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EFFICACY OF DIFFERENT DIETARY LEVELS OF ANTIOXIDANTS VITAMIN C, E AND THEIR COMBINATION ON THE PERFORMANCE OF HEAT-STRESSED LAYING HENS

By

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Abstract: *An experiment was conducted to investigate the effect of different dietary levels of antioxidants of vitamin C and E and their interactions on the performance of local Dandarawi laying hens exposed to natural high environmental temperature in the summer season (July-August-September) of upper Egypt. A 3 x 3 factorial design experiment was conducted using two hundred seventy, 28 week old, Local Dandarawi laying hens. Birds were randomly distributed into nine equal groups of thirty birds each (three replicates of 10 birds each). Three levels of vitamin E (0, 100, 200 mg/kg diet) and three levels of vitamin C (0, 100, 200 mg/kg) were used. Results indicated that supplemental 200 mg/kg diet of vitamin C had a positive significant (P<0.05) effect on final body weight, mortality rate and feed conversion. Vitamin E had no additive effect on final body weight, body temperature, feed intake and feed conversion. Hens that fed vitamin C generally resulted in a higher egg mass during experimental period. Birds fed vitamin C at 200 mg/kg had the best egg production compared to control birds. In some criteria such as feed conversion and egg mass, the addition of mixtures of vitamin C and E (200 mg/kg each) gave similar positive results as the addition of vitamin C alone. Egg production was significantly (P<0.05) higher in hens fed 200 mg/kg vitamin C alone or in combination with 200 mg/kg of vitamin E when compared to the control. Egg quality traits (egg yolk, shell weight, shell thickness and specific gravity), tibia ash and tibia calcium were significantly increased (P<0.05) when hens were fed the highest level of vitamin C (200 mg/kg) compared with control birds or any levels of vitamin C or E. Plasma glucose, albumin (except for 100 mg vitamin E alone), and cholesterol concentrations decreased, whereas plasma total protein concentration increased when vitamins C and E singly or together were added to the diet. Vitamin C and vitamin E supplementation resulted in an increase in plasma concentration of calcium* *(except for 100 mg vitamin E alone) and phosphorus. The results of the present study suggest that vitamin C supplementation at 200 mg/kg diet, alter plasma concentrations of glucose, albumin, cholesterol, total protein, calcium and phosphorus diet and may enhance egg production. The addition of 200 mg/kg vitamin C alone offer a good management practice in Dandarawi laying hens reared at high temperature*.

INTRODUCTION

Several researchers have been investigating the effect of high environmental temperature on the performance of different poultry species. In laying hens, heat stress depresses body weight (Scott and Balnave, 1988), egg production (Whitehead *et al*., 1998), egg weight (Balnave and Muheereza 1997) and shell quality (Deaton *et al.,* 1981 Daghir 1995 and Mahmoud *et al.,* 1996) and were generally accompanied by suppression of food intake which could be the cause of the decline in egg production.

Cell-mediated immunity are affected by heat stress. In this respect, Deyhim *et al*., (1994) reported that heat stress depressed cellular mediated immunity. They explained that cell-mediated immunity suppression occuring during heat stress conditions may be related to insufficient vitamins as feed consumption is adversely affected.

Poultry are known not to require a dietary source of vitamin C because of the ability of the bird to synthesize its own. Pardue and Thaxton (1986) have documented evidence that particular environmental stressors can alter ascorbic acid synthesis in avian species. It has been also reported that ascorbic acid synthesis is inadequate under stress conditions such as high environmental temperature, humidity and parasitic infestation (McDowell, 1989; Cheng *et al.,* 1990; Kutlu and Forbes, 1993; Sahin and Kucuk, 2001; and Sahin *et al.,* 2002a, b).

Previous studies have shown that ascorbic acid is an indispensable micronutrient required to maintain the physiological processes of certain animals including poultry (McDowell, 1989). Vitamin C alleviates the negative effects of stress such as heat stress-related depression in poultry (McDowell, 1989 and Kutlu and Forbes, 1993).

The antioxidation property of vitamin E has been considered to have a role in the development of immune response in chickens. It act as a physiological synergist and as a functioning portion of specific enzymes. It increases the immune response in chicken, whereas it is involved in immune response, such as lymphocytes, macrophages, and plasma cells, against oxidative damage and to enhance the function and proliferation of these cells (Franchini *et al.,* 1991) and increases circulating yolk precursor concentrations during exposure to high environmental temperature which improved yolk and egg production (Utomo *et al.,* 1994).

Metwally (2003) reported that a dietary supplement of 310 mg vitamin E/kg diet during high environmental temperature is optimum for alleviating, at least in part, the adverse effects of heat stress in Dandarawi laying hens.

Because of apparent differences in the role of vitamins to reduce the detrimental effects of heat stress, the present study was conducted to investigate the effect of different dietary levels of antioxidants vitamin C and E as well as their combination on the performance of Dandarawi laying hens under Upper Egypt summer conditions.

MATERIALS AND METHODS

Management and feeding.

This experiment was carried out at the Poultry Farm, Animal Production Department, Faculty of Agriculture, Assiut University, Assiut. Egypt. A 3 x 3 factorial design experiment was conducted using two hundred seventy, 28 week old, Local Dandarawi laying hens. Birds were randomly distributed into nine equal groups of thirty birds each (three replicates of 10 birds each). The birds were housed in individual wire cages in an open room exposed to natural high environmental temperature prevailing in the Summer season (July-August-September) of Upper Egypt. Three levels of vitamin E (0, 100, 200 mg/kg diet) and three levels of vitamin C (0, 100, 200 mg/kg) were used. Vitamin E was added as dl-α-tocopherol acetate and vitamin C was fed as L-ascorbic acid. Hens in the control groups were fed corn-soybean meal diet containing 10 mg/kg of vitamin E (Table 1). All birds were given feed and water *ad libitum* and subjected to a photoperiod of 16 h light and 8 h dark/day. The experimental diet was formulated to meet or exceed the nutrient requirements of laying hens (NRC, 1994). The feeding trial continued for fourteen weeks. Two weeks for adapting birds on experimental diets and 12 weeks for data recording.

Samples of the experimental diet were analyzed for chemical composition using methods of AOAC (1995).

Egg production and egg quality measurements.

Individual body weight was recorded at the beginning and at the end of the experiment. Body temperature was recorded daily using ten birds per group. Eggs were collected and recorded daily. Mortality was recorded daily. Food consumption was determined weekly and feed conversion was calculated. Egg quality measurements were determined on eggs of the last 3 days of each month. Yolk index % (Well, 1968) was calculated as yolk height divided by yolk diameter. Specific gravity was measured.

Bone characteristics and blood parameters.

At the end of the experiment, six birds/treatment were randomly taken and slaughtered and blood samples were collected in a sterile heparinized centrifuge tubes. The samples were then centrifuged for 20 min. at 3000 r.p.m. and plasma samples were then stored frozen at – 20 C until analyzed. Plasma samples were analyzed for glucose (mg/dl), albumin (g/dl), cholesterol (mg/dl), total protein (g/dl), calcium (mg/dl) and phosphorus (mg/dl) using kits supplied by Diamond Diagnostic (Cairo, Egypt) Also, both tibia (left and right) were dissected and were oven dried at 105 C for 24 hr. Bone fragments were fat extracted and ashed in a muffle furnace at 600 C for 3 hr. Tibia ash was expressed as a % of dry weight (Qian *et al*., 1996). Known weights of tibia ash samples were subjected to wet digestion for the determination of calcium and phosphorus according to the official methods of the AOAC (1995).

Ambient temperature and relative humidity.

During the experimental period, the average minimum and maximum ambient temperature and relative humidity were 23 and 38 C and 24 and 63.3%, respectively.

Statistical analysis.

Data were subjected to ANOVA using GLM procedure of SAS (1990). Duncan's multiple range test was used to determine differences among means when treatment effects were significant (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight changes, body temperature and mortality rate.

The results of the main effects of vitamin C and E and their interactions on body weight changes, body temperature and mortality rate of Dandarawi laying hens kept under upper Egypt summer conditions are presented in Tables 2 and 3. There was a significant effect ($P<0.05$) of vitamin C levels on final body weight and body weight changes. Birds fed control diets (without vitamin C, regardless of vit. E levels) under high environmental temperature (38 C) exhibited lower final body weight and body weight changes % (1327 g, 6.84%, respectively) than that fed diets supplemented with 200 mg/kg vitamin C (1424 g, 12.48%, respectively). Similar findings were reported by Deaton *et al.,* (1986), Bollengier-Lee *et al*. (1999) and Puthponsiripern *et al*., (2001). No significant effect (P<0.05) of vitamin E on final body weight and body weight changes of Dandarawi laying hens. The interaction effects of vitamin C and E levels were significant (P<0.05) on final body weight and body weight changes %. It is noticed that birds fed diets supplemented with 200 mg/kg vitamin C plus 100 mg/kg of vitamin E had the best final body weight and body weight changes %.

Results showed that there were no significant effects due to vitamin C or E (Table 2) on Dandarawi laying hens body temperature.

The insignificant differences in body temperature due to vitamin C supplementation are supported by the findings of Pardue *et al*., (1985) who compared chicks supplemented with 1000 ppm vitamin C and unsupplemented chicks maintained at 22 C or acutely exposed to 43 C. However, it has been stated by various workers that vitamin C supplementation resulted in significantly lower body temperature and greater oxygen consumption at elevated environmental temperature (Ahmed *et al*., 1967 and Lyle and Moreng, 1968). Wide physiological effects of vitamin C were also reported in chickens. Vitamin C ameliorated the steriod-mediated immunosuppression (Pardue and Thaxton, 1984).

Also, the insignificant (P<0.05) effect of vitamin E on Dandarawi laying hens body temperature was found by Metwally (2003).

Lower mortality rate was observed during the experimental period under high environmental temperature with birds that fed diets supplemented with the highest levels of vitamin C or E (Table 2). Birds that received 200 mg/kg vitamin C exhibited lower percentages of mortality (8.48%) compared to control birds (11.78%). The obtained results are in agreement with that reported by Attia (1976). While birds that received 200 mg/kg of vitamin E had 9.21% mortality rate *vs* 11.71% for their control. Concerning with the effects of vitamin E on mortality rate of laying hens under heat stress, similar finding was obtained by Metwally (2003) and Siam *et al.,* (2004).

The interaction effects between vitamin C and E on mortality rate (Table 3) showed that birds fed the highest level of vitamin C alone had the lowest level of mortality rate (7.85%) compared to any other levels of mixtures of vitamin C and E.

Feed consumption, feed conversion and egg production.

Results in Tables 2 and 3 showed that vitamin C or E and their interactions had not a significant ($P<0.05$) effect on feed consumption. The obtained results are in agreement with that reported by Siam *et al.,* (2004), who found that vitamin E supplementation had no significant effect on feed intake. Wolfenson *et al.,* (1979) and Deaton *et al.,* **(**1981, 1982**)** reported that heat stress did not reduce feed consumption in layers. Metwally (2003) found that no significant differences in feed intake between birds fed control diets and that fed control diets supplemented with 110 or 210 mg/kg vitamin E under high environmental temperature, while the level of 310 mg vitamin E/kg increased significantly ($P<0.05$) feed intake.

The main effect of vitamin C on feed conversion (Table 2) showed that it was significantly ($P<0.05$) improved during high environmental temperature by vitamin C supplementation. The obtained results are in agreement with the findings of Bell and Marion (1990).

No significant differences were observed in feed conversion due to vitamin E supplementation. The obtained results are in disagreement with that reported by Metwally (2003) who used higher level (310 mg/kg)

The beneficial effects of vitamin C on feed conversion may be due to that vitamin C helps to control the increase in body temperature and plasma corticosterone concentration. It also, protects the immune system (Rama Rao *et al.,* 2002).

The interaction effects between vitamin C and E on feed conversion (Table 3) showed that birds fed the highest levels of vitamin C alone had the best feed conversion (4.52) compared to any other levels of mixtures vitamin C and E.

Diets supplemented with vitamin C generally resulted in a higher egg mass (Table 3) during the 90 days experimental period. An improved effect was observed with layers fed 100 or 200 mg vitamin C/kg diet without vitamin E probably due to higher rate of laying and relatively large egg weight. This response indicates the beneficial effect of vitamin C in laying hen diets under high environmental temperatures. Results reported herein in harmony with those obtained by Abd-Ellah (1995), Behl *et al*., (1995) and Puthpongsiriporn *et al.,* (2001).

Results in Table 2 and 3 showed that birds fed vitamin C alone at 100 or 200 mg/kg had the best egg production compared to control birds under high environmental temperature. Vitamin C helped the birds to cope with the stressful conditions (Cheng *et al.,* 1990).This effect appears to be mediated through the adrenal gland, as vitamin C plays an important role in the synthesis of steriod hormones (Seemann 1991). Al-Shoquiry (1999), Newman and Leason (1999) and Puthpongsiriporn *et al.,* (2001) found that vitamin C had beneficial effect on egg production. Also, hens fed the highest level of vitamin C alone (200 mg/kg) had a higher averages of egg number and egg mass (18.03 and 786.8 g) than control birds.

The main effect of vitamin E on egg number, egg mass and egg production showed that there were no any significant effects on these traits. Similar trend was found by Puthpongsiriporn *et al.,* (2001), they reported that hen-day egg production was not influenced by vitamin E supplementation at 65 IU/kg diet during heat stress. The obtained results are in disagreement with the findings of Scheidler and Froning (1996), and Kirunda *et al.,* (2001). Also, Bollengier-Lee *et al*., (1998) found that vitamin E supplementation between 125 and 500 mg/kg diet can alleviate the detrimental effects of high temperature and maintain egg production by maintaining the supply of egg precursors in plasma. Puthpongsiriporn *et al.,* (2001) reported that vitamin E supplementation at 65 IU/kg diet may enhance production, and antioxidant properties of egg yolk and plasma of White Leghorn hens during heat stress.

The obtained results showed that no significant effects of vitamin C or E or their interactions on egg weight (Tables 2 and 3). Similar trends were found by Qruwari *et al*., (1995), Zapata and Gernat (1995), Balnave and Muheereza (1997) and Al-Shoquiry (1999) who indicated that vitamin C had no beneficial effect on egg weight.

The interaction effects of vitamin C and E on egg production showed that birds fed diets containing 100 or 200 mg/kg vitamin C alone had better egg production (61.5%) and the control (53.2%).

In some criteria such as egg mass, feed conversion and egg production, the addition of mixtures of vitamin C and E (200 mg for each) gave similar results as the addition of vitamin C alone. Vitamin E supplementation was effective because it reduces the negative effects of corticosterone induced by stress factors (Tengerdy, 1989).

Martin (1985) illustrated the general stress hormones relationships with ascorbic acid, where vitamin C is a cofactor for activity of dopamine B-oxidase, which is catalyzing the conversion of dopamine to norepinepherine, hence deficiency in vitamin C impairs catecholeamine biosynthesis. Also, she added that adrenocorticotrophic hormones (ACTH) regulates the transport of vitamin C from the adrenal cortex to medulla and it also causes dose-related depletion in vitamin C.

Egg Quality Measurements.

The results of egg quality measurements of Dandarawi laying hens during summer condition as affected by vitamin C or vitamin E or by the interactions are presented in Table 4 and 5. There were significant effect ($P<0.05$) of vitamin C on yolk weight, shell weight, shell thickness and specific gravity. Bird that fed the highest level of vitamin C had a good quality of yolk weight, shell weight, shell thickness and specific gravity when compared with control birds.

The results of the main effect of vitamin E on egg quality criteria (Table 4) showed that there were no significant effects ($P<0.05$) of vitamin E at the levels up to 200 mg/kg diet on the measured traits. On the contrary to the results of this study, Pulthpongsiriporn *et al.,* (2001) reported that egg yolk was significantly increased when laying hens fed 45 and 65 IU/kg compared with the control vitamin E level (25 IU/kg). Metwally (2003) found that the level of 310 mg/kg diet had a significant increase in shell thickness of laying Dandarawi hens under high environmental temperature.

The interaction effects of between vitamin C and E showed that there were significant ($P<0.05$) effects on yolk weight, shell weight, shell %, shell thickness and specific gravity. 200 mg vitamin C alone, resulted in best values of shell %, shell thickness (mm) and specific gravity, while 100 or 200 mg vitamin C in combination with 200 mg vitamin E/kg diet gave the best values of shell weight and yolk weight. (Table 5).

The beneficial effect of vitamin C appears to be due to a reduction in heat stress and consequent improvement in absorption of calcium. Hence, increased egg shell thickness resulted from more calcium being deposited as a result of supplemental vitamin C. Similar findings on shell quality were reported by Abd-Ella (1995) and Al-Shoquiry (1999)

Vitamin C supplementation in the hot climate helped the birds to cope with the stressful conditions (Cheng *et al.,* 1990). This action appears to be mediated through the adrenal gland, as vitamin C plays an important role in the synthesis of steriod hormones (Seemann, 1991).

***Bone characteristics and plasma biochemical constituents*.**

The main effects of vitamin C and E and their interaction on tibia ash, tibia calcium and phosphorus, blood biochemical constituents are presented in Table 6 and 7. Vitamin C increased the percentages of tibia ash and calcium. Also, the levels of plasma total protein, calcium and phosphorus were significantly ($P<0.05$) higher with birds fed the highest level of vitamin C when compared to either control birds or that fed 100 mg vitamin C/kg diet. No significant effects of vitamin E on tibia ash, calcium and phosphorus, plasma albumin, cholesterol, total protein, calcium and phosphorus (Table 6). Vitamin E supplementation increased plasma glucose level insignificantly (248.24 *vs* 238.27 mg/dl for 200 mg vitamin C and control, respectively. This might be due to increased alpha-amylase activity which hydrolyzes glycogen and starch to yield glucose. Similar trends were found by Reddy *et al*. (1985) in calves.

The interaction results (Table 7) showed that the values of tibia ash and tibia calcium were increased significantly (P<0.05) being 45.7 and 52.8 % for 200 mg vitamin C/kg diet compared to 42.4 and 44.7%, respectively for control birds. A significant decrease in tibia phosphorus was observed in birds fed the highest level of vitamin C in combination with each level of vitamin E (0, 100 or 200 mg/kg diet) compared to control birds. Keshavarz, (1996) and Al-Shoquiry, (1999) found no significant effect on tibia bone ash due to dietary vitamin C supplementation.

Plasma glucose, albumin and cholesterol concentrations decreased, whereas plasma protein, calcium and phosphorus concentrations increased significantly (P<0.05) when vitamin C added at 200 mg/kg diet alone compared to control. The obtained results are in agreement with Sahin *et al*., (2002a). El-Gendi *et al.,* (1999) reported that plasma calcium concentration was increased by vitamin C supplementation at 300 or 400 mg/kg diet during summer season under upper Egypt conditions.

Reports by Pardue *et al*., (1985) and Kutlu and Forbes (1993) indicated that vitamin C ameliorated a reduction in calcium concentrations due to high environmental temperature. The vitamin C on calcium metabolism may explain the improvements in egg shell quality observed (Makled, 1990).

The experiment showed that the highest level (200 mg/kg) of vitamin C markedly reduced the detrimental effect of high environmental temperature (during summer season under upper Egypt condition) on egg production, feed intake and feed conversion and egg quality in Dandarawi laying hens. Vitamin C alone (200 mg/kg diet) during heat stress improved total protein, calcium and phosphorus concentrations while decreased levels of glucose, albumin and cholesterol in plasma.

Yin *et al*., (1993) reported that a mixture of vitamin C and E delayed myoglobin oxidation, whereas Vitamin C or E alone did not delay metmyoglobin formation. Schaefer *et al.,* (1995) demonstrated that oxidation of myoglobin is prone to retardation when tocopheroxyl radical at the membrane-sarcoplasma interface is reduced by ascorbate. Regarding antioxidant property, there is a positive synergistic effect of vitamin C and E on the immune response. The immune response of guinea pigs has been shown to be enhanced when they were fed diets containing high levels of vitamin C and E (Bendich *et al.,* 1984).

Also, vitamin E had little positive effects on some criteria when added at 200 mg/kg diet. Vitamin E has a role in the circulating amounts of egg yolk percursors (vitellogenin, calcium and triglycerids). This may due to the protective effect of vitamin E on the membrane of hepatocytes or by the effect of vitamin E on oestradiol concentration or activity. Hepatic synthesis of vitellogenin and triglycerides is under direct oestrogenic control. Oestradiol has an effect on circulating calcium through its control of the synthesis of 1, 25-dihydroxycholecalciferol (Taylor and Drake, 1984), the active cholecalciferol metabolite that regulates calcium absorption.

Vitamin C at highest level (200 mg/kg diet) enhanced egg production and egg quality during summer season under upper Egypt conditions. Vitamin C has been demonstrated to enhance antioxidant activity of vitamin E by reducing the tocopheroxyl radicals back to their active form of vitamin E (Jacob, 1995) or by sparing available vitamin E (Retsky and Frei, 1995).

In conclusion, the data reported herein indicated that a combination of vitamin C and E (200 mg/kg diet, each) led to a significant increase in body weight gain, feed conversion, egg production and egg quality. Supplementation of 200 mg/kg diet of vitamin C alone decreases the detrimental effects of heat stress by enhancing body weight gain, feed conversion, egg production and egg quality in the Dandarawi laying hens and gave positive grater effects than the combination of both vitamin C and E.

Based on the reported findings that supplementation of 200 mg/kg diet of vitamin C alone (not the combination with vitamin E) was adequate to reduce the bad effects of heat stress and to give the best performance of Dandarawi laying hens during summer season under upper Egypt conditions.

Table (1): Composition of the basal diet.

Ingredient	%
Ground yellow corn	69.80
Soybean meal (44%)	11.20
Layer concentrate* (50%)	10.00
Wheat bran	1.24
Ground limestone	6.56
Bone meal	1.10
Dl-methionine	0.10
Calculated analysis:	
ME, kcal/kg	2895
Crude Protein,%	16.04
Calcium, %	3.51
Phosphorus, % (available)	0.53
Lysine., %	0.69
Methionine.,%	0.46
Met.+ cys.,%	0.71
Chemical composition	
Crude protein,%	16.14
Crude fiber,%	2.67
Fat,%	3.30
Calcium,%	3.59
Phosphorus,%	0.57

*Layer concentrate supplied the following per kilogram of the diet: Vit. A,10000 IU; vit. D_3, 1000 IU; vit. E, 10 mg; vit. K, 1 mg; vit. B_1,1 mg; vit. B_2, 4 mg; pantothenic acid, 10 mg; folic acid,1 mg; Niacin,20 mg; vit. B_6, 1.5 mg; vit. B_{12}, 0.01 mg; biotin, 0.05 mg; Choline chloride, 500 mg; Fe, 30 mg; I, 0.3 mg; Zn, 45 mg; Mn, 40 mg; Cu, 3 mg; and Se, 0.1 mg.

Table (2): Body weight, feed intake, feed conversion, egg production traits, mortality rate and body temperature of Dandarawi laying hens as affected by dietary levels of antioxidants vitamin C and E during the experimental periods.

Items	Vitamin C (mg/kg)			Sign.	Vitamin E (mg/kg)			Sign.
	0	100	200		0	100	200	
Initial body weight, g	1242±23	1285±18	1266±21	NS	1268±20	1253±20	1273±22	NS
Final body weight, g	1327±24^{b}	1413±20^{a}	1424±22^{a}	*	1390±22	1376±24	1398±22	NS
Body weight changes, g	85±18^{b}	128±11^{a}	158±11^{a}	*	122±13	123±18	125±10	NS
Feed intake, g/day	120.81±0.34	121.10±0.01	120.93±0.2	NS	120.80±0.3	121.12±0.0	120.95±0.2	NS
Egg number/30 days	16.61±0.4^{b}	17.54±0.3^{ab}	18.03±0.4^{a}	*	17.67±0.4	17.15±0.4	17.36±0.4	NS
Average egg weight, g	43.32±0.2	43.34±0.2	43.68±0.2	NS	43.21±0.2	43.56±0.2	43.59±0.2	NS
Average egg mass, (g/ 30days)	719.5±16^{b}	760.2±13^{ab}	787.6±15^{a}	*	763.5±16	747.1±15	756.7±16	NS
Feed conversion (g feed/g eggs)	5.04±0.2^{a}	4.78±0.1^{b}	4.61±0.1^{b}	*	4.75±0.12	4.86±0.12	4.80±0.16	NS
Egg production, %	55.36±1.0^{b}	58.49±1.0^{ab}	60.12±1.2^{a}	*	58.90±1.2	57.18±1.2	57.88±1.2	NS
Mortality rate,%	11.78^{a}	10.81^{a}	8.48^{b}	*	11.71^{a}	11.04^{a}	9.21^{b}	*
Body temperature (C)	41.21±0.04	41.28±0.03	41.17±0.01	NS	41.31±0.03	41.28±0.02	41.17±0.02	NS

[a-c] Means in the same row followed by different letters within each factor are significantly different at $P<0.05$.

NS= not significant, * = Significat at *P<0.05*

Table (3): Body weight, feed intake, feed conversion, egg production traits, body temperature and mortality rate of Dandarawi laying hens as affected by interaction between vitamin C and E during the experimental periods.

Dietary treatment		Initial body weight (g)	Final body weight (g)	Body weight changes (g)	Feed intake, g/day	Egg number /30 days	Egg weight (g)	Egg mass (g/30days)
Vitamin C mg/kg	Vitamin E mg/kg							
0	0	1223±38	1308±39^{b}	85.0±26^{bc}	120.1±1	15.96±6^{b}	42.8±.2	683.0±27^{b}
	100	1246±43	1304±43^{b}	58.0±45^{c}	121.2±0	17.19±0.5^{ab}	43.55±.4	748.6±23^{ab}
	200	1257±42	1365±42^{ab}	108.0±19^{ab}	121.2±0	16.71±0.7^{ab}	43.61±.4	728.7±33^{ab}
100	0	1299±29	1420±32^{ab}	121.0±17^{abc}	121.1±0.5	18.57±0.5^{a}	43.11±.3	800.6±21^{a}
	100	1235±21	1367±39±^{ab}	132.0±22^{abc}	121.1±0	16.86±0.5^{ab}	43.39±.3	731.6±24^{ab}
	200	1320±33	1451±35^{a}	131.0±17^{abc}	121.2±0	17.19±0.6^{ab}	43.52±.4	748.1±23^{ab}
200	0	1280±35	1440±38^{a}	160.0±20^{ab}	121.2±0	18.44±0.6^{a}	43.67±.4	805.3±28^{a}
	100	1277±35	1451±38^{a}	174.0±17^{a}	121.1±0	17.40±0.7^{ab}	43.74±.3	761.1±30^{ab}
	200	1241±40	1378±38^{ab}	132.0±18^{ab}	120.5±0.6	18.25±0.6^{a}	43.63±.3	796.2±24^{a}
Significance		NS	*	*	NS	*	NS	*

$^{a-d}$ Means in the same column followed by different letters are significantly different at $P<0.05$.

Table (3) continued

Dietary treatment		Feed conversion (g feed/g eggs)	Egg production (%)	Body Temperature (C)	Mortality rate (%)
Vitamin C mg/kg	Vitamin E mg/kg				
0	0	$5.28\pm.2^{a}$	53.2 ± 2.0^{b}	41.20	12.73^{a}
	100	$4.86\pm.2^{ab}$	57.3 ± 2^{ab}	41.22	12.20^{a}
	200	$4.99\pm.4^{ab}$	55.7 ± 2.3^{ab}	41.20	10.41^{abc}
100	0	$4.54\pm.1^{b}$	61.9 ± 1.8^{a}	41.28	11.87^{ab}
	100	$4.97\pm.2^{ab}$	56.2 ± 1.9^{ab}	41.31	11.20^{abc}
	200	$4.86\pm.2^{ab}$	57.3 ± 1.8^{ab}	41.27	9.35^{cd}
200	0	$4.52\pm.2^{b}$	61.5 ± 2.0^{a}	41.10	7.85^{d}
	100	$4.77\pm.2^{ab}$	58.0 ± 2.3^{ab}	41.17	9.72^{bcd}
	200	$4.54\pm.2^{b}$	60.8 ± 1.9^{a}	41.22	7.87^{d}
Significance		*	*	NS	*

$^{a-d}$ Means in the same column followed by different letters within each factor are significantly different at $P<0.05$.

Table (4): Egg quality traits of Dandarawi laying hens as affected by dietary levels of antioxidants vitamin C and E during the experimental periods.

Items	Vitamin C (mg/kg)			Sign.	Vitamin E (mg/kg)			Sign.
	0	100	200		0	100	200	
Egg weight (g)	44.08±0.65	45.74±0.68	45.74±0.85	NS	43.89±0.85	44.64±0.55	46.83±0.70	NS
Albumen weight (g)	22.67±0.52	22.62±0.54	22.35±0.64	NS	21.64±0.73	22.81±0.49	23.20±0.41	NS
Yolk weight (g)	14.89±0.29^{b}	15.66±0.35^{ab}	15.84±0.27^{a}	*	15.02±0.31	15.59±0.33	15.77±0.29	NS
Shell weight (g)	5.21±0.13^{b}	5.98±0.15^{a}	5.78±0.14^{a}	*	5.57±0.15	5.49±0.14	5.91±0.16	NS
Albumen, %	51.46±0.99	49.55±1.12	49.58±1.67	NS	49.75±1.7	51.14±0.98	49.70±1.0	NS
Yolk, %	33.78±0.49	34.27±0.66	35.19±1.06	NS	34.59±1.0	34.96±0.66	33.69±0.50	NS
Shell, %	13.89±11.8	13.86±0.29	12.86±0.45	NS	12.82±0.43	12.33±0.30	12.62±0.31	NS
Yolk index, %	46.18±0.64	48.04±0.72	47.26±0.71	NS	47.50±0.91	46.98±0.68	46.98±0.70	NS
Shell thickness (mm)	0.32±0.01^{b}	0.36±0.0^{a}	0.36±0.0^{a}	*	0.34±0.0	0.34±0.01	0.36±0.01	NS
Specific gravity	1.1021±.001^{b}	1.1029±.002^{a}	1.1037±.002^{a}	*	1.1028±.002	1.1029±.002	1.1028±.001	NS

$^{a-b}$ Means in the same row followed by different letters within each factor are significantly different at P<0.05.

- NS= not significant, * = Significat at *P<0.05*

Table (5): Egg quality traits of Dandarawi laying hens as affected by interaction between vitamin C and E during the experimental periods.

Vitamin C mg/kg	Vitamin E mg/kg	Egg weight (g)	Albumen weight (g)	Yolk weight (g)	Shell weight (g)	Albumen %	Yolk, %	Shell, %	Yolk index, %	Shell thickness %	Specific gravity
0	0	42.9±1.4^{b}	21.2±1.0	14.4±0.6^{b}	5.0±0.2^{c}	49.4±1.9	33.4±0.4	11.7±0.3^{b}	47.2±2.0	0.31±0.0^{bc}	1.1016^{d}
	100	44.5±1.0^{b}	23.1±1.0	15.3±0.5^{ab}	5.1±0.3^{c}	52.1±1.9	34.4±1.1	11.4±0.5^{b}	45.5±0.9	0.31±0.02^{c}	1.1027^{abcd}
	200	44.9±0.9^{b}	23.7±0.3	15.0±0.4^{ab}	5.5±0.2^{bc}	52.9±1.1	33.5±0.9	12.2±0.5^{ab}	45.9±1.0	0.34±0.02^{abc}	1.1019^{cd}
100	0	43.9±0.7^{b}	21.5±0.8	15.1±0.5^{ab}	5.7±0.3^{bc}	49.1±1.8	34.4±0.8	12.9±0.6^{ab}	47.4±1.7	0.34±0.01^{abc}	1.1029^{abcd}
	100	44.2±1.1^{b}	22.9±1.0	16.0±0.7^{ab}	5.8±0.2^{bc}	51.9±1.6	36.2±1.4	13.1±0.6^{ab}	48.3±1.2	0.36±0.01^{ab}	1.1034^{abc}
	200	49.1±0.7^{a}	23.4±1.0	15.8±0.6^{ab}	6.5±0.2^{a}	47.7±2.3	32.2±0.8	13.3±0.5^{ab}	48.5±0.6	0.38±0.01^{a}	1.1025^{bcd}
200	0	44.8±2.0^{b}	22.2±1.8	15.6±0.5^{ab}	6.0±0.3^{ab}	50.8±4.8	36.0±3.1	13.8±1.0^{a}	47.9±0.9	0.38±0.01^{a}	1.1041^{a}
	100	45.3±0.7^{b}	22.3±0.6	15.5±0.5^{ab}	5.6±0.2^{bc}	49.4±1.5	34.2±0.8	12.4±0.4^{ab}	47.2±1.2	0.35±0.02^{abc}	1.1029^{abcd}
	200	46.4±0.8^{ab}	22.5±0.6	16.4±0.4^{a}	5.7±0.3^{bc}	48.5±1.0	35.4±0.6	12.4±0.7^{ab}	46.6±1.5	0.35±0.01^{abc}	1.1040^{ab}
Significance		*	NS	*	*	NS	NS	*	NS	*	*

$^{a-d}$Means in the same column followed by different letters within each factor are significantly different at $P<0.05$.

Table (6): Tibia characteristics and plasma constituents of Dandarawi laying hens as affected by dietary levels of antioxidants vitamin C and E during the experimental periods.

Items	Vitamin C (mg/kg)			*Sign.*	Vitamin E (mg/kg)			*Sign.*
	0	100	200		0	100	200	
Tibia								
Ash,%	42.64±0.31[b]	43.13±0.57[b]	44.91±0.33[a]	*	43.19±0.71	43.62±0.45	43.88±0.38	NS
Calcium,%	44.80±0.32[c]	47.28±0.24[b]	49.79±0.97[a]	*	48.04±1.3	46.20±0.60	47.63±0.58	NS
Phosphorus,%	15.96±0.24[a]	14.82±0.36[b]	13.05±0.24[c]	*	15.03±0.43	14.40±0.60	14.41±0.45	NS
Plasma								
Glucose (mg/dl)	259.66±2.0[a]	243.73±2.5[b]	225.23±4.9[c]	*	238.27±2.9	242.10±3.8	248.24±2.76	NS
Albumin (g/dl)	2.69±0.06[a]	2.34±0.05[b]	2.34±0.05[b]	*	2.48±0.07	2.47±0.09	2.41±0.07	NS
Cholesterol (mg/dl)	172.54±4.5[a]	153.43±3.7[b]	148.34±1.2[b]	*	162.81±5.61	158.06±6.28	153.44±0.63	NS
Total protein(g/dl)	4.24±0.06[c]	4.60±0.5[b]	4.79±0.03[a]	*	4.48±0.10	4.52±0.10	4.64±0.07	NS
Calcium (mg/dl)	9.72±0.11[c]	11.60±0.20[b]	13.12±0.19[a]	*	11.35±0.49	11.12±0.52	11.97±0.49	NS
Phosphorus(mg/dl)	7.32±0.06[c]	8.37±0.29[b]	9.38±0.07[a]	*	8.07±0.36	8.60±0.27	8.76±0.36	NS

[a-c] Means in the same row followed by different letters within each factor are significantly different at P<0.05.

NS= not significant, * = Significat at *P<0.05*

Table (7): Bone characteristics and plasma biochemical constituents of Dandarawi laying hens as affected by interaction between vitamin C and E during the experimental periods.

Dietary treatments V.C mg/kg	Dietary treatments V.E mg/kg	Bone ash %	Bone Ca As % of bone ash	Bone P As % of bone ash	Glucose (mg/dl)	Albumin (g/dl)	Cholesterol (mg/dl)	Total Protein (g/dl)	Calcium (mg/dl)	Phosphorus (mg/dl)
0	0	42.4±.83^{cd}	44.7±.6de	16.2±.6^{a}	267.7±1.1^{a}	2.69±.01^{a}	183.6±.6^{a}	4.12±.01^{d}	9.63±.08de	7.13±.02^{d}
	100	42.9±.6^{bcd}	44.1±.8^{e}	15.9±.6^{a}	256.9±1.0^{b}	2.74±.2^{a}	179.2±2^{a}	4.18±.03^{d}	9.41±.12^{e}	7.50±.1^{c}
	200	42.7±.15^{bcd}	45.6±.9^{cde}	15.8±.2^{a}	254.4±.4^{bc}	2.64±.1^{a}	154.8±1.6^{bc}	4.43±.12^{c}	10.12±.05^{d}	7.32±.06^{cd}
100	0	41.5±.18^{d}	46.6±.1^{cd}	15.3±0.2^{ab}	241.5±1.1^{d}	2.48±.1^{ab}	159.7±.6^{b}	4.49±.06^{bc}	11.35±.12^{c}	7.59±.19^{c}
	100	43.6±1.1^{bc}	47.4±.8^{cb}	14.6±1.5^{ab}	236.6±1.2^{e}	2.24±.05^{b}	147.8±1.[illegible]^{bc}	4.54±.05^{bc}	11.10±.05^{c}	9.14±.02^{b}
	200	44.3±.6^{abc}	47.8±.1^{cb}	14.6±0.5^{ab}	253.1±7^{c}	2.30±.04^{b}	152.8±.6^{bc}	4.77±.06^{a}	12.37±.07^{b}	9.47±.09^{a}
200	0	45.7±.6^{a}	52.8±1.5^{a}	13.6±0.4^{bc}	205.6±.4^{g}	2.27±.05^{b}	145.1±.5^{c}	4.82±.02^{a}	13.07±.09^{a}	9.48±.08^{a}
	100	44.4±.4^{abc}	47.1±.6^{c}	12.8±0.6^{c}	232.8±1.2^{f}	2.45±.1^{ab}	147.2±.5^{bc}	4.84±.06^{a}	12.86±0.6^{ab}	9.17±.09^{b}
	200	44.6±.6^{ab}	49.5±.6^{b}	12.8±0.2^{c}	237.3±.5^{e}	2.31±.1^{b}	152.8±.6^{bc}	4.72±.08^{ab}	13.43±.11^{a}	9.51±.08^{a}
Significance		*	*	*	*	*	*	*	*	*

$^{a-d}$ Means in the same column followed by different letters within each factor are significantly different at P<0.05.

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الملخص العربي

تأثير استخدام مستويات مختلفة من مضادات الأكسدة من فيتامين C و E أو مخلوطهما على معدل أداء الدجاج البياض المعرض للإجهاد الحراري

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اجريت التجربة لدراسة تأثير استخدام مستويات مختلفة من مضادات الأكسدة من فيتامين C و E مخلوطهما على معدل اداء دجاجات الدندراوى البياضة المعرضة لدرجات حرارة مرتفعة اثناء موسم الصيف خلال شهور (يوليو واغسطس وسبتمبر) تحت ظروف مصر العليا. اجريت تجربة عاملية ٣ X٣ استخدم فيها ٢٧٠ دجاجة بياضة عمر ٢٨ أسبوع. قسمت الطيور عشوائيا الى ٩ مجموعات كل منها ٣٠ طائر وكل مجموعة ٣ مكررات بكل منها ١٠ طيور. استخدم ٣ مستويات من فيتامين C هى صفر، ١٠٠ ، ٢٠٠ مجم/كجم علف و كذلك ٣ مستويات من فيتامين E هى صفر ، ١٠٠ ، ٢٠٠ مجم/كجم علف وكانت النتائج ما يلى .

١- استخدام ٢٠٠ مجم من فيتامين C /كجم عليقة كان له تاثير معنوى ايجابيا على وزن جسم الطائر النهائى وكذلك انخفضت نسبة النفوق وتحسن معدل التحويل الغذائى مقارنة بمجموعة الكنترول.

٢- وجد ان الطيور المغذاة على نفس الفيتامين بنفس المستوى (٢٠٠ مجم/كجم علف) أعطت افضل القيم معنويا بالنسبة لمعدل انتاج البيض وكتلتة و معدل التحويل الغذائى مقارنة

بمجموعة الكنترول وان كانت تتساوى معنويا مع المجموعة المغذاة على خليط من فيتامين C و E (٢٠٠ مجم/كجم عليقة لكل منهما).

٣- بالنسبة لبعض صفات جودة البيض مثل نسبة الصفار، وزن القشرة، سمك القشرة، الكثافة النوعية وكذلك بعض الصفات المقاسة على عظمة ال Tibia مثل نسبة الرماد ونسبة الكالسيوم فكانت هذه الصفات مرتفعة معنويا بالنسبة للطيور المغذاه على ٢٠٠ مجم/كجم عليقة عن الطيور المغذاة على اى مستوى اخر سواء من فيتامين C او E.

٤- انخفضت تركيزات الجلوكوز والالبيومين والكلوستيرول فى بلازما دم الطيور المغذاة على المستوى المرتفع من فيتامين C بينما ارتفعت تركيزات البروتين الكلى مقارنة بمجموعة الكنترول.

٥- اضافة فيتامين C او E ادى الى زيادة تركيز بلازما الدم من الكالسيوم.

وقد بينت نتائج التجربة ان إضافة فيتامين C بمعدل ٢٠٠ مجم/كجم غيرت من تركيزات الجلوكوز والالبيومين والكلوستيرول والبروتين الكلى والكالسيوم والفوسفور فى بلازما الدم ومن ثم حسنت من معدل انتاج البيض وصفات جودة البيض بشكل جوهرى ، كما ان الطيور المغذاة على خليط من فيتامين C و E بمعدل ٢٠٠ مجم/كجم عليقة لكل منهما أعطت نتائج إيجابية مشابهة للطيور المغذاة على فيتامين C بمفردة بمعدل ٢٠٠ مجم/كجم عليقة فى كل من معدل انتاج البيض وصفات جودة البيض.

هذا وقد خلصت الدراسة الى ان اضافة فيتامين C بمفرده بمعدل ٢٠٠ مجم /كجم عليقة افضل من استخدام خليط من فيتامين C و E معا بمعدل ٢٠٠ مجم/كجم عليقة لكل منهما حيث قلل من تاثير الحرارة المرتفعة و اعطى نتائج ايجابية مرضية وحسن من معدل اداء الدجاج البياض المربى تحت ظروف الاجهاد الحرارى اثناء موسم الصيف وفى مصر العليا.