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EFFECT OF DIFFERENT SOURCES OF ANTIOXIDANT SUPPLEMENTATION ON THE PERFORMANCE OF NORFA LAYING HENS.

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SUMMARY

This study was conducted to compare the effect of some antioxidants i.e., 15 g hot red pepper (HP), 0.2 mg organic selenium (OS) and 100 mg zinc oxide (ZO)/ kg diet and their combinations on performance of Norfa laying hens. One hundred and sixty laying hens (31 wks old) were randomly distributed into eight groups (20 birds each) as follows: T1: fed a basal diet without any supplementation(control); T2: fed the basal diet supplemented with 15 g hot red pepper (HP)/ kg diet; T3: fed the basal diet contaminated with 0.2 mg organic selenium (OS)/ kg diet;T4: fed the basal diet supplemented with 100 mg zinc oxide (ZO)/ kg diet; T5: fed the basal diet supplemented with combination of 15 g HP+0.2 mg OS/ kg diet; T6: fed the basal diet supplemented with combination of 15 g HP+100 mg ZO / kg diet; T7: fed the basal diet contaminated with combination of 0.2 mg OS+ 100 mg ZO/ kg diet and T8 : fed the basal diet contaminated with combination of 15 g HP + 0.2 mg OS+ 100 mg ZO. The experiment lasted for twelve weeks. Results showed that antioxidants supplementation significantly ($P<0.05$) increased egg weight, egg mass, egg production and feed intake and significantly ($P<0.05$) improved feed conversion. Separately or in combination, antioxidants supplementation improved shell weight and shell thickness. With respect to egg shape index and egg yolk percent, there were no significant differences among all groups. Besides, dietary hot pepper alone or in combination with OS, ZO or OS+ZO significantly improved yolk color. Antioxidants supplementation had no effect on plasma total protein, plasma creatinine, AST and ALT. Red hot pepper addition either alone or combination with OS, ZO and OS+ZO significantly ($P<0.05$) decreased plasma total lipids, total cholesterol and glucose. Economical efficiency of experimental diets was improved with OS addition alone or in combination with ZO and HP supplementation alone. Results of the present study show that dietary supplemental antioxidants (OS addition, 0.2 mg/ kg diet: alone or in combination with ZO, 100 mg/kg diet, and HP, 15g/ kg diet supplementation alone) improved the performance, some egg quality and some Blood biochemical parameters without any adverse effects.

***Keywords**: Antioxidant, performance, hen, diet.*

INTRODUCTION

Norfa hens were developed in the Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shebin El-Kom, Egypt; as egg layers through a breeding program by crossing two White Leghorn strains imported from Norway with the indigenous Fayoumi and White Baladi chickens. All possible crossing were used along with the selection of high egg production chickens to develop Norfa chickens. Norfa hens are characterized with small body weight (less than 1500 g), low maintenance requirements and early sexual maturity (i.e., 150 d Zanaty 2006). Details of the breeding programs of developing Norfa chickens were reported by Abdou (1996).

Poultry production during summer season in open housing system resulted in many problem. High environmental temperature not only has adverse effects on laying performance but also can impede disease resistance of laying hens. Heat stress causes oxidative stress and impairs antioxidant status (Sahin *et al.*, 2001) and initiates lipid per oxidation in cell membranes (Whitehead *et al.*, 1998). In this respect antioxidant nutrient either natural such as red pepper (bio antioxidant vitamins A, E and C) or organic selenium (OS) or mineral such as zinc oxide (ZO) may ameliorate the detrimental effects of environmental temperature.

It is well known that red pepper is rich in vitamins A, E, C and capsaicin which make it advantageous in usage. Also, capsaicin which is the major pungent principal in red pepper is 83 % in its fleshy part and 11 % in ripe seeds (Scutte, 1993). Among the protective mechanism against free radical, ant oxidative vitamins E, C and A are of special interest.

Selenium (Se) is an essential trace element of fundamental importance to health due to its antioxidant, anti- inflammatory and chemopreventaive properties attributed to its presence within at least 25 selenoproteins. Selenium is a highly effective antioxidant and essential trace mineral in animal organisms and acts as primary antioxidant by quenching lipid peroxyl radicals (Macpherson 1994), connected with immunity, required for normal functions of pancreas (Combs and Combs, 1986), metabolism of thyroid hormones and other functions (Arthur *et al.*, 1998). Selenium deficiency is related to decrease productive and reproductive performance of laying hens, and its content of the egg yolk and albumin depends on its concentration in the diet and the form of dietary selenium and also, on the age of laying hens.

Zinc is an essential element for animals and has important functions in metabolic activities such as protein synthesis, carbohydrate metabolism, reproductive, enzyme activation, growth (Underwood and Suttle, 1999) and immune system (Beisel, 1982).

The aim of this study was to investigate the effect of antioxidants (red hot pepper, organic selenium and zinc oxide) supplementation on the performance of Norfa laying hens.

MATERIALS AND METHODS

The present study was conducted at the Poultry Research Farm, Faculty of Agriculture, Minufiya University, Shebin El-Kom.

Management and feeding

One hundred and sixty laying hens (31 wks old)were divided into eight equal groups, twenty birds / group, having nearly similar body weight allotted to eight experimental diets. Birds were housed in individual layer cages. The nutrient compositions of the basal diets were formulated according to the NRC (1994) recommendation (Table 1).

Birds in the eight experimental groups were fed a basal diet (control), or basal diet supplemented with either 15g hot red pepper (HP)/ kg diet, 0.2 mg organic selenium (OS)/ kg diet, 100 mg zinc oxide (ZO)/ kg diet, combination of 15 g HP plus 0.2 mg OS, combination of 15 g HP plus100 mg ZO/ kg diet, combination of 0.2 mg OS/ kg diet plus100 mg ZO/ kg diet, or of 15 g HP plus 0.2 mg OS plus100 mg ZO/ kg diet, respectively.

Hens were submitted to the same managerial conditions of layer farms, given feed and water *ad libtum* throughout the experimental period which lasted for twelve weeks. Artificial light was used beside the normal day to provide 16-hour day photo period. Feed intake (FI) was recorded and feed conversion (FC) was calculated. Egg production traits including hen day production percent (EP), egg weight (EW), egg number (EN) and egg mass (EM) were recorded. Representative egg samples (5 eggs) from each treatment were collected monthly throughout the experimental period in order to determine egg and shell quality. Egg shape and yolk index were determining according to Romanoff and Romanoff (1949).

Egg shape index % = (width /length)× 100.

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

Egg shell thickness, including shell membranes, was measured using a micrometer at the equator. Haugh unit was applied from a special chart using egg weight and albumen height which was measured using a tripod micrometer according to Haugh (1937), Kotaiah and Mohapatra (1974) and Eisen *et al.*, (1962) as follows:

$$\text{Haugh units} = 100 \log (H + 7.57 - 1.7\, W^{0.37}).$$

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, Roche improved Yolk Color Fan".

Table (1). Composition and chemical analysis of the experimental laying diet

Ingredients (%)	Control	Control + HP	Control + OS	Control +ZO
Yellow Corn (8.5 %)	65.69	64.76	65.69	65.69
Soybean meal (44%)	23.57	23.27	23.57	23.57
Additives:	----	1.50	0.00002	0.01
Di-Calcium phosphate	1.32	1.32	1.32	1.32
Limestone, ground	8.39	8.39	8.39	8.39
Vit.& Min. Mix.[1]	0.30	0.30	0.30	0.30
Dl- Methionine[2]	0.15	0.15	0.15	0.15
Sodium Chloride	0.31	0.31	0.31	0.31
Total	100	100	100	100
Calculated Values[3]:				
Crude Protein %	15.98	15.97	15.98	15.97
ME, kcal/ kg diet	2736	2721	2736	2721
C/P ratio	171	170.00	171	170.00
Lysine %	0.80	0.80	0.80	0.80
Methionine %	0.41	0.41	0.41	0.41
Met + Cysteine %	0.66	0.66	0.66	0.66
Calcium %	3.66	3.66	3.66	3.66
Av. Phosphorus %	0.28	0.28	0.28	0.28
Determined Values:				
Dry matter %	89.54	89.54	89.54	89.54
Crude Protein %	15.96	15.96	15.96	15.96
Ether extract %	3.75	3.75	3.75	3.75
Crude fiber %	2.95	2.95	2.95	2.95

[1] Vitamin and mineral mixture at 0.30 % of the diet supplies the following / kg of the diet: Vit. A, 12000 IU; Vit. D_3 ,2500 IU; Vit. E, 10 mg; Vit. K_3 ,3 mg ; Vit B_1, 1 mg; Vit. B_2 ,4 mg; Pantothenic acid ,10 mg ; Nicotinic acid , 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B_6 ,3. Mg; Vit B $_{12}$, 20 mcg; Choline chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01 mg.

[2] DL – methionine : 98% feed grade (98 % methionine).

3 calculated according to NRC (1994).

Blood samples were obtained at the end of the experimental period from wing vein and centrifuged at 3500 rpm for 15 minutes. The plasma produced was frozen at -20 until analysis. Plasma total protein (g/dl), albumin (g/dl), creatinine (mg/dl), urea (mg/dl), alanine transaminase (ALT, U/L), aspartate transaminase (AST, U/L) concentrations, total cholesterol (mg/dl), total lipids (mg/dl) and glucose were calorimetrically determined using available commercial kits produced by Bio Merieux, France. The globuline values were obtained by subtracting the values of albumen from the corresponding values of total protein. Representative sample from the experimental diet was determined according to AOAC (2003).

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

Data were subjected to one way analysis of variance using SPSS 11.50 (1997) 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.

Statistical analysis:-

Data were statistically analyzed by the completely randomized design using one way grouping according to the following model:- $Y_{ij} = \mu + \alpha_i + E_{ij}$

Where:-

Y_{ij} = an observation, μ = Overall mean

α_i = effect of treatment (I = 1,2,3,4,.....8), and E_{ij} = Random error.

RESULTS AND DISCUSSION

Egg Production:

The egg number (EN), egg production (EP), egg weight (EW) and egg mass (EM) are tabulated in Tables (2 and 3). Hen day egg number as well as egg weight and egg mass were significantly higher ($P<0.05$) in hens fed diets supplemented with antioxidants either singly or in combinations under the environmental conditions comparably with the control group and the group supplemented with the three combinations at 31 , or 35 or 39 wks of age. Percentages of egg production were higher with OS (52.03%), combination of OS + ZO (51.83%), HP (50.11%), ZO (46.40%), combination of HP + ZO (42.89%), combination of HP + OS (40.73%) comparing to the control (40.09%) and the combination of the three additions (HP +OS + ZO) was 31.03%.

Mc Dowell (1992) noted that zinc is involved with the production and secretion of reproductive hormones and affects respect sites. Egg weight may have been influenced by interacting with the endocrine system since the hens is undergoing changes in the production and secretion of reproductive hormones during sexual maturity (Renema *et al.*, 1999), and enhance egg production (Khajaren *et al.*, 2002).

Al-Harthi (2004) and Soliman (2002) reported that addition of hot pepper yielded a significantly better egg production, egg weight and egg mass than the control group. The improvements in egg production and egg mass due to feeding hot pepper could be attributed to their antimicrobial, antioxidant and improving nutrient utilization (Jones *et al.*, 1997; El -Husseiny *et al.*, 2002 and Al- Harthi 2004).

Zanaty (2006) found that birds fed 1.5% hot pepper were significantly higher in egg number, egg production and egg mass than those received diet without red hot pepper. Tollba *et al.*,(2007) noted that hen – day - egg number as well as egg weight and egg mass were significantly higher in hens fed diets supplemented with antioxidant either singly or in-combinations under environmental stress compared to the control group at 32 or 36 wks. Percentage of egg production were higher with selenium (59.26)%, zinc (56.30) %, hot pepper (61.13)% combination of hot pepper and zinc (61.30%) and combination of hot pepper and selenium (62.20) % comparing to the control (49.30)%.

Concerning the results of selenium addition, it is contradicting with results reported by Hassan (1990) who found significant reduction in egg production of white leghorn hens fed diet deficient in selenium (0.03 mg / kg diet) from 28 to 36 wks old .Also, he added that increasing dietary selenium to the level of 0.6 mg /kg diet had no adverse effect on hen performance. This contradiction may be due to deficiency of selenium from 28 to 36 wks old or differences in selenium sources.

Feed intake and Feed conversion ratio

Diets supplemented with single or combinations of antioxidants showed significant effects on feed intake of Norfa laying hens (Table 4). Feed conversion ratio was significantly ($P<0.05$) improved due to different antioxidants supplementation. The best ratios (3.17, 3.24 and 3.35) were achieved at the addition of organic selenium, combination of OS+ ZO and HP compared to other antioxidants additions. On the contrary, feed intake was sharply decreased in T8 (HP+ OS+ZO) may be due to the antagonistic effect between the three antioxidants.

Schafer et al.,(1985) reported no effect on feed intake with selenium at 0.2, 0.4, 0.6 or o.8 mg /kg diet of LSL hens. Red hot pepper gave the minimum feed intake (Soliman, 2002) . Nevertheless, feed conversion was improved at 32 and 36 wks of age when supplemental single or combinations of antioxidants were provided to laying hen diets comparing to control group.

Table (2): Egg number and egg production of Norfa hens as affected by different sources of antioxidant supplementation

Age (wks)	Treatments							
	Control	Hot pepper (HP)	Organic Selenium (OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	OS+ ZO	HP+OS+ZO
	.....Egg Number (egg/hen/day).....							
31-34 wks	10.44±0.01	12.29±0.01	14.83±0.01	12.24±0.01	10.82±0.01	11.31±0.01	12.95±0.01	7.80±0.07
35-38 wks	12.05±0.03	16.20±0.01	16.40±0.01	14.61±0.01	11.91±0.01	12.65±0.01	16.29±0.01	10.10±0.01
39-42 wks	11.18±0.01	13.60±0.01	15.00±0.01	13.45±0.01	11.48±0.01	12.07±0.01	14.26±0.01	8.17±0.01
Average	11.22^{g} ±0.01	14.03^{c} ±0.01	15.51^{a} ±0.01	13.43^{d} ±0.01	11.40^{f} ±0.01	12.01^{e} ±0.01	14.50^{b} ±0.01	8.69^{h} ±0.01
	.....Egg Production (%).....							
31-34 wks	37.29±0.01	43.89±0.01	52.96±0.01	43.71±0.01	38.64±0.01	40.39±0.01	48.89±0.01	27.86±0.01
35-38 wks	43.04±0.01	57.86±0.01	58.57±0.01	52.18±0.01	42.54±0.01	45.18±0.01	55.68±0.01	36.07±0.01
39-42 wks	39.93±0.01	48.58±0.01	53.57±0.01	43.31±0.01	41.00±0.01	43.11±0.01	50.93±0.01	29.17±0.01
Average	40.09^{g} ±0.01	50.11^{c} ±0.01	52.03^{a} ±0.01	46.40^{d} ±0.01	40.73^{f} ±0.01	42.89^{e} ±0.01	51.83^{b} ±0.01	31.03^{h} ±0.01

Means within the same row with different superscripts are significantly different (P<0.05).

Table (3): Egg weight and egg mass of Norfa hens as affected by different sources of antioxidant supplementation

Age (wks)	Treatments							
	Control	Hot pepper (HP)	Organic Selenium(OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	OS+ ZO	HP+OS+ZO
	.....Egg Weight (g).....							
31-34 wks	44.10±0.01	48.24±0.66	49.33±0.75	47.95±0.01	46.90±0.01	47.40±0.04	48.62±0.01	43.84±0.01
35-38 wks	46.48±0.01	49.00±0.09	50.14±0.01	48.39±0.01	47.55±0.01	48.15±0.01	49.13±0.01	45.32±0.01
39-42 wks	45.09±0.01	48.91±0.01	48.87±0.01	48.20±0.01	47.00±0.09	47.75±0.01	48.79±0.01	44.80±0.01
Average	45.22^{f} ±0.01	48.72^{b}±0.01	49.45^{a} ±0.01	48.18^{c} ±0.01	47.15^{e} ±0.01	47.77^{d} ±0.01	48.85^{b} ±0.07	44.65^{g} ±0.01
	.....Egg Mass (g egg /hen /day).....							
31-34 wks	16.45±0.01	21.17±0.01	26.13±0.01	20.98±0.01	18.13±0.01	19.15±0.01	22.50±0.01	12.21±0.01
35-38 wks	20.01±0.01	28.35±0.01	29.36±0.01	25.25±0.01	20.22±0.01	21.75±0.01	28.58±0.01	16.35±0.01
39-42 wks	18.00±0.09	23.76±0.01	26.68±0.01	23.03±0.01	19.27±0.01	20.58±0.01	24.85±0.01	13.07±0.01
Average	18.10^{g} ±0.01	24.43^{c}±0.01	27.39^{a} ±0.01	23.08^{d} ±0.01	19.21^{f} ±0.01	20.49^{e} ±0.01	25.31^{b} ±0.01	13.88^{h} ±0.01

Means within the same row with different superscripts are significantly different (P<0.05).

This improvement may be due to increasing both egg production and egg weight. Hess *et al*, (2001) and Schafer *et al*., (1985) reported improved feed utilization when dietary zinc was supplemented and when dietary selenium was supplemented Schafer *et al*.,(1985). Abdel Galil and Abdel Samad (2004) showed that hens fed diets with Se consumed more feed (84.9 g feed /hen/day) with higher feed efficiency (3.56 g feed /g egg) than other treatments. Tollba *et al*.,(2007) noted that hens fed diets supplemented with single or combinations of antioxidants showed insignificant effects in feed intake. Nasr (2010) found highly significant effect of Se with respect to dietary feed intake. Concerning hot red pepper, Soliman (2002) found that hot pepper improved feed conversion.

Zanaty (2006) found that birds fed hot pepper, consumed significantly less feed than those received diet without hot pepper .Feed conversion was significantly improved with hot pepper supplementation.

Egg Quality:

Egg quality measurements of laying hens fed different antioxidants supplementation are shown in Table (5).

Exterior egg quality:

The results of feeding different sources of antioxidants supplementation on egg quality showed that antioxidant supplementation significantly ($P<0.05$) increased egg weight. With respect to egg shape index, there was insignificant difference among all groups. Shell weight and shell thickness were significantly($P<0.05$) improved due to addition of antioxidants at 31-42 wks of age as compared to the control group and the treatment which contained the three combinations.

Guo *et al*.,(2002) reported that supplementing hen diets with zinc enhanced egg shell quality. Soliman (2002) and Al-Harthi (2004) found that diet supplemented with 0.2 % hot pepper significantly improved shell thickness. Tollba *et al*., (2007) mentioned that there was insignificant differences among all groups in egg shape index and shell percentage. Shell thickness (including shell membrane) was significantly improved due to antioxidant addition at 31 and 36 wks old.

Interior egg quality:

There was a significant increase ($P<0.05$) in all interior egg quality traits. In contrary, egg yolk percent was significantly differ by adding antioxidants. Yolk color score was significantly increased in groups fed diets contained hot red pepper or combinations addition in contrary was in Se and Zn addition. Results of Soliman (2002) and Al-Harthi (2004) found that diet supplemented with 0.2% QS improved Haugh unit, yolk index and yolk percentage. Hamilton *et al*., (1990) found that yolks from hens fed red pepper were redder and yellower and capsaicin was deposited with an efficiency of 16%. The improvements in yolk color of hot pepper supplemented diet may be due to pigment contents of hot pepper. Abdel Galil and Abdel Samad (2004) showed that adding Se to diets enhanced egg weight and yolk weight. Zanaty (2006) noted that hot pepper addition did not significantly affect Haugh units. Yolk color was significantly improved by hot pepper supplementation. The improvement may be due to pigment content of hot pepper. Tollba *et al*., (2007) mentioned that there was a significant increase in albumin percentage .

Blood parameters:

Results on the effect of feeding different sources of antioxidants supplementation on blood parameters are presented in Table (6). No significant differences were observed among different treatments in plasma total protein, albumen (A), globuline (G), A/G ratio, creatinine, ALT and AST. However, a significantly ($P<0.05$) decrease were observed in total lipids, total cholesterol and glucose due to feeding hot pepper in single or in compound addition compared to feeding control diet (328.40,115.60 and 210.50) vs. (428.30, 143.40 and 236.30) respectively, Table (6). Increasing globulin may reveal immunity enhancement as affected by studied antioxidant. In birds, the low A/G ratio indicates more diseases resistance and immune response (Griminger, 1986).

El-Ghamry *et al*.,(2004) found that hot pepper increased plasma total protein, albumen and globulin of birds. Zanaty (2006) noted that total proteins, albumen and globulin of hot pepper group were significantly higher than those received diet without hot pepper .

Table (4):Feed intake and feed conversion of Norfa hens as affected by different sources of antioxidant supplementation

Age (wks)	Treatments							
	Control	Hot pepper (HP)	Organic Selenium (OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	OS+ ZO	HP+OS+ZO
	.....Feed intake (FI),(g feed /hen /day)							
31-34 wks	61.03±0.01	71.13±0.01	82.31±0.01	71.47±0.01	65.99±0.01	67.41±0.01	75.44±0.01	45.54±0.01
35-38 wks	72.04±0.01	92.14±0.01	89.91±0.01	83.58±0.01	70.77±0.01	73.99±0.01	90.88±0.01	56.83±0.01
39-42 wks	68.76±0.01	81.73±0.01	86.28±0.01	80.84±0.01	72.26±0.01	76.35±0.01	76.08±0.01	50.80±0.01
Average	67.28^{g} ±0.01	81.67^{b} ±0.01	86.17^{a} ±0.01	78.63^{d} ±0.01	69.67^{f} ±0.01	72.58^{e} ±0.01	79.98^{c} ±0.01	51.06^{h} ±0.01
	..... Feed conversion (FC),(g FI /g EM).....							
31-34 wks	3.71±0.01	3.36±0.01	3.15±0.01	3.41±0.01	3.64±0.01	3.58±0.01	3.21±0.01	3.73±0.01
35-38 wks	3.60±0.01	3.25±0.01	3.06±0.01	3.31±0.01	3.50±0.01	3.49±0.01	3.18±0.01	3.48±0.01
39-42 wks	3.82±0.01	3.44±0.01	3.29±0.01	3.51±0.01	3.75±0.01	3.76±0.01	3.19±0.01	3.88±0.01
Average	3.71^{a} ±0.01	3.35^{c}±0.11	3.17^{c} ±0.01	3.41^{b} ±0.01	3.63^{a} ±0.01	3.61^{a}±0.01	3.24^{a} ±0.01	3.70^{a} ±0.01

Means within the same row with different superscripts are significantly different (P<0.05).

Table(5) : Egg quality measurements of Norfa hens as affected by different sources of antioxidant supplementation

Item	Treatments							
	Control	Hot pepper (HP)	Organic Selenium(OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	OS+ZO	HP+OS+ZO
	.....Exterior Egg Quality							
Average Egg Weight (g)	45.90^{e} ±0.08	48.90^{b} ±.08	49.80^{a} ±0.05	48.35^{c} ±0.02	46.70^{d} ±0.04	48.30^{c} ±0.04	49.00^{b} ±0.13	43.50^{f} ±0.03
Shell Weight %	11.31^{c} ±0.02	11.50^{bc} ±0.03	12.15^{a} ±0.02	11.63^{b} ±0.01	11.32^{c} ±0.02	11.44^{bc} ±0.02	12.00^{a} ±0.20	11.30^{c} ±0.05
Shell Thickness(mm)	0.344^{e} ±00	0.353^{c} ±00	0.366^{a} ±00	0.351^{cd} ±00	0.344^{e} ±00	0.350^{d} ±00	0.363^{b} ±00	0.341^{f} ±00
Egg Shape Index	76.95^{a} ±0.05	77.01^{a} ±0.03	76.81^{a} ±0.16	76.92^{a} ±0.01	77.22^{a} ±0.07	76.89^{a} ±0.11	76.79^{a} ±2.19	77.11^{a} ±0.01
	..... Enterior Egg Quality.....							
Albumen Weight %	52.32^{c} ±0.08	52.55^{b} ±0.04	53.89^{a} ±0.10	52.50^{bc} ±0.03	52.43^{bc} ±0.06	52.46^{bc} ±0.06	53.40^{bc} ±0.05	52.12^{d} ±0.06
Yolk Weight %	36.00^{a} ±0.32	35.00^{b} ±0.44	33.46^{c} ±0.13	35.22^{b} ±0.04	35.40^{ab} ±0.03	35.23^{b} ±0.03	34.82±0.07^{b}	36.00±0.28^{a}
Yolk Index %	43.21^{f} ±0.07	44.91^{c} ±0.03	45.33^{a} ±0.02	44.06^{d} ±0.04	43.22^{f} ±0.07	43.80^{e} ±0.03	45.12^{b} ±0.03	43.12^{f} ±0.03
Yolk Color	6.87^{c} ±0.02	11.95^{a} ±0.03	6.81^{c} ±0.03	6.85^{c} ±0.04	11.87^{ab} ±0.03	11.89^{ab} ±0.04	6.84^{c} ±0.03	11.84^{b} ±0.03
Haugh Unit	72.80^{f} ±0.02	75.65^{c} ±0.02	76.22^{a} ±0.07	73.16^{e} ±0.02	73.15^{e} ±0.03	73.55^{d} ±0.05	76.01^{b} ±0.05	72.75^{f} ±0.03

Means within the same row with different superscripts are significantly different (P<0.05).

Table (6): Blood constituents (Means± S.E) of Norfa hens as affected by different sources of antioxidant supplementation

Item	Treatments							
	Control	Hot pepper (HP)	Organic Selenium (OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	OS+ZO	HP+OS+ZO
Total protein(g/dl)	4.06±0.015	4.06±0.015	4.08±0.022	4.08±0.022	4.11±0.007	4.07±0.024	4.06±0.019	4.10±0.010
Albumen(A) ,(g/dl)	2.610±0.011	2.604±0.006	2.596±0.014	2.598±0.012	2.020±0.008	2.580±0.007	2.606±0.005	2.580±0.007
Globulin (G),(g/dl)	1.458±0.017	1.456±0.009	1.486±0.032	1.484±0.029	1.508±0.011	1.494±0.027	1.456±0.014	1.524±0.014
A/G ratio	1.786±0.025	1.789±0.008	1.751±0.049	1.754±0.044	1.726±0.018	1.729±0.035	1.790±0.014	1.693±0.019
Total lipids,(mg/dl)	428.30^{e} ±0 .10	328.40^{h} ±0 .10	485.60^{a} ±0 .10	441.50^{d} ±0 .10	345.70^{f} ±0 .10	335.80^{g} ±0 .10	466.30^{b} ±0 .10	445.30^{c} ±0 .10
Total cholesterol,(mg/dl)	143.40^{d} ±0 .07	115.60^{h} ±0 .07	168.20^{a} ±0 .07	148.20^{c} ±0 .10	132.30^{f} ±0 .07	119.40^{g} ±0 .07	157.60^{b} ±0 .07	141.50^{e} ±0 .07
Glucose,(mg/dl)	236.30^{d} ±0 .07	210.50^{h} ±0 .07	238.90±0 $.16^{c}$	242.10±0 $.11^{a}$	214.30±0 $.07^{g}$	220.40±0 $.07^{f}$	240.20±0 $.07^{b}$	224.20±0 $.07^{e}$
Creatinine,(mg/dl)	1.386 ±0.004	1.400 ±0.011	1.394 ±0.007	1.388 ±0.008	1.394 ±0.007	1.390 ±0.007	1.390 ±0.010	1.420 ±0.011
ALT,(U/L)	13.712 ±0.006	13.718±0.059	13.664±0.012	13.684±0.012	13.694±0.005	13.654±0.005	13.666±0.010	13.676±0.009
AST,(U/L)	81.264±0.011	81.284±0.005	81.262±0.020	81.294±0.004	81.268±0.012	81.272±0.004	81.270±0.007	81.266±0.009

Means within the same row with different superscripts are significantly different (P<0.05).

Table (7): The economical efficiency of the experimental diets fed during the laying period (from 31-42wks of age) of Norfa hens

Item	Treatments							
	Control	Hot pepper (HP)	Organic Selenium (OS)	Zinc Oxide (ZO)	HP+OS	HP+ZO	ZO+OS	HP+OS+ZO
Price /kg feed (L.E)	1.89	1.90	1.90	1.90	1.91	1.91	1.91	1.92
Total feed intake /hen(kg)	5.65	6.62	7.24	6.60	5.85	6.10	6.72	4.29
Total feed cost / hen (L.E)	10.68	12.58	13.76	12.54	11.17	11.65	12.84	8.24
Total number of eggs /hen	33.63	42.09	46.53	40.29	34.20	36.03	43.50	26.07
Total price of eggs/hen (L.E)[1]	20.18	25.25	27.92	24.17	20.52	21.62	26.10	15.64
Net revenue /hen (L.E)[2]	9.50	12.67	14.16	11.63	9.35	9.97	13.26	7.40
Economical efficiency (%)[3]	88.95	100.72	102.91	92.74	83.71	85.58	103.27	89.81

[1] *Assuming that price of one – egg was 60 P.T. (according to Egyptian market, 2010).*

[2] *Net revenue / hen (L.E) =Total price of eggs – Total feed cost,.*[3] *Economical efficiency = (Net revenue ÷ Total feed cost) × 100.*

In agreement with results reported here in groups El-Sebai, (2000) and Abaza (2002) reported that Se plays a major role in lipid metabolism. Also, hot pepper had hypoglycemic or hypocholesterolemic effect (El-Husseiny *et al.*, 2002). Moreover, Satio *et al.*, (1999) suggested that single high dose of capsaicin may inhibit the absorption of lipid from the gastrointestinal tract. Azose (2001) stated that the decrease in lipid digestibility was due to the addition of red pepper in the diet. Plasma lipid and cholesterol significantly decreased when hot pepper was included in laying hen diets (Al -Harthi,2004). Zanaty (2006) found that hot pepper significantly decreased total lipid, total cholesterol and glucose.

Plasma creatinine, AST and ALT were not significantly affected by different types of antioxidants (Table 6). The values obtained were within the normal ranges of the laying hens and supplemented doses of antioxidants were not toxic or pathological to hens and having no deleterious effects on liver or kidney.

Abdo *et al.*, (2003), El -Ghamry *et al* .,(2004), Zanaty(2006) and Tollba *et al* .,(2007) found that plasma creatinine, AST and ALT were not significantly affected by different types of either singly or combinations of antioxidants. However, the results disagreed with those reported by El-Husseiny *et al.*, (2002) who reported that there was significant increase in AST and ALT.

Economical Efficiency:

The economical efficiencies of experimental diets are shown in Table (7). Data show that highest economical efficiency was obtained with the diet supplemented with OS separately or combined with ZO also, hot pepper singly. This may be due to the better feed conversion obtained in birds received the experimental diet compared to other diets.

CONCLUSION

Based on the results of this study, single hot red pepper and organic selenium single or combined with zinc oxide are good natural antioxidants feed additives for improving performance of local Norfa laying hens strain without any adverse effects.

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تأثير إضافة مصادر مختلفة من مضادات الأكسدة على أداء دجاج النورفا البياض

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أجريت هذه الدراسة فى مزرعة أبحاث الدواجن- قسم إنتاج الدواجن- كلية الزراعة- جامعة المنوفية، وذلك لمقارنة تأثير إضافة بعض مضادات الأكسدة (الفلفل الأحمر الحار 15 جم/ كجم عليقة والسيلينيوم العضوى 0,2 مجم /كجم عليقة وكذلك أكسيد الزنك بمعدل 100 مجم /كجم عليقة) ومخاليطها على أداء دجاج النورفا البياض. استخدم عدد 160 دجاجة بياضة عمر 31 أسبوع قسمت عشوائيا إلى ثمانية مجموعات متساوية تقريبا فى الوزن بكل مجموعة 20 دجاجة تبعا للمعاملات الغذائية التالية: (1) المجموعة الأولى (المقارنة) : تم تغذيتها على العليقة الأساسية بدون أى اضافات.(2) المجموعة الثانية :غذيت على العليقة الأساسية + 15جم من الفلفل الأحمر الحار/ كجم عليقة.(3) المجموعة الثالثة : تم تغذيتها على العليقة الأساسية + 0,2مجم من السيلينيوم العضوى/ كجم عليقة. (4) المجموعة الرابعة : غذيت على العليقة الأساسية + 100 مجم من أكسيد الزنك/ كجم عليقة. (5) المجموعة الخامسة : غذيت على العليقة الأساسية + مخلوط من الفلفل الأحمر الحار(15 جم) والسيلسنيوم العضوى(0,2مجم)/ كجم عليقة. (6) المجموعة السادسة : غذيت على العليقة الأساسية + مخلوط من الفلفل الأحمر الحار(15جم) وأكسيد الزنك (100مجم)/ كجم عليقة. (7) المجموعة السابعة : تم تغذيتها على العليقة الأساسية + مخلوط من السيلينيوم العضوى(0,2مجم) وأكسيد الزنك(100مجم)/ كجم عليقة. (8) المجموعة الثامنة : تم تغذيتها على العليقة الأساسية + مخلوط من الفلفل الأحمر الحار(15جم) +السيلسنيوم العضوى(0,2مجم) + أكسيد الزنك(100مجم)/ كجم عليقة. و كانتأهم النتائج كالتالى: أدت إضافة مضادات الأكسدة (الفلفل الأحمر الحار، السيلينيوم العضوى، أكسيد الزنك) بصورة منفرده أو معاً إلى زيادة معنوية فى كل من وزن وكتلة ومعدل إنتاج البيض وكذلك كمية العليقة المستهلكة كما تحسنت الكفاءة التحويلية للغذاء معنويا. كما حسنت اضافة الفلفل الأحمر الحار أو السيلينيوم العضوى بصورة منفردة أو معاً إلى العلائق من وزن وسمك القشرة ولكن لم تظهرأى إختلافات معنوية فى دليل شكل البيضة ووزن الصفار. و ادت إضافة الفلفل الأحمر الحارإلى العلائق بمفرده أو مع السيلينيوم العضوى، أو مع أكسيد الزنك، أو مع السيلينيوم العضوى وأكسيد الزنك إلى تحسن معنوى فى لون الصفار. كما أن إضافة مضادات الأكسدة كل على حده أو معاً إلى العلائق لم تؤثر على كل من مستوى البروتين الكلى أو الكرياتينين أو إنزيمى ALT،AST فى البلازما. و أدت إضافة الفلفل الأحمر الحار إلى العلائق بمفرده أو مع السيلينيوم العضوى، أو مع أكسيد الزنك، أو مع السيلينيوم العضوى وأكسيد الزنك إلى انخفاض معنوى فى تركيزكل من: الدهون الكلية والكوليستيرول الكلى والجلوكوز فى البلازما. و تحسنت الكفاءة الإقتصادية بإضافة السيلينيوم العضوى بمفرده أو مع أكسيد الزنك، وكذلك بإضافة الفلفل الأحمر الحار بمفرده إلى العليقة.

و الخلاصة أن إضافة السيلينيوم العضوى (0,2مجم/كجم عليقة) بمفرده أو مع أكسيد الزنك (100 مجم / كجم عليقة) أو الفلفل الأحمر الحار (15 جم / كجم عليقة) بمفرده حسنت من الأداء الإنتاجى وبعض صفات جودة البيضة وكذلك بعض مقاييس الدم فى دجاج النورفا البياض وبدون حدوث أى تأثيرات ضارة.