the experimental at 38 wks of age and body weight change was calculated. Feed intake and feed conversion for egg production: Total feed intake / dietary treatment group / day was recorded and expressed as (g)/hen/day. Feed conversion was determined as feed (g)/egg mass (g). Egg number, egg weight, egg mass and daily egg production for each dietary treatment group and individual egg weight were recorded. Means of egg weight as well as egg mass of each treatment group were determined.

Table (1). Composition and chemical analysis of the experimental Sinai Bedouin hens diets fed during the experimental periods.

Ingredient	Diets[1]				
	T_1 Control	T_2	T_3	T_4	T_5
Ground yellow corn (8.9%)	61.31	61.30	61.29	61.27	61.25
Soybean meal (44%)	15.01	14.99	14.97	14.96	14.95
Gluten corn (55%)	8.01	8.01	8.01	8.01	8.01
Wheat bran	5.18	5.18	5.18	5.18	5.18
Limestone , ground	7.85	7.85	7.85	7.85	7.85
Di-calcium phosphate	1.93	1.93	1.93	1.93	1.93
Vitamin and mineral mixture [2]	0.30	0.30	0.30	0.30	0.30
DL-methionine[3]	0.05	0.05	0.05	0.05	0.05
L- Lysine	0.03	0.03	0.03	0.03	0.03
L- Tryptophan[4]	-	0.03	0.06	0.09	0.12
Sodium chloride (salt)	0.33	0.33	0.33	0.33	0.33
Total	100	100	100	100	100
Calculated values[4]:					
Crude protein ,%	17.00	17.00	17.00	17.00	17.00
ME, Kcal/kg diet	2760	2760	2760	2760	2760
C/P ratio	161	161	161	161	161
Lysine,%	0.76	0.76	0.76	0.76	0.76
Methionine,%	0.36	0.36	0.36	0.36	0.36
Tryptophan,%	0.14	0.17	0.20	0.23	0.26
Calcium,%	3.46	3.46	3.46	3.46	3.46
Total phosphorus ,%	0.68	0.68	0.68	0.68	0.68
Determined Values:					
Dry matter, %	89.95	89.96	89.65	89.37	89.42
Crude protein, %	16..98	17.01	16.97	16..98	16.94
Ether extract, %	3.01	2.98	3.04	3.08	3.02
Crude fiber, %	3.82	3.76	3.88	3.78	3.56
Calcium,%	3.50	3.51	3.52	3.52	3.52
Total phosphorus ,%	0.71	0.71	0.71	0.71	0.71

[1] T_1; control; without supplementation, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 023%Trp. andT_5, control + 0.26%Trp.
[2]Vitamin and Mineral mixture at 0.30%of the diet supplies the following per kilogram of the diet: vit.A, 1200 IU; Vit.D3, 2500 IU; Vit. E, 10 mg; Vit .K3, 3mg; Vit.B1, 1mg; Vit.B2, 4mg; pant Nicotinic acid, 10 mg; Nicotinic acid, 20 mg; Folic- acid, 1 mg; Biotin, 0.05 mg; Niacin , 40 mg; Vit.B6, 3 mg, Vit. B12, 20 mcg; Choline Chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01mg.
[3]Dl-Methionine: 98% feed grade (contains 98% methionine).
[4]L-Tryptophan; 98% feed grade (contains 98% tryptophan).
[5]Calculated according to NRC (1994).

At the end of the experiment (38 weeks of age), egg quality measurements were determined utilizing three eggs were randomly taken from each dietary treatment group for the determination of the following egg quality factors; Eggs were collected individual weighted, broken and separated into shells, yolk and albumen. Egg shape index and yolk index were calculated from length and width, measure by digital a tripod micro meter according to Romanoff and Romanoff (1949) as follows: Egg shape index % = (Width / Length) × 100, Egg shell thickness, including shell membranes, was measured using a micrometer at the equator was determined according to Brant and Shrader (1952). Haugh unit was applied from a special chart using egg weight and albumin height which was measured using a tripod micrometer according to Haugh (1937), Kotaiah and Mohapatra (1974) and Eisen *et al.* (1962) as follows: Haugh units = 100 log (H + 7.57 – 1.7 $W^{0.37}$), where: H = Albumin height (mm). W = egg weight (g). Egg yolk visual color was determined by matching the yolk with one of the 15 bands of the "1961, Roch improved Yolk Color Fan". In Tables (6 and 7), phenotypic correlation coefficient (r_p) between final body weight and some productive performance and r_p between egg weight and some egg quality traits were calculated according to Snedecor (1940).

Blood samples were collected from the wing veins of three hens from each treatment whose body weight were near the average of its respective treatment into un-heparin zed tubes and plasma was separated by centrifugation at 3500 rpm for 15 min and frozen at -20 °c for the determination of total protein, albumin, total cholesterol, triglycrides and transaminases (ALT and AST) which were calorimetrically determined using commercial kits. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein (Coles, 1974); also albumin / globulin ratio (A/G ratio) was calculated. Proximate analysis of representative samples from experimental diets, Crude protein, calcium and phosphours contents of feed samples were determined by the standard Kjeldahl method and atomic absorption spectorophotometer methods, respectively, AOAC, (2003). Dry matter of feed samples was determined by drying at 105 °C for 3h. The metabolizable energy was calculated according to isocaloric and isonitrogenios based on National Research Council (NRC, 1994) recommendation, from the proximate composition of the feed which was obtained from the feed manufactures.

Economical efficiency for egg production was calculated from the input -output analysis (Heady and Jensen. 1954) according to the price of the experimental dietary treatments and egg produced. Values of economical efficiency were calculated as the net revenue per unit of total costs (Soliman and Abdo - Zeineb , 2005).

Data were statistically analyzed by the completely randomized design using the statistical software of SPSS 11.0 (2011) program and the differences among means were determined using Duncan's multiple range test (Duncan 1955). Percentages were transformed to the corresponding arcsine values before performing statistical analysis. The following statistical model was applied:

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

Where: Y_{ij} = an observation, μ = Overall mean, T_i = effect of treatment (i = 1,2.3.4.5) and e_{ij} = experimental random error.

RESULTS AND DISCUSSION

Laying performance traits:

Effect of dietary different levels of dietary Tryptophan (Trp) supplementation on production performance of Sinai Bedouin hens during 26 – 38 weeks of age weeks are summarized in Tables (2, 3, 4 and 5). Final body weight, body weight gain were significantly (P≤0.05) affected by the addition of tryptophan to Sinai Bedouin hens diets during all experimental period (Table 2). The results revealed that birds consuming 0.23% Trp at (26 – 38) weeks of age had significantly (P ≤ 0.05) higher final body weight and body weight change than those the control group, by 5.60% and 53.45%, respectively. The birds fed diet contained 0.17, 0.20 and 0.26% Trp recorded higher final body weight by 0.97, 2.57, 5.60 and 4.62%, respectively when compared with the control group (T1) and the same figures for the body gain weight were 9.13, 23.68, 53.45 and 45.89%, respectively. These findings agree with the results of Smith and Waldroup (1988), Ohtani *et al.* (1989), Han *et al.* (1991) and Rosebrough (1996).

Recently, Antar *et al.* (2004) indicated that the level of dietary Trp did not affect body weight gain. On the other hand, Corzo, *et al.* (2005); Ryozo and Makoto (2007) and El-Slamoney, *et al.* (2010) who's showed that body weight gain improved as Trp increased. Mousavi *et al.,* (2018) showed a significant improvement (P<0.001) in body weight by increasing the standardized ileal digestible (SID) Trp:Lys ratio from 11 to 19. The improvement in weight gain was independent of feed intake. Therefore, it might be expected that increased dietary tryptophan would increase feed intake through the influence of Trp on the synthesis and release of serotonin, which would in turn influence feed intake through gastric emptying.

Hens fed 0.23 and 0.26% Trp. recorded an increase (P≤0.05) in egg number and percentage egg production (Table 3). Average values were 61.43, 65.10, 67.35, 65.86 for 0.17, 0.20 0.23%, 0.26% and 60.43% for control group. Average egg numbers were 17.21, 18.25, 18.86 and 18.43 eggs for the respective dietary treatments. In agreement with these results, Ohtani *et al.* (1989) reported that hen day egg production and daily egg output were proportionately higher with higher levels of supplemental L–tryptophan (500 mg/kg diet) was due to some metabolic changes induced by L-tryptophan feeding. Also, the improvement of EP in layers from L- Trp supplementation of diets may be interpreted as a consequence of a decrease in

Table (2). Effect of supplemental Tryptophan (Trp.) on body weight and body weight gain of Sinai Bedouin hens during the experimental periods (Mean ± SE)[2].

Dietary treatments[1]	Initial body weigh (IBW) 26 wks of age (g.)	Final body weight (FBW) 38 wks of age (g.)	Body weight gain (BEG) 26 to 38 wks of age (g.)
T_1 (Control)	1162.60 ± 19.25	1302.14^{dc} ± 17.34	139.54^{d} ± 12.77
T_2	1162.53 ±23.44	1314.82^{d} ± 19.40	152.29^{bc} ± 13.43
T_3	1163.03 ± 23.40	1335.62^{c} ± 9.58	172.59^{c} ± 8.98
T_4	1160.96 ± 11.65	1375.08^{a} ± 20.11	214.12^{a} ± 15.12
T_5	1161.55 ± 17.90	1362.34^{b} ± 12.53	200.79^{b} ± 10.56
Total average	1162.13 ± 12.33	1338.00 ± 21.08	175.87 ± 10.89
Significance	NS	*	*

[1] *T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.*
[2] *means ± SE of 3 replicates / treatment.*
[3]*a, b, c and ….etc: means within the colum with each different superscript are significantly different ($P \leq 0.05$).*

Table (3). Effect of supplemental Tryptophan (Trp.) on egg number and Egg production of Sinai Bedouin laying hens during the experimental periods (Mean ± SE)[2].

Age (weeks)	Dietary treatments[1]					
	T_1 Control	T2	T3	T4	T5	Sig.
			---Egg Number (EN /hen) ---			
26-30 wk	16.88^{d} ± 0.23	16.23^{e} ± 0.75	16.79^{c} ± 0.25	17.93^{a} ± 0.11	17.31^{b} ± 0.26	?
30–34 wk	17.23^{d} ± 0.45	17.85^{c} ± 0.33	18.96^{ab} ± 0.18	19.53^{a} ± 0.15	19.05^{b} ± 0.22	?
34–38 wk	16.79^{e} ± 0.33	17.55^{d} ± 0.27	18.63^{c} ± 0.43	19.11^{a} ± 0.65	18.93^{b} ± 0.24	?
Average	16.96 ± 0.20	17.21± 0.34	18.25 ± 0.19	18.86 ± 0.35	18.43 ± 0.32	
			---Egg Production (EP), % ---			
26-30 wk	60.29 ± 0.89	57.96^{c} ± 0.77	59.96^{ab} ± 0.87	64.04^{a} ± 0.67	61.18^{b} ± 0.46	?
30–34 wk	61.54^{bc} ± 0.76	63.75^{c} ± 0.54	67.71^{ab} ± 0.55	69.75^{a} ± 0.78	68.80^{b} ± 0.43	?
34–38 wk	59.46^{c} ± 0.88	62.68^{b} ± 0.82	67.64^{a} ± 0.43	68.25^{a} ± 0.72	67.61^{a} ± 0.58	?
Average	60.43 ± 1.01	61.46 ± 0.61	65.10 ± 0,52	67.35 ± 0.65	65.86 ± 0.61	

[1]*T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.*
[2] *Means ± SE of 3 replicates / treatment.*
[3]*a, b, c and ….etc: means within the row with each different superscript are significantly different ($P \leq 0.05$).*

plasma estradiol concentration or a decrease of estrogenic activity. Similar trend was found by Jensen *et al.* (1990) Harms and Russell (2000) and recently, Deponti *et al.* (2004) concluded that levels below 0.150% digestible Trp result in a decrease in egg production. Cardos *et al.* (2014) reported that The digestible 0.192% Trp levels, in the diet had a quadratic effect on egg production, egg mass, and conversion per mass and per dozen eggs, for white egg layers of 60 to 76 wk of age. Arlindo *et al.* (2016) reported that the digestible tryptophan-to digestible lysine ratios in the diets increased from 21.5 to 24.6%, egg production increased by 3.93%. Mousavi *et al.,* (2018) noted that egg production was significantly increased by increasing the standardized ileal digestible (SID) Trp:Lys ratio from 11 to 19 for Hy-Line W-36 hens from 30 to 36 wk of age. On the contrast Ajinomoto (2004) and Antar *et al.* (2004) reported that the levels of dietary Trp (0.166, 0.176 and 0.193%) did not significantly affect in egg production.

Table (4). Effect of supplemental Tryptophan (Trp.) on egg weight and Egg mass of inai Bedouin hens during the experimental periods (Mean ± SE)[2].

Age (weeks)	Dietary treatments[1]				
	T_1 Control	T2	T3	T4	T5
	---------------------Egg weight (EW.), g. /hen ---------------------------				
26-30 wk	42.32ab ± 0.36	42.67^{b} ± 0.22	43.03^{a} ± 0.08	43.86^{a} ±0.17	43.38^{a} ±0.26
30–34 wk	43.65^{b} ± 0.12	43.76^{b} ± 0.05	43.68^{a} ± 0.32	44.86^{a} ±0.24	44.73^{a} ±0.22
34–38 wk	43.76^{bc} ± 0.15	44.00^{c} ± 0.16	44.82^{b}± 0.16	45.62^{a} ±0.25	45.11^{a} ±0.18
Average	43.24 ± 0.22	43.48 ± 0.04	43.61 ± 0.12	44.78±0.22	44.41±0.12
	---------------Egg Mass (EM.), g/h/d --------------------				
26-30 wk	25.51^{c} ± 0.64	24.59^{bc}±0.64	25.82^{ab}± 0.44	28.05^{a} ± 0.53	26.83^{b} ±0.17
30–34 wk	25.64^{d}± 0.74	26.90^{c}± 0.46	29.58^{ab}±1.01	31.34^{a} ± 0.06	30.41^{b}±0.44
34–38 wk	26.04^{d}± 0.08	28.05^{c}±0.13	30.01^{b}± 0.82	31.42^{a} ± 0.27	30.42^{b}±0.27
Average	25.71±0.32	26.55±0.06	28.47±0.63	30.38 ±1.02	29.24 ±0.62

[1] T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. and T_5, control + 0.26%Trp.
[2] means ± SE of 3 replicates / treatment.
[3] a, b, c and ….etc: means within the row with each different superscript are significantly different (P ≤ 0.05).

The obtained results indicated that egg weight was increased with tryptophan supplementation (Table 4). Hens fed diets supplemented with 0.23% Trp (T4) recorded significantly higher egg weight than those fed other treatments and control groups by 3.65% of overall average all experimental periods. On contrary to our results regarding egg weight Harms and Russell (2000) and El-Slamoney, *et al.* (2010) they showed that EW increased as dietary Trp increased.Brain neurotransmitters are intricately linked with Trp and its role in body metabolism. Because of its involvement with brain serotonin, Trp has been shown to be responsible for affecting mood regulation, feed intake, behavior, and sleep patterns (Leathwood, 1987 and Baranyiova, 1991).

While, Antar *et al.* (2004) and Mousavi *et al.,* (2018) reported that there were no significant increases in egg weight as dietary levels of Trp increased. Diets supplemented with tryptophan, generally in a higher egg mass during th 90 days experimental periods, An improved effect was observed with layer fed 0.23%Trp probably due to higher rate of laying and relatively large egg weight and different age. Results reported herein are in harmony with those obtained by Peganova and Eder (2003); El-Slamoney, *et al.* (2010) and Arlindo *et al.* (2016).

In respect of feed intake, the results showed that hens fed supplemented diets significantly consumed more amount of feed compared to the chicks fed control diet (Table 5). The diet with 0.23%Trp. significantly (P≤0.05) recorded the highest feed intake (113.03 g) in compression with other experimental diets and control diets, T_2, T_3, T_5 and T_1 (110.51, 111.70, 112.26 and 110.26 g), respectively. This effect could be due to the function of Trp as a precursor of serotonin and good source of amino acid. Therefore, it might be expected that increased dietary Trp would increase feed intake through the influence of Trp on the synthesis and release of serotonin, which would in turn influence feed intake through gastric emptying.

Similar results were reported by Peganova *et al.* (2003), who found an increase in the feed intake of laying hens due to the increased levels of tryptophan in the diet, this positive effect on feed intake is because tryptophan play a precursor of serotonin, a neurotransmitter which has been attributed the function of regulating appetite in birds. But, Antar *et al.* (2004); Deponti *et al.* (2007) and Arlindo *et al.* (2016) observed that the feed intake of 137mg/bird/day digestible tryptophan was not low enough to influence the feed intake of laying hens.

Table (5). Effect of supplemental Tryptophan (Trp.) on feed intake and feed conversion ratio of Sinai Bedouin laying hens during the experimental periods (Mean ± SE)[2].

Age (weeks)	Dietary treatments[1]				
	T_1 Control	T2	T3	T4	T5
	------------------------------- Feed Intake (FI, g./ h/ d) ----------------------------				
26-30 wk	$106.48^{d} \pm 0.76$	$106.83^{d} \pm 0.07$	$109.00^{c} \pm 0.23$	$111.18^{a} \pm 39$	$110.35^{b} \pm 0.81$
30–34 wk	$111.79^{c} \pm 0.44$	$111.83^{ab} \pm 0.13$	$112.93^{b} \pm 0.45$	$113.55^{a} \pm 0.64$	$112.84^{b} \pm 0.77$
34–38 wk	$112.57^{c} \pm 0.77$	$112.88^{c} \pm 0.71$	$113.18^{ab} \pm 0.21$	$114.28^{a} \pm 0.33$	$113.60^{b} \pm 0.22$
Average	$110.26^{d} \pm 0.32$	$110.51^{bc} \pm 0.04$	$111.70^{c} \pm 0.06$	$113.03^{a} \pm 0.18$	$112.26^{b} \pm 0.50$
	--------------- Feed Conversion Ratio (FCR.), g. feed / g. egg mass ------------				
26-30 wk	$4.42^{a} \pm 0.04$	$4.34^{b} \pm 0.03$	$4.22^{c} \pm 0.06$	$3.96^{e} \pm 0.03$	$4.11^{d} \pm 0.07$
30–34 wk	$4.36^{a} \pm 0.01$	$4.15^{b} \pm 0.02$	$3.81^{ab} \pm 0.03$	$3.61^{d} \pm 0.04$	$3.73^{c} \pm 0.03$
34–38 wk	$4.29^{a} \pm 0.04$	$4.02^{b} \pm 0.02$	$3.75^{c} \pm 0.04$	$3.56^{e} \pm 0.06$	$3.69^{d} \pm 0.01$
Average	4.36 ± 0.04	4.17 ± 0.04	3.93 ± 0.03	3.71 ± 0.04	3.84 ± 0.06

[1] T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.
[2] means ± SE of 3 replicates / treatment
[3] a, b, c and ….etc: means within the row with each different superscript are significantly different (P ≤ 0.05)..

Feed conversion ratio was improved by tryptophan supplementation at 0.23%Trp significantly (P≤0.05) recorded better (3.5) feed conversion ratio (g feed/g egg) compared to other experimental diets and control (3.66, 3.56 and 3.73), respectively. Ohtani, *et al.* (1989) reported that average FCR, g feed/ g eggs were 2.58, 2.46 and 2.35 for 0, 250 and 500 mg/kg diet Trp in layers (Rhode Island Red x White Leghorn). El-Slamoney, *et al.* (2010) reported that tryptophan supplementation on laying hens ha significant effect on feed conversion ratio. Arlindo *et al.* (2016) noted that feed conversion per egg mass improved by 4.67% when the digestible tryptophan to-digestible lysine ratios in the diets were increased from 21.5 to 26.2%. Dong and Zou, (2017) noted that Laying rate, average egg weight, and feed conversion ratio (FCR) were significantly increased by Trp levels from 0.19 to 0.23%.

Phenotypic correlation (r_p) between final body weight and some productive performance are presented in Table (6). The results indicated that positive correlation on Final body weight and some productive performance as egg number, egg weight, egg mass and feed conversion ratio under increase levels of tryptophan to Sinai Bedouin layer hens diets. some authors reported that the genetic and phenotypic correlations between body weight and egg number were positive (Abd El - Ghany, 2005 and Saleh *et al.*, 2006), It may be body weight had strongly effects on egg weight and egg number. Pan *et al.* (2013) reported that Trp supplementation promoting the balance of amino acids may be also an important reason in increased bird performance.

Table (6). Phonetic Correlation between Final body weight and some other productive performance of the experimental diets under different levels of tryptophan (Trp.) supplementation.

Item	Dietary treatments[1]				
	T_1 Control	T_2	T_3	T_4	T_5
Egg number	- 0.51*	- 0.34	0.32	0.22	0.43
Egg weight	0.46	0.40	0.52*	0.65*	0.74*
Egg mass	- 0.02	- 0.02	0.13	0.26	0.36
Feed conversion	0.55*	0.64*	0.56*	0.84*	0.81*

[1] T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp. *significant.

Table (7). Effect of supplemental Tryptophan (Trp.) on some egg quality of Sinai Bedouin laying hens (Mean ± SE) [2].

Item	Dietary treatment[1]				
	T_1 Control	T_2	T_3	T_4	T_5
Egg shape index, %	74.98^{c} ± 0.33	76.17^{ab} ±0.04	76.50^{b} ±0.23	77.42^{a}±0.22	76.36^{b} ±0.14
Egg shell percent, %	10.09^{d} ± 0.01	10.33^{bc}±0.02	10.18^{c}±0.01	11.66^{a} ±0.02	11.13^{b}±0.02
Egg shell thickness, mm	0.336 ± 0.04	0.342±0.11	0.348±0.01	0.364±0.11	0.350±0.18
Yolk percent, %	29.49^{c} ± 0.22	30.23^{b}±0.21	31.30^{ab}±0.12	32.55^{a} ±0.27	30.79^{b} ±0.05
Yolk color	5.34 ± 0.01	5.34±0.11	5.36±0.09	5.33±0.02	5.37±0.01
Yolk index,%	39.05^{c} ± 0.40	40.12^{ab} ±0.34	41.12^{a}±0.18	40.86^{b}±0.19	40.22^{ab}±0.09
Albumenpercent,%	56.82^{dc} ±0.72	57.81^{c}±0.63	57.06^{d}±0.28	61.38^{a} ±0.19	60.84^{b}±0.22
Albumen index,%	10.33^{b} ± 0.03	10.52^{a}±0.01	10.66^{a}±0.18	10.34^{b}±0.22	10.13^{c}±0.30
Haugh units	86.03^{c} ± 0.63	86.82^{b}±0.43	86.38^{ab}±0.52	87.11^{a} ±0.44	85.97^{bc}±0.87

[1]T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.

[2] means ± SE of 3 replicates / treatment.

[3]a, b, c and ….etc: means within the row with each different superscript are significantly different ($P \leq 0.05$).

[1]T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.[2] means ± SE of 3 replicates / treatment.[3]

a, b, c and ….etc: means within the row with each different superscript are significantly different ($P \leq 0.05$).

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Egg quality traits:

The effect of supplemental different levels of tryptophan on egg quality traits of Sinai Bedouin laying hens are presented in Table (7). The egg shape index, egg shell percent were significantly ($P \leq 0.05$) increased by included tryptophan in laying hens diets at the experiment. While the effect of dietary treatment on thickness of egg shell, albumen index and yolk color were not significant. Insignificant differences were observed between tryptophan supplementation with yolk percent and yolk index. Values ranged from (30.23, 31.30, 32.55 and 30.79%) and (40.12, 41.12, 40.86 and 40.22%) for yolk percent and index, respectively. Haugh unit was improved with dietary of tryptophan supplementation. The highest value was obtained for groups fed 0.23%Trp. Experimental results obtained are in a harmony with those reported by El-Slamoney, *et al.* (2010), Dong *et al.* (2012), Lima *et al.* (2012) and Rojas *et al.* (2015) and Dong and Zou, (2017). Recently, Mousavi *et al.*, (2018) noted that shell percentage, strength and thickness were increased quadratic ally by increasing the tryptophan level in diets.

Table (8). Phonetic correlation between egg weight and some other egg quality of the experimental diets unde different levels of tryptophan (Trp) supplementation.

Item	Dietary treatment[1]				
	T_1 Control	T_2	T_3	T_4	T_5
Egg shape index	-0.05	-0.02	-0.04	-0.02	-0.02
Shell weight	0.16	0.16	0.30	0.32	0.34
Shell thickness	-.053	-0.06	-0.02	0.21	0.24
Albumen weight	0.16	0.18	0.32	0.42	0.53*
Albumen index	-0.40	-0.32	0.02	0.12	0.12
Yolk weight	0.61	0.66*	0.65*	0.84*	0.82*
Yolk index	0.25	0.22	0.26	0.52*	0.46
Haugh units	0.29	0.41	0.33	0.51*	0.51*

*[1] T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp. *: significant.*

Table (9). Effect of supplemental Tryptophan (Trp.) on some blood plasma constituents of Sinai Bedouin hens (Mean ± SE) [2].

Item	Dietary treatments[1]				
	T_1 Control	T_2	T_3	T_4	T_4
Total protein, g/dI	5.62 ^{a}±0.09	5.72 ^{a}±0.08	5.80 ^{a}±0.04	5.93 ^{a} ±0.0	5.86 ^{a} ±0.08
Albumin (A), g/dl	2.69 ^{a}±1.01	2.73 ^{a}±0.09	2.77 ^{a}±1.11	2.86 ^{a} ±0.05	2.82^a±0.05
Globulin (g), g/dl	2.93^c±0.03	3.01^b±0.04	3.03^b±0.08	3.07 ^{a} ±0.01	3.04 ^{b} ±0.01
A / G ratio	0.92^b±0.02	0.91^{ab}±0.02	0.91^{ab}±0.01	0.93 ^{a} ±0.02	0.93 ^{a} ±0.01
Total cholesterol, mg/dl	162.46^a±1.21	159.20 ^{b}±0.92	154.26 ^{a}±1.11	142.4^c±1.21	141.06^d±0.1
Triglycerides (mg / dI)	468.98 ^{a}±0.74	442.39 ^{b}±1.21	439.02 ^{c} ±.99	432.19^{bc}±1.5	429.86^d±1.3
ALT (U/L)	13.36±0.22	13.02±0.18	13.25±0.11	12.98±0.32	13.06±0.07
AST (U/L)	25.36±0.05	25.12±0.14	24.82±0.19	24.76 ±0.42	24.89 ±0.15

On the other hand Deponti *et al.* (2007) concluded that the egg weight, percentage of yolk and albumen and the total solids content of yolk and albumen of the eggs from laying hens are not influenced by ingestion of tryptophan in levels of 137.1 to 228.0mg/bird/day. Mousavi *et al.*, (2018) reported that increasing SID Trp:Lys did not affect egg yolk, albumen content and albumen quality. phenotypic correlation (r_p) between egg weight and some egg quality traits at 38 weeks of age (Table 8), positive correlation by adding supplementation (0.23 and 0.26%) tryptophan to Sinai Bedouin layer hens diets especially shell weight , albumen index, yolk weight and Haugh units. It may be relation between egg weight and some quality and age of hens.

Blood constituents:

Results of blood constituents as affected by different levels of tryptophan are summarized in Table (9). The plasma total protein and albumin concentration were significantly (P ≤ 0.05), when that hens fed diet containing tryptophan at level 0.23% (T_4) compared with other groups (T_2, T_3 and T_5) and control group (T_1). However, here is no significant difference among treatments in blood components representing liver function (as measured by ALT and AST). Similar effects of increased plasma total protein and albumin by tryptophan supplementation were reported by Emadi *et al.*, (2010) in broiler chicken at 0.07, 0.13, 0.20, g/kg, in 40 weeks old Babcock Brown layers at 0.4 g/kg of diet (Dong *et al.,* 2012), at 0.22 and 0.30 % tryptophan and Preedaa *et al.* (2017) reported that the addition of tryptophan levels at 0.18 and 0.20 % had significantly ($P \leq 0.01$) increased total protein and albumin levels. The increase in plasma total protein and albumin in tryptophan supplemented groups might be due to tryptophan induced increased serum IGF-I which enhances the cellular absorption of amino acids (Jacob *et al.,* 1989).

Further, tryptophan inhibits the expression of cathepsin B and 20S protease and plasma cortisol secretion thus inhibiting protein degradation (Simmons *et al.*, 1984). Dietary nutrient levels can also influence amino acid balance and plasma total protein levels which tends to increase when birds are raised with rich nutrition (Choi *et al.*, 2005). The mean plasma cholesterol and triglycerides level was significantly ($P \leq 0.05$) low in tryptophan supplementation by 0.23%Trp. and 0.26% Trp for T_4 and T_5, respectively, compared with other treatments and control group.

Similar to the present study, reduction in the levels of plasma total cholesterol by supplemental tryptophan were observed in broilers and layer by (El-Slamoney, *et al.*, 2010 and Gogary and Azzam 2014). But Preedaa *et al.* (2017) indicated that increasing tryptophan levels at 0.18 and 0.20 % had significantly ($P \leq 0.01$) decreased plasma cholesterol, the reduction in total cholesterol level in tryptophan supplemented groups may be due decreased lipolysis and reduction in plasma free fatty acid by niacin yielded from supplemental tryptophan. Niacin also inhibits diacylglycerol acyltransferase-2 (DGAT2) resulting in decreased triglyceride synthesis. Decrease in cholesterol may be due to reduced stress by tryptophan supplementation as plasma cholesterol is a promising stress indicator (Puvadolpirod and Thaxton, 2000).

Economical efficiency:

Results presented in Table (10) showed that economic efficiency of birds fed dietary tryptophan was superior to that of the control group. Relative economical efficiency values were improved by 5.67, 27.38, 48.70 and 32.01 % for the groups fed 0.17, 0.20, 0.23 and 0.26% Trp, respectively as compared to control group. It may be due to better feed conversion ratio and egg number of birds received the experimental diets. Also, El-Slamoney, *et al.* (2010) recorded that The highest values of economical efficiency of 0.71 with the relative economical efficiencies of and 129.09 were obtained with the groups fed 0.21%tryptophan.

Table (10). The economic efficiency of the experimental diets as effected by different levels of tryptophan (Trp) supplementation.

Item	Dietary treatments[1]				
	T_1 Control	T_2	T_3	T_4	T_5
Price of Kg feed, (L.E.)	6.25	6.26	6.27	6.28	6.29
Total feed intake / hen, (Kg)	9.26	9.28	9.38	9.49	9.43
Total feed cost hen. (L.E.)	57.88	58.09	58.81	59.28	59.31
Total number of eggs / hen,	50.90	51.63	54.38	56.57	55.29
Total price of egg / hen, (L.E.)[2]	71.26	72.28	76.13	79.19	77.41
Net revenue / hen, (L.E)[3]	13.38	14.19	17.32	20.38	18.10
Economic efficiency, (%)[4]	23.38	24.43	29.45	34.38	30.52
Relative Economic efficiency[5]	100	105.67	127.38	148.70	132.01

[1]*T_1; control; without supplementation normal, T_2; control + 0.17%Trp.; T_3, control + 0.20%Trp., T_4, control + 0.23%Trp. andT_5, control + 0.26%Trp.*
[2] *Assuming that price of one – egg was 1.40 P. T. (according to Egyptian market, 10 / 2017).*
[3] *Net revenue / hen. (L. E.) = Total price of eggs – Total feed cost.*
[4] *Economical efficiency = (Net revenue / Total feed cost) x 100.* [4] *Relative economical efficiency of control considered 100.*

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تأثير إضافة التربتوفان في علائق سينا البدو على الأداء الإنتاجي وصفات جودة البيض وبعض صفات الدم

محمد السيد سلطان و إيمان عاشور محمد حسين

قسم إنتاج الدواجن والأسماك – كلية الزراعة – جامعة المنوفية – شبين الكوم – مصر

أجريت هذه الدراسة في محطة أبحاث الدواجن – قسم إنتاج الدواجن كلية الزراعة – جامعة المنوفية ، وذلك بهدف دراسة تأثير إضافة مستويات مختلفة من الحمض الأمينى (التربتوفان) إلى علائق دجاج سينا (البدو) البياض فى عمر 26 أسبوع إلى 38 أسبوع على الأداء الإنتاجي وصفات جودة البيض وبعض صفات الدم ، حسبت الكفاءة الإقتصادية والرتباط البيئى بين بعض الصفات .

استخدم فى هذه الدراسة عدد 150 دجاج بياض (سينا البدو) , تم تقسيمها عشوائياً إلى 5 معاملات تجريبية متماثلة , قسمت كل معاملة إلى 3 مكررات بكل منها 10دجاجات لكل منها. وكانت الطيور تم تسكينها فى أقفاص بصورة فردية و جميعها خضعت لظروف الرعاية والإدارة المتماثلة.غذيت طيور المعاملة الأولى (الكنترول) على العليقة الأساسية (المستوى الطبيعي من الحمض الأمينى التربتوفان 0.14) بينما غذيت طيور المعاملة الثانية والثالثة والرابعة والخامسة على العليقة الأساسية مضافا إليها التربتوفان بمستويات 0.17 و 0.20 و0.23 و 0.26 % على التوالي .

أوضحت النتائج أن الطيور المغذاة على العليقة الأساسية والتي تحتوى على مستويات عالية من التربتوفان أدت إلى زيادة معنوية في وزن الجسم ومعدل الزيادة في وزن الجسم وخاصتاً المعاملة الرابعة بالمقارنة بالمعاملة الأولى (الكنترول). تحسنت معنوياً كل من النسبة المئوية لإنتاج البيض وعدد البيض الناتج وكذلك كتلة البيض بإضافة التربتوفان بمستوى 0.23% بالمقارنة بالمعاملة الكنترول والمعاملات الأخرى.

وسجلت النتائج أيضاً أن الطيور المغذاة على المعاملة الرابعة المضاف لها 0.23% تربتوفان أعطت أفضل معدل تحويل غذائي خلال فترة التجربة. وأدى إضافة الزيادة فى مستوى التربتوفان فى علائق دجاج سينا (البدو) الى التحسن المعنوى لصفات جودة البيض والممثلة فى دليل البيضة ، وجودة القشرة (% القشرة وصلابتها) وكذلك تحسنت كل من صفات جودة الألبيومين والصفار ووحدات هوف ولم يلاحظ أى تأثير معنوى للون الصفار. ولوحظ أيضاً وجود ارتباط بيئى عالى بين بعض الصفات الإنتاجية ووزن الجسم النهائى وكذلك صفات جودة البيض ووزن البيضة وذلك بزيادة مستويات التربتوفان.

كما لوحظ أن الاضافة عند مستوى 0.23% ، 0.26% تربتوفان (المعاملة الرابعة) أدت إلى زيادة تركيز كل من البروتين الكلى, والألبيومين والجلوبيولين معنوياً بينما انخفض مستوى ثلاثى جلسريدات والكوليسترول الكلى فى بلازما الدم بالمقارنة بالكنترول. وتحسنت الكفاءة الاقتصادية عند مستوى0.23% تربتوفان. وبصفة عامة يمكن إضافة الحمض الأمينى التربتوفان فى علائق دجاج سينا (البدو) لما لة تأثير معنوى على الأداء الإنتاجى وصفات جودة البيض وغير ضار بالحالة الصحية للطائر وتحسنت الكفاءة الاقتصادية وخاصةً عند مستوي 0.23% تربتوفان .