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IMPROVEMENT OF FAYOUMI LAYING HENS PERFORMANCE UNDER HOT CLIMATE CONDITIONS 2- BETAINE, FOLIC ACID AND CHOLINE

By

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Abstract: *The study was performed to evaluate the effect of betaine, folic acid and choline on performance of Fayoumi laying hens under hot environmental temperature of summer month's conditions in Egypt. A total number of one hundred and twenty, 20th wks old Fayoumi hens were randomly selected and distributed into four equal groups, thirty birds of each, in three replicates, ten birds of each. Birds in the 1st group were served as control, while those in the 2nd group were fed on a diet with betaine (1 g/kg feed). The 3rd group was received a diet supplemented with folic acid (10 mg/kg feed). Whereas, the 4th group was given a diet inclusive choline (1 g/kg feed). All groups were put under observation for 12 or 16 weeks from 20 to 36 weeks of age.*

Results of 12 or 16 weeks feeding trail of betaine, folic acid and choline to laying hens during the environmentally high temperature stress at summer months, showed ($P<0.05$) improved egg production, egg mass, feed conversion and mortality rate as compared to the respective control hens. Live body weight in dietary supplemental betaine group was significantly ($P<0.05$) better than that of control and those supplemented either by folic acid or choline groups. However, there was no significant ($P<0.05$) effect on feed consumption, exterior and interior egg qualities between supplementation treatments and counterpart control. Also, plasma parameters of layers fed supplemental diets for 16 weeks under hot climate stress were not affected significantly as observed in the concentration of T_3, GPT and GOT enzymes, creatinine, cholesterol and total lipids. While, there were significant differences ($P<0.05$) found in total plasma proteins as well as albumin and globulin. Furthermore, feeding trail showed increase ($P<0.05$) in blood indices such as hemoglobin and hematocrit. Along the same line, lymphoid organs such as relative weights of thymus and spleen were found. Also, immune response such as hemagglutination-inhibittion (HI) titter were ($P<0.05$) increased compared to corresponding control values. It could be concluded from this trial that, supplementation of betaine, folic acid and choline for 12 or 16 weeks to Fayoumi laying hens can improve ($P<0.05$) the

productive performance and immune responses by reducing the side effects of environmentally high temperature stress during summer months in Egypt.

INTRODUCTION

Proper steps should be taken for minimizing the adverse effects of environmental temperature of summer months on performance of laying flocks. The main consequences of hot environment are a reduction in feed intake, egg production, egg weight (Peguri and Coon, 1991), eggshell quality (Grizzle *et al*., 1992) and concomitant with poor feed efficiency and growth (McKee, *et al*., 1997). Therefore, dietary supplementation of some compounds such as vitamins (Folic acid and Choline) or amino acid (Glycine betaine) may give us the opportunity to take appropriate preventive to avoid the adverse effects of hot summer months on laying hens performance.

Betaine, known as glycine betaine or trimethyl glycine, is present in most organisms. The principal physiologic role of betaine is as an osmolyte and methyl donor (Craig, 2004). Betaine is a tertiary amine formed by the oxidation of choline (Wang *et al*., 2004) and implicated in methionine sparing, osmoprotective, and fat distribution and immune responses (Kettunen *et al*., 2001 and Remus *et al*., 2004). However, betaine supplementation seems to be important to improve productivity and resistance to stress (Wang *et al*., 2004). Betaine also reduces the negative effects of dehydration of high temperature or diseases (Garcia *et al*., 2000) and improves immune response (Swain and Johri, 2000). Betaine addition at 2.000 ppm may have the potential to improve the performance, feed conversion, eggshell breaking strength and liver betaine during the environmentally high temperature stress (Ryu *et al*., 2002).

Also, the supply of **folates** in the diet and their synthesis by intestinal microflora are sufficient to prevent folic acid deficiency. However, as suspected from results of Harms *et al*., (1990) and Liu and Feng (1992), using folic acid in poultry diets led to a positive role on improving egg production and feed conversion efficiency. Folic acid has numerous and complex interrelationships with other nutrients and that possibility of deficiency play a part in reducing the animal performance (Radostits *et al*., 2000). Folic acid status is linked to increase serum levels of the sulfur amino acid homocystine due to the role of folic acid that play as co-factor in the remethylation of homocystine to form methionine (House *et al*., 1999).

Choline is an essential nutrient for the poultry production and for prevention of perosis in chicken. The major functions are to give methyl groups (Harms and Russell, 2002). Choline also has three essential metabolic roles, e.g. as a constituent of phospholipids, hepatic lipid metabolism to prevent fatty liver, and as a precursor for acetylcholine synthesis (Workel *et al*., 1999). Harms *et al*., (1990) and Harms and Russell (2002) reported that laying hens would responded positively to choline supplementation of a corn-soybean meal diet. Nonetheless, choline level at 2300 or 3300 mg/kg feed improved cellular and humoral immune response (Swain and Johri, 2000). These beneficial effects might be more profound if birds were under stressful environmental conditions. Literature on using betaine, folic acid and choline on productive performance of laying hen with stress factors is very scarce.

Therefore, the objective of this research was to evaluate the effects of betaine, folic acid and choline supplementation on the performance of Fayoumi laying hens under stressful summer hot conditions.

MATERIALS AND METHODS

The present study was performed at El- Fayoum Poultry Research Station, Animal Production Research Institute, Ministry of Agriculture during summer months from May to August. A total number of one hundred and twenty selected Fayoumi hens at 20 wks of age having nearly equaled live weights were distributed randomly into four groups. Thirty birds were assigned to each group which divided into three replicates, each containing ten birds. The feed supplementations were betaine (97%), choline chloride (60% choline) and folic acid (100%). Birds were assigned to each of the following diet treatments: 1) Basal diet (Table1) served as a control; 2) Basal diet plus 1 g/kg feed of betaine; 3) Basal diet inclusive 10 mg/kg feed of folic acid; 4) Basal diet containing 1 g/kg feed of choline. All groups were put under observation for 12 or 16 weeks from 20 to 36 weeks of age. All birds were kept under local conditions of Fayoum region in metallic layers batteries, where temperature ranged between 38°C and 30°C with 75 % relative humidity throughout the experimental period. Water and experimental diets were supplied *ad libitum*. Pullets were weighed at 20 wks of age and then weighed at interval period of 4-weeks. Sexual maturity was pointed at 24 weeks of age thereupon, egg number, egg weight and mortality rate were recorded daily to 36 wks of age. At 30 weeks, hemagglutination-inhibittion (HI) test was applied for determination of antibody response in serum samples according to Laver (1969) after 15 days of immunization of the flock by Lasota vaccine against Newcastle Disease Virus (NDV). Feed consumption was recorded weekly and feed conversion was calculated. Egg quality was measured at 12 and 16 weeks of feeding trial. Ten eggs from each replicate were collected, weighed, broken and separated into shells, yolks and albumens. The weights of yolk, albumen and shell (with membranes) were recorded and calculated as percentages of egg weight. At the end of experiment, 2 birds per replicate were sacrificed for slaughtering, and their lymphoid organs were weighed (mg/100g body weight). Blood samples were collected then hemoglobin (g/dl) was determined by hemoglobinometer and hematocrit (%) by centrifuged heparinized microhematocrite tubes. Remaining blood was centrifuged and plasma separated and stored at –20°C until analyzed. Plasma total protein (g/dl) albumin (g/dl), T_3 (ng/dl), cholesterol (mg/dl), Total lipids (mg/dl), creatinine (mg/dl), glutamic pyruvic transaminase (GPT) (U/L) and glutamic oxalacetic transaminase (GOT) (U/L) were calorimetrically determined using commercial kits following the recommendations of manufactures. Data were statistically analyzed using one way analysis of SAS Institute, Inc. (1996). Mean differences were tested at ($P<0.05$). The percentage values were transferred to percentage angle using arcsine equation before statistical analyses then turned to natural number.

RESULTS AND DISCUSSION

1 – Productive performance:

A – Live body weight and mortality rate:

Live body weight at 12 and 16 wks of betaine supplemented group during hot climate stress was significantly ($P<0.05$) increased compared to that of the respective control and either folic acid or choline supplementations groups. While, no ($P<0.05$) differences were detected between folic acid, choline supplementations and control groups. Mortality rate at 16 wks was ($P<0.05$) decreased due to betaine, folic acid and choline supplementations (Table 2). These results are in agreement with the findings of Hassan *et al*., (2005) who reported that betaine addition at either 0.072 or 0.144% significantly improved body weight gain by 4.4 and 4.8%, respectively. Also, Augustine *et al*., (1997) and Waldenstedt *et al*., (1999) reported that dietary betaine addition improved performance of chicks. Saunderson and Mackinlay (1990) reported that accumulation of betaine in the cell protects it from osmotic stress. Concomitant were the results of Harms and Russell, (2002), Hebert *et al*., (2004) and El-Husseiny *et al*., (2005) found no significant differences in body weight gain among hens receiving diets containing choline or folic acid. Keshavarz (2003) observed that reducing dietary folic acid resulted in reducing body weight.

B – Egg production and egg mass:

During hot climate stress, pullets provided with betaine, folic acid and choline for 12 or 16 wks increased ($P<0.05$) egg production by 18.8, 16.7 or 15.8% at 12 wks and by 21.1, 13.8 or 12.3% at 16 wks, respectively in comparison with their respective control pullets. Meanwhile, supplementing layers diet with betaine increased ($P<0.05$) egg production compared with the diets supplemented with folic acid or choline by 6.4 or 7.8 % at 16, respectively (Table 3).

Egg mass expressed as the total cumulative egg weight per treatments. Results shows in Table (3) an increase ($P<0.05$) in egg mass for hens fed diets supplemented with betaine, folic acid and choline when compared with those of counterpart control hens at 12 or 16 wks of feeding trail. The values were higher by 18.2; 16.4 or 16.3% at 12 wks and 20.6, 13.7 and 12.5%, respectively at 16 wks of feeding trail. Meanwhile, supplementing layers diets with betaine significantly ($P<0.05$) increased egg mass compared with folic acid or choline supplementations. The values were higher by 6.1, or 7.3%, respectively at 16 wks of feeding trail.

Supplementing layers diets with betaine, folic acid and choline has been reported to improve layer performance. Castaing *et al.*, (2002) and Ryu *et al.*, (2002) reported that an improvement ($P<0.05$) in egg production and egg mass were observed when 2,000 ppm betaine was fed to the laying hens during the environmentally high temperature stress. They add that dietary supplemental betaine may have the potential to improve the performance of laying hens. The improving performance due to betaine supplementation could be attributed to several reasons, e.g. as methyl donor group, its diverse physiological properties that could improve gut environment and thus enhance the ability of the chicks to withstand coccidial infection (Augustine *et al.*, 1997; Kettunen *et al.*, 2001 and Remus *et al.*, 2004), reduce intestinal membrane damage, dehydration, diarrhea and mal-digestion and\or absorption (Crompton, 1976; Kettunen *et al.*, 2001). Saunderson and Mackinlay (1990) reported that accumulation of betaine in the cell protects it from osmotic stress.

Also, these results agree with those of Harms *et al.*, (1990) who found a significant ($P<0.05$) increase in egg production when 878 mg choline/kg was added to the diet containing 0.033% supplemental methionine. Harms and Russell (2002) reported that laying hens would respond to choline supplementation of a corn-soybean meal diet. Rao *et al.*, (2001) reported that the addition of choline to broiler breeders' diet increased their performance significantly. Liu and Feng (1992) reported that folic acid increased egg production when added at levels of 0.54 to 1.5 mg/kg to the diet.

C – Feed consumption and conversation ratio:

Despite of no differences (P<0.05) in feed consumption among treatments during the whole experimental periods were found during hot climate stress (Table 3). More eggs were produced by treatment groups compared to the control group. Therefore, addition of betaine, folic acid and choline improved (P<0.05) the feed conversion ratio when compared with that of control group at 12 or 16 wks of feeding trail (Table 3). Feed conversion ratio of birds fed betaine supplemented diet were (P<0.05) improved compared to that of folic acid or choline supplemented diet.

These results of feed consumption are in a good agreement with those of Ryu *et al.*, (2002), Castaing *et al.*, (2002), Hebert *et al.*, (2004) and El-Husseiny *et al.*, (2005). Also, the present improvement in feed conversion ratio by betaine, folic acid and choline supplementation are in accordance with those of Khan *et al.*, (1991), Emmert *et al.*, (1996), House *et al.*, (2002), Ryu *et al.*, (2002) and Hassan *et al.*, (2005). Furthermore, Miles *et al.* (1987) reported that betaine was more efficient than choline for improving feed conversion ratio and betaine could replace choline in chicken diets.

2 – Egg quality:

No (P<0.05) differences in egg weight, interior or exterior egg quality (Table 4) were observed due to either betaine, folic acid or choline supplementations during hot climate stress. Although betaine, folic acid or choline supplementations improved (P<0.05) egg production (Table 3), they did not retard the decline of egg quality. The fact is that egg shell thickness and egg shell weight reduced as egg size increased (Roland, 1988; Jackson *et al.*, 1987), this fact was not observed in the resent study. As stated above, results indicate that adding betaine, folic acid or choline can improve layer performance without sacrificing egg size or qualities. These results were confirmed by those of Ryu *et al.*, (2002) and Castaing *et al.*, (2002), Rao *et al.*, (2001) and Bhardwaj *et al.*, (2000) reported that egg weights and Haugh unit score did not differ among dietary treatments containing 500 mg choline/kg. there no significant difference (P>0.05) in egg weight, egg shell thickness and Haugh units due to folic acid supplementation up to 4 mg/kg of the diet (Hebert *et al.*, 2004) and due to increasing choline from 300 to 900 mg/kg or folic acid from 2.0 to 6.0 mg/kg (Keshavarz, 2003 and El-Husseiny *et al.,* 2005).

3 – Blood biochemical parameters:

Plasma T_3 of birds provided with betaine, folic acid or choline supplemental diets tended to increase relative to that of control, however, the differences was not statistically different (Table 5). There was an increase ($P<0.05$) in plasma total protein as well as albumin and globulin fractions when either betaine, folic acid or choline was added to layers diets comparing to counterpart control. Ratio of A/G was decreased ($P<0.05$) as a result of the changes in globulin with the additions of betaine, folic acid or choline. Increasing the previous blood parameters may indicate that an enhancement of immunity occurred corresponding to feeding betaine, folic acid or choline as a result of improving feed conversation, absorption and utilization of nutrients. These results agree with the findings of Mathews and Southern (2000) and Hassan *et al*., (2005) when reported that the improvement in serum total protein, albumin and globulin due to betaine and\or choline supplementation indicating further evidence about the role of methyl donor groups in protein metabolism.

There were no statistical significant ($P<0.05$) influences of the dietary supplemental betaine, folic acid or choline on plasma cholesterol or total lipids (Tables 5). Support was found by Rao *et al*., (2001) and Hassan *et al*., (2005) who observed that serum cholesterol was not affected by betaine and choline dietary addition.

No ($P<0.05$) differences in GOT, GPT enzymes activity and creatinine were observed among treatments (Table 5). The similitude of enzyme activity and creatinine concentration in supplemented or not groups is exhibit healthy, non-pathological or non-toxic effects of either betaine, folic acid or choline on liver or kidney functions. No significant differences were detected in the hepatic enzyme activities or liver functions as judged by liver enzymes AST and ALT as a response to dietary betaine and choline have been reported by (Saunderson and Mackinlay, 1990 and Hassan *et al.*, 2005).

4 – Blood indices:

Supplementing layer diets with betaine, folic acid or choline for 16 wks increased ($P<0.05$) hemoglobin and hematocrit values when compared with the control diet (Table 6). Saunderson and Mackinlay (1990) reported that accumulation of betaine in the cell protects it from osmotic stress.

5– Some lymphoid organs and immune response:

Significant ($P<0.05$) increases was detected in HI antibody titter as immune response to NDV and relative weighs of thymus and spleen in supplemented treated groups compared with that of control group (Table 6).

The increases in weights of thymus, spleen (Table 6) and globulin value (Table 3) probably are due to the immunostimulate as affected by feeding of betaine, folic acid or choline. Concomitant were the results of Swain and Johri (2000), Mathews and Southern (2000), Remus *et a*l., (2004) and Hassan *et al*., (2005) reported that choline and\or betaine significantly increased secondary response to SRBC's, while primary responses to SRBC's was linearly increased ($P<0.05$) with increasing choline or betaine addition and that confirmed by they positive effect in serum proteins. Moreover, Saunderson and Mackinlay (1990) reported that accumulation of betaine in the cell protects it from osmotic stress.

It's strongly recommend that, the addition of betaine, folic acid or choline to Fayoumi laying hens diets during the environmentally high temperature stress in order to improve its performance, livability, healthy or immunostimulant, and reduce the side effects of hot climate.

Table (1): Composition and chemical analysis of the basal diet fed to experimental birds.

Ingredients	%
Yellow corn	63.14
Soybean meal 44 %	27.10
Di-calcium phosphate	1.50
Limestone	7.60
Salt (NaCl)	0.30
DL-Methionine	0.06
Vit. & Min. Mixture*	0.30
Total	**100.00**
Calculated analysis	
Metabolizable energy (Kcal / Kg)	2722.00
Crude protein %	17.50
Crude fiber %	3.03
Calcium %	3.30
Available phosphate %	0.42
Methionine %	0.36
Met + cyct %	0.68

*Supplied per Kg of diet: Vit. A, 10 000 IU; Vit. D_3, 2 000 IU; Vit. E,10 mg; Vit. K_3,1 mg; Vit. B_1, 1mg; Vit. B_2, 5 mg; Vit. B_6, 1.5 mg; Vit. B_{12}, 10 mcg; Niacin, 30mg; Pantothenic acid, 10mg; Folic acid,1mg; Biotin, 50mcg;Choline,260mg; Copper, 4 mg; Iron, 30mg; Manganese, 60mg; Zinc,50mg; Iodine,1.3mg; Selenium, 0,1mg; Cobalt, 0.1mg;

Table (2): Body weight (g) and mortality rate % of Fayoumi laying hens provided with betaine, folic acid and choline under hot climate Stress (LSM±S.E.)

Treatment / feeding time (wks)	Control	Betaine	Folic acid	Choline
Body weight (g)				
0	1231.00 ^{a}±10.23	1225.25 ^{a}±15.10	1241.50 ^{a}±15.71	1236.50 ^{a}±10.22
8	1470.70 ^{b}±7.00	1559.32 ^{a}±3.56	1506.59 ^{ab}±18.31	1513.07 ^{ab}±13.31
12	1562.40 ^{b}±9.00	1645.13 ^{a}±12. 62	1547.70 ^{b}±13. 69	1566.44 ^{b}±10.19
16	1634.45 ^{b}±11.35	1756.32 ^{a}±10.31	1663.57 ^{b}±8.18	1654.82 ^{b}±23.31
Mortality rate %				
16	15 ^{a}	3 ^{b}	7 ^{b}	7 ^{b}

Means with differing superscript (a, b) within a row, differ significantly (P<0.05)

Table (3): Productive performance of Fayoumi laying hens provided with Betaine, folic acid and choline under hot climate stress (LSM ± S.E.)

Treatment / feeding time (wks)	Control	Betaine	Folic acid	Choline
Cumulative egg production (egg/hen house/wk)				
12	26.21 ^{b}±0.46	31.14 ^{a}±0.55	30.61 ^{a}±1.69	30.36 ^{a}±0.43
16	43.18 ^{c}±0.82	52.29 ^{a}±1.43	49.13 ^{b}±0.24	48.49 ^{b}±1.55
Egg weight (g)				
12	45. 23 ^{a}±0.20	44.96 ^{a}±1.62	45.09 ^{a}±0.75	45.41 ^{a}±1.09
16	46.62 ^{a}±1.12	46.44 ^{a}±1.98	46.58 ^{a}±1.93	46.69 ^{a}±1.82
Cumulative egg mass (g egg/ hen house/ wk)				
12	1185.54 ^{b}±36.24	1401.08 ^{a}±0.92	1380.15 ^{a}±65.01	1378.63 ^{a}±29.22
16	2013.23 ^{c}±62.91	2428.56 ^{a}±48.50	2288.45 ^{b}±4.55	2264.13 ^{b}±48.52
Cumulative feed consumption (g feed/hen house /wk)				
12	4682.58 ^{a}±12.00	4432.60 ^{a}±16.50	4654.50 ^{a}±54.50	4770.50 ^{a}±100.00
16	7670.95 ^{a}±52.50	7361.50 ^{a}±10.00	7346.50 ^{a}±98.00	7473.50 ^{a}±140.00
Feed conversion (g feed / g egg)				
12	3.95 ^{a}±0.13	3.16 ^{c}±0.01	3.37 ^{b}±0.13	3.46 ^{b}±0.17
16	3.81 ^{a}±0.11	3.03 ^{c}±0.06	3.21 ^{b}±0.03	3.30 ^{b}±0.16

Means with differing superscript (a, b, c) within a row, differ significantly (P<0.05)

Table (4): Some egg quality characteristics of Fayoumi laying hens provided with betaine, folic acid and choline under hot climate stress (LSM±S.E.)

Treatment / Item	Feeding time (wks)	Control	Betaine	Folic acid	Choline
Exterior egg quality					
Egg weight	12	45. 31 [a]±0.20	44.96 [a]±1.62	45.09 [a]±0.75	45.41 [a]±1.09
	16	46.77 [a]±1.12	46.44 [a]±1.98	46.58 [a]±1.93	46.69 [a]±1.82
Shell weight%	12	10.31 [a] ±0.15	10.47 [a]±0.42	10.03 [a]±0.44	10.43 [a]±0.53
	16	10.05 [a]±0.28	10.06 [a]±0.95	9.99 [a]±0.77	10.11 [a]±0.30
Shell thickness (mm)	12	3.87 [a]±0.07	4.06 [a]±0.01	3.71[a]±0.01	3.65 [a]±0.01
	16	3.79 [a]±0.09	3.93 [a]±0.01	3.93 [a]±0.01	3.76 [a]±0.01
Egg Shape index	12	74.19 [a]±1.70	74.94 [a]±1.08	75.09 [a]±1.31	74.89 [a]±1.19
	16	76.92 [a]±1.33	77.02 [a]±1.22	76.88 [a]±1.41	77.10 [a]±1.53
Interior egg quality					
Albumin weight%	12	58.57 a±0.01	58.52 a±0.61	58.74 a±0.24	58.53 a±0.30
	16	58.92 [a]±0.01	58.76 [a]±0.48	58.78 [a]±0.11	58.59[a] ±0.21
Yolk weight%	12	31.12 a±0.44	31.01 a±0.83	31.23 a±0.97	31.04 a±0.71
	16	31.03 [a]±0.98	31.18 [a]±1.87	31.23 [a]±0.23	31.30 [a]±0.26
Yolk index	12	37.50 [a]±5.90	37.11 [a]±.4.23	37.14 [a]±5.16	37.28 [a]±3.01
	16	35.62 [a]±6.21	35.68 [a]±1.24	35.91 [a]±0.67	35.58 [a]±1.14
Haugh unit	12	84.08 [a]±1.96	84.97 [a]±1.96	85.12 [a]±1.96	85.27 [a]±0.01
	16	80.96 [a]±1.96	83.19 [a]±1.40	82.91 [a]±1.19	83.10 [a]±1.25

Means with differing superscript within a row, differ significantly (P<0.05)

Table (5): Plasma biochemical parameters of Fayoumi laying hens provided with betaine, folic acid and choline for 16 wks under hot climate stress (LSM±S.E)

Treatment / Items	Control	Betaine	Folic acid	Choline
T_3 (ng/dl)	194.12 [a]±10.14	203.14 [a]±11.80	198.51 [a]±4.55	200.19. [a]±9.10
Total protein (g/dl)	3.22 [c]±0.19	4.13 [b]±0.12	4.41 [a]±0.13	3.95 [b]±0.18
Albumin(A) (g/dl)	2.20 [c]±0.15	2.52 [b]±0.13	2.69 [a]±0.15	2.45 [b]±0.11
Globulin(G) (g/dl)	1.02 [d]±0.10	1.61 [b]±0.02	1.72 [a]±0.02	1.50 [c]±0.03
A/G ratio	2.15 [a]±0.02	1.56 [b] ±0.01	1.56 [b] ±0.02	1.63 [b] ±0.03
Creatinine (mg/dl)	0.46[a]±0.03	0.45[a]±0.04	0.46[a]±0.01	0.45[a]±0.02
GPT (U/L)	44.16[a] ±2.13	43.91 [a]±2.09	45.02[a]±2.10	44.17 [a]±1.92
GOT (U/L)	20.82 [a]±1.33	21.00 [a]±1.13	21.10 [a]±1.05	20.74 [a]±1.21
Cholesterol (mg/dl)	114.50 [a] ±4.06	109.80 [a]±3.231	117.30 [a]±4.72	106.50 [a]±3.90
Total lipids (mg/dl)	178.11[a] ±3.50	169.61 [a]±3.25	176.18 [a]±5.10	172.30 [a]±3.47

Means with differing superscript (a, b, c) within a row, differ significantly (P<0.05)

Table (6): Blood indices, HI titter and relative weights of some lymphoid organs (mg/100g B.W.) of Fayoumi laying hens fed on betaine, folic acid and choline for 16 wks under hot climate stress (LSM±S.E.)

Treatment / Items	Control	Betaine	Folic acid	Choline
Hemoglobin (g/d)	10.22 [b] ±0.81	11.15 [a] ±0.24	11.06 [a] ±0.32	11.08 [a] ±0.21
Hematocrit (%)	26.73 [b] ±1.14	27.82 [a] ±0.72	27.61[a] ±0.68	27.76 [a] ±0.67
HI titter	125.7 [b] ±6.25	180.50[a] ±6.15	165.2 [a] ±7.33	169.12 [a] ±7.73
thymus	66.22 [b] ±5.15	70.25 [a] ±4.12	71.00 [a] ±3.62	70.40 [a] ±3.55
spleen	198.67 [b] ±8.15	221.20 [a] ±8.51	214.28 [a] ±9.25	217.56 [a] ±7.13

Means with differing superscript (a, b) within a row, differ significantly (P<0.05)

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الملخص العربى

تحسين الأداء الانتاجي للدجاج الفيومي البياض تحت ظروف المناخ الحار

2 – البيتايين وحامض الفوليك والكولين

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أجريت هذه الدراسة لمعرفة تأثير الحامض اميني (جليسين البيتايين) والفيتامينات (حامض الفوليك و الكولين) لتحسين بعض الصفات الإنتاجية والفسيولوجية للدجاج الفيومي البياض تحت ظروف المناخ الحار. وقد تم استخدام 120 دجاجة فيومي عمر 20 اسبوع تم توزيعهم عشوائيا إلى اربعة مجموعات متساوية كلا منها 30 دجاجة في 3 مكررات(كل منها 10دجاجات) وتم تربيتهم تحت ظروف متماثلة. المجموعة الأولي علىة المقارنة. والثانية تم إضافة مستحضر البيتايين في صورة (الحامض الأميني جليسين البيتايين 97%) بمعدل 1جم/ كجم عليقه. والثالثة تم إضافة حامض الفوليك (الفيتامين) في صورة نقية بمعدل 10ملجم/ كجم عليقه. والرابعة تم إضافة الكولين (الفيتامين) في صورة كلوريد الكولين (60%) بمعدل 1جم/ كجم عليقه. وذلك حتي عمر 36 اسبوع من مايو إلي أغسطس أثناء قصل الصيف الحار 28- 38 درجة مئوية ودرجة الرطوبة نسبية 75%. **وكانت النتائج كالأتي : -**

- **هناك زيادة معنوية** بمستوي (P<0.05) لإضافة البيتايين الي علائق الدجاج البياض لمدة 8 أو12 أو16 اسبوع تحت ظروف المناخ الحار علي وزن الجسم الحي بينما إضافة حامض الفوليك أوالكولين لم يؤثر في أي عمر بالمقارنة بمجموعة الكنترول.
- **هناك تحسن معنوي** لمعدل النفوق بمستوي (P<0.05) لإضافة البيتايين وحامض الفوليك أوالكولين الي علائق الدجاج البياض لمدة 16 اسبوع تحت ظروف المناخ الحار
- **كما أدت الإضافات** لمدة 12 أو 16 اسبوع تحت الظروف المناخ الحار إلي زيادة معنوية بمستوي (P<0.05) في كل من معدل إنتاج البيض وكتلة البيض والكفاءة التحولية تراكميا بينما العلف المأكول لم يتأثر في أي فترة وذلك بالمقارنة بمجموعة الكنترول.
- **وأيضا لم تؤثر الإضافات** المستخدمة لمدة 12 أو 16 اسبوع معنويا علي كل صفات جودة البيض حيث تشابهت قيم كل من وزن البيضة ووزن الألبيومين وزن القشرة ووزن الصفار وسمك القشرة ودليل الصفار ودليل شكل البيضة وكذلك قيم Haugh unit.
- **كما أدت الإضافات** لمدة 16 اسبوع تحت الظروف المناخ الحار إلي زيادة معنوية (P<0.05) في تركيزكل من البروتين الكلى والألبيومين والجلوبيولين في بلازما الدم
- **وأيضا لم تؤثر الإضافات** المستخدمة لمدة 16 اسبوع تحت الظروف المناخ الحار معنويا علي تركيز الكرياتينين وإنزيمي GOT and GPT و مستوى الكولسترول والدهون الكلية في بلازما الدم وذلك بالمقارنة بمجموعة الكنترول.
- **كما أدت الإضافات** لمدة 16 اسبوع تحت الظروف المناخ الحار إلي زيادة معنوية في كل من مستوي الأجسام المناعية لفيروس النيوكاسل بعد 15يوم من التحصين . وتركيز الهيموجلوبين والهيماتوكريت وكذلك الوزن النسبي لكل من الغدة الثيموسية والطحال وذلك بالمقارنة بمجموعة الكنترول.
- وأظهرت النتائج أنة ينصح باستخدام البيتايين أو حامض الفوليك أوالكولين لتحسين وزن الجسم ومعدل التحويل الغذائى ومعدل إنتاج البيض وكتلتة والصفات البيوكيميائية للدم وخفض معدل النفوق وذلك فىعلائق الدجاج الفيومي البياض في الأجواء الحارة وشبة الحارة أو تحت أي ظروف بيئية مجهدة.