Egyptian J. Nutrition and Feeds (2008) 11 (3) : 595- 609

EFFECT OF CHROMIUM ON SOME PRODUCTIVE AND PHYSIOLOGICAL PARAMETERS OF MATROUH LAYING HENS UNDER HOT SUMMER SEASON IN EGYPT.

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(Received 22-6-2008, Accepted 8-9-2008)

SUMMARY

This experiment was designed to evaluate of the efficacy of chromium (Cr) in alleviating the negative effects of heat stress on egg production, egg quality, carcass characteristics and some physiological parameters of Matrouh Laying hens. The hens fed on four experimental diets, first group fed on the control diet (without supplementation), second, third and fourth groups were fed on the diets supplemented with 600, 1200 or 1800µg Cr/kg diet, respectively. Two hundred and sixteen hens from 40 until 52 weeks of age were randomly divided into four equal groups with three replicate each (18 hens/ replicate). The results indicated that, birds received 1200 µg Cr /kg recorded heavier body weight change and highest value of feed intake than other treatments including control group during the total period. The addition of Cr to laying hen diets resulted no significant difference in feed conversion under heat stress compared with control group at different experimental periods. Supplementation of Cr decreased mortality, where 1800 µg/kg diet resulted in the lowest mortality. Egg production was increased by 4.89, 6.68 and 5.83 % for hens fed 600, 1200 or 1800µg/Cr /kgdiet, respectively than the control group. Chromium supplementation had significantly improved egg weight when compared with control during 44-48 weeks of age only, while there was no significant differences therafter. Egg mass was significantly ($P \leq 0.05$) increased by 9.46, 15.55 and 12.87% during the total period for hens fed 600, 1200 or 1800µg/Cr /kg, respectively than the control group. Dietary treatments with Cr did not affect egg components (yolk wt %, albumen wt % and shell wt %). Egg yolk cholesterol was significantly reduced by supplementation of chromium as compared to the control group. The highest value of Haugh unit score was observed in birds received 1200 µg/Cr /kg. Eggshell thickness followed the same trend, where it increased with increasing Cr levels in hen diets. Chromium supplementation to layer hen diets significantly increased ($P \leq 0.05$) carcass % and decreased abdominal fat percentages. A significant linear decrease in the serum glucose levels, low density lipoprotein cholesterol (LDL) values and increased total protein, albumin and high density lipoprotein cholesterol (HDL) values in groups received Cr supplemented diet were observed compared to the control. Serum total lipids were significantly ($P \leq 0.01$) increased by 46.85, 49.55 and 76.28% and serum tri-glycerdes increased by 17.79, 22.00 and 21.36% for hens fed 600, 1200 or 1800µg/Cr /kg, respectively than the control groups. Addition of

Cr to diets at levels of 600, 1200, and 1800 µg /kg diet improved economic efficiency (EE) compared to the control group.
It is clear that 1200 µg Cr /kg was the most effective for improving growth performance, egg number and production, egg quality, carcass characteristics, and economic efficiency and reducing abdominal fat, glucose and cholesterol under hot summer season in Egypt.

***Keywords:** laying hens, chromium, summer season, egg yield.*

INTRODUCTION

Heat stress is one of the major stressors in poultry production in many regions of the World. Under Egyptian conditions, poultry production suffered from high environmental temperature during summer season, which causes many troubles. Large economic losses occur because of mortality and decreased production. Acute stress caused by sudden increases in temperature results in large number of death and evokes a wide range of behavioral, biochemical, physiological and molecular adjustments (Etches *et al.*, 1995). Also, Dawoud (1998) reported that low growth occurred in summer season was due to high ambient temperature (30-36°C) which has a direct effect on central nervous system to reduce metabolic rate and feed consumption.

Several methods are available to alleviate the effect of high environmental temperature on poultry performance. Chromium is used in the Poultry diet because of the reported benefits of Cr supplementation to laying hens (Sahin, 2002a,b) during heat stress. The primary role of Cr in metabolism is to potentiate the action of insulin through its presence in an organometallic molecule (Anderson, 1994). Chromium, function, also as an antioxidant (Preuss *et al.*, 1997). Moreover, Cr is thought to be essential for activating certain enzymes and for stabilizing proteins and nucleic acids (Anderson, 1994). Chromium deficiency can disrupt carbohydrate and protein metabolism, reduce insulin sensitivity in peripheral tissues and impair growth rate (Pagan *et al.*, 1995). By evaluating the effect of supplemental chromium on performance, it is possible to gain an understanding of the metabolic changes in heat-stressed Poultry.

Dietary chromium supplementation promotes the growth rate and feed efficiency of growing poultry and these beneficial effects appear to be greater under heat stress (Onderci *et al.*, 2005). In the previous experiments, supplementation of chromium picolinate (CrPic) as a chromium source in birds subjected to high environmental temperature ameliorated the deletorious effect of heat stress. (Sahin *et al.*, 2002a)

Chromium is involved in protein metabolism (NRC, 1997) and is thought to have a role in nucleic acid metabolism because an increase in stimulation of amino acid incorporation into liver protein in vitro was observed (Weser and Koolman 1969). Okada *et al.*, (1983) showed an interaction of chromium with DNA templates that resulted in a significant stimulation of RNA synthesis in vitro. The oligopeptide low-molecular-weight, Cr-binding protein (chromodulin) tightly binds four chromic ions before the oligopeptide obtains a conformation required for binding to the tyrosine kinase active site of the insulin receptor (Vincent, 2000). The oligopeptide chromodulin binds chromic ions in response to an insulin-mediated chromic ion flux, and the metal-saturated oligopeptide can bind to an insulin-stimulated insulin receptor, activating the receptor's tyrosine kinase activity. Thus, chromodulin appears to play a role in an autoamplification mechanism in insulin signaling.

In addition, release of chromium from chromium picolinate for use in cells requires reduction of the chromic center, a process that can lead potentially to the production of harmful hydroxyl radicals (Vincent, 2001).

On the other hand, because of the relationship between cholesterol and coronary heart disease in humans researchers have devoted considerable efforts to the study of cholesterol-reducing products, for example, low cholesterol eggs. Chromium can reduce the concentration of cholesterol in serum and egg yolks and alter lipid metabolism. High temperatures deleteriously affect egg production performance (Puthpongsiriporn *et al.*, 2001), reduced egg production rates (Usayran *et al.*,), egg weight (Peguri and Coon, 1993), feed intake (Usayran *et al.*, 2001), egg quality (Samara *et al.*, 1996 ; James, 2005) , improved feed conversion efficiency (Cheng *et al.*, 1990) and decreased mortality (Ibrahim, 2005).

Therefore, this study amid to evaluate the efficacy of chromium supplementation) in alleviating the negative effects of heat stress on egg production, egg quality, carcass characteristics and some physiological parameters of Matrouh Laying hens.

MATERIALS AND METHODS

The present work was carried out at Inshas Poultry Breeding Research Station, Anim. Production Research Institute, Agricultural Research Center, Egypt, during summer season, where the environmental temperature ranged from 22 °C at night to 38 °C after noon and relative humidity from 35 – 60%. Two hundred and sixteen Matrouh local laying hens from 40 until 52 weeks of age were used. The birds were randomly divided into four similar groups of 54 hens in three replicates (18 hens/each). The treatments consisted of the basal diet supplemented with 0 Cr (control), 600, 1200 or 1800 µg Cr/kg of diet from chromium picolinate (contain 12.27% Cr). All experimental birds were housed in 12 pens and fed *ad libitum* a basal diet containing 15.99% crude proteins and 2713.5 Kcal. ME/kg. diet, (Table 1).

Table (1): Composition and calculated analysis of the basal diet fed.

Item	%
Yellow corn	64.00
Soybean meal 44 %	24.50
Wheat bran	1.50
Di-calcium phosphate	1.50
Limestone	7.70
Salt (NaCl)	0.40
Dl-Methionine	0.10
Vit.. & Min. Mixture *	0.30
Total	100.00
Calculated analysis**	
Metabolizable energy (Kcal / Kg)	2713.5
Crude protein %	15.99
Cost/100 kg (L.E.)	95.00

* Vitamins and minerals premix provides per 3kgVit.A 10 000 000 IU,Vit.D3 2000 000 IU, Vit. E 10000mg,,Vit.K3 1000mg,Vit. B1 1000mg,Vit.B2 5000mg,Vit.B6 1500mg,Vit.B12 10mg, pantothenic acid 10000mg,Niacin 30000mg, Biotin 50mg,Folic acid 1000mg, Choline 250gm, Selenium 100mg, Copper 4000mg, Iron 30000mg, Manganese 60000mg و Zinc 50000mg, Iodine 1000mg, Cobalt 100mg and $CaCO_3$ to 3000g.

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

The diet in each group was weighed weekly to calculate feed consumption and the birds were individually weighed every month. Mortality rate was calculated during the experimental period. Water was provided *ad-libitum* throughout the experimental period and the birds were exposed to 16 hours light daily. The experiment was conducted between June and September, 2005.

At the end of experimental period, blood samples were withdrawn from six birds in each group from Jugular vein in tubes. Blood was centrifuged for 20 minutes at 4000g and serum samples were stored at -20°C until analysis of the total protein, albumin, total cholesterol, HDL, LDL, total lipids, and triglycerides.

Egg weight and number were daily recorded per pen during 40 to 52 weeks of age, then the egg mass (egg number × egg weight average) and Hen-Day% were calculated per pen. At 50 weeks of age 5 eggs from each pen was broken at the same day to determine egg quality traits then egg shape index was estimated as the ratio of the egg maximum width to its length, Haugh unit score was calculated for each individual egg according to Haugh (1937) and shell thickness in mm. Arc-sine transformations were done for percentage of egg shape index, yolk percentage, albumin percentage and shell percentage before stimulation of the data. Also, at the end of the experiment (52 weeks old), six hens were taken randomly from each group for slaughter test. Weights of liver, heart, empty gizzard, eviscerated carcass, giblets and abdominal fat were recorded to the nearest gram and calculated as a percentage of live body weight. The analyses of crude protein in the diet were carried out according to A.O.A.C. (1990).

Cholesterol was extracted from yolk samples by chloroform: method (2:1) according to Folch *et al.* (1957). Total protein, albumin, , total cholesterol , HDL, LDL, total lipids, triglycerides concentrations were determined in the serum and in addition to yolk cholesterol by spectrophotometer method using commercial kits, (Stanbio Laboratory., Boerne, Texas 78006, USA).

Economical efficiency for egg production was calculated from the input/ output analysis according to the price of experimental diets and eggs produced. Values of economical efficiency were calculated as the net revenue per unit of total costs (Osman, 2003 and Soliman *et al.* 2003).

Data were subjected to one-way analysis of variance applying SAS program (SAS, 1996) using general linear model (GLM). Significant differences among treatment means were separated using Duncan's Multiple Range test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight change:

Data of the body weight changes are shown in Table (2). The results indicated that treated groups showed significantly increased ($P \leq 0.05$) body weight change as compared to the control group at all the experimental periods except (48-52wk). Birds received 1200 µg Cr/kg diet recorded the highest body weight gain during the total periods. The increase in body weight was associated with the increase in feed intake. Similar results were obtained by Sahin *et al.* (2002a) who reported that increasing supplemental chromium at 200,400,800 or 1200 µg Cr/kg diet increased live weight. Ezzat *et al.* (2006) found that Cr supplementation up to 400 µg /kg diet tended to improve body weight, however, they recommended 1200 µg Cr/kg diet, which resulted in the highest body weight could be recommended as a suitable supplemental level for Japanese quail chick diets. The observed increase in body weight due to supplementing Cr is involved in protein metabolism (Anderson, 1999). Also, Cr plays an important role as integral component of the glucose tolerance factors (GTF), which potentiate the action of insulin and regulate fat metabolism. At low insulin level glucose is converted into fat and stored in fat cells (Mertz, 1993). The ability of insulin to regulate glucose levels in blood and lipid metabolism is dependent upon the binding of this pancreatic hormone to specific receptors found in many peripheral tissues like adipocytes, muscle and liver, increasing the number of actual insulin receptors present in target cell. Chromium also has been demonstrated to increase the actual binding of insulin to its receptors.

Feed consumption and conversion:

Data presented in Table (2) showed the effect of treatments on the amount of feed intake and conversion for different experimental periods. Birds received 1200 µg Cr/kg diet recorded the highest ($P \leq 0.05$) value of feed intake compared to control group (106 vs. 99g). Addition of Cr to laying hen diets had no significant effect on feed conversion ratio. Sahin *et al.* (2002b) reported that increase supplemental Cr (200,400,800 or 1200 µg Cr picolinate) results in an increase feed intake and feed efficiency in broilers reared under heat stress. However, Uyanik *et al.* (2002) reported that 20 mg/kg supplemental Cr in broiler diets resulted in 18.57% reduction in feed consumption. Increased supplemental chromium picolinate (CrPic) in laying Japanese quail diets increased feed intake (Sahin, *et al.*, 2002a). Kim *et al.* (1996) showed that the addition Cr (0, 800, 1600 and 2400 ppb) to laying hen diets resulted in no significant difference in feed conversion under heat stress compared with control group at different experimental periods. Kwon *et al.* (1999) found that feed conversion rates did not differ which received chromium picolinate 5 mg/kg (Cr).

Mortality rate:

The present study showed that supplemental Cr decreased mortality of layer hens and that 1800 µg/kg diet of Cr supplementation resulted in the lowest mortality rate under heat stress (Table 2). These results are in agreement with those reported by Ibrahim (2005) who reported that mortality rates were 10.0, 4.0, 2.0, 7.5, 4.0, and 7.5 % in the control and treated groups received Cr, respectively .It was shown that mortality rates were decreased in groups received Cr supplemented with the diets up to 50 mg Cr/kg compared to control group. The results of this study could be explained by the results of Uyanik *et al.* (2002) who showed that broiler chicks fed 20, 40, or 80 µg Cr/kg diet for 44 day, increased lymphocyte counts, total antibody, IgG, and IgM titers. All levels of Cr increased the cell-mediated response to phytohemagglutinin. In the same respect, Steele and Rosebrough (1981)found that supplemented Cr in turkey poultry diets increased rate of glucose utilization and immune response which explains the decreased mortality rate observed.

Table (2): Effect of chromium supplementation on body weight changes, feed consumption, feed conversion and mortality rate % of Matrouh laying hens during the experimental periods.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr	Sig.
Body weight changes(gm)					
40-44wk	38.33 ± 1.48^{c}	48.67 ± 2.04^{ab}	54.00 ± 2.34^{a}	48.00 ± 1.44^{b}	**
44-48 wk.	70.83 ± 2.88^{b}	89.50 ± 1.65^{a}	84.67 ± 3.06^{a}	88.17 ± 2.68^{a}	**
48-52 wk	74.17 ± 4.42	69.50 ± 3.95	73.33 ± 6.28	70.33 ± 5.32	NS
40-52wk	183.33 ± 2.94^{b}	207.67 ± 3.92^{a}	212.00 ± 2.94^{a}	206.50 ± 5.11^{a}	**
Feed consumption(gm / hen/ day)					
40-44wk	96.83 ± 1.65^{b}	101.34 ± 1.59^{a}	103.10 ± 1.08^{a}	99.32 ± 1.38^{ab}	*
44-48 wk.	99.89± 1.98^{b}	102.65 ± 1.65^{b}	108.13 ±1.23^{a}	102.55 ±1.80^{b}	*
48-52 wk	101.53 ± 0.98^{b}	105.04 ± 2.14^{ab}	108.83 ± 1.27^{a}	106.13±1.42^{ab}	*
40-52wk	99.42± 1.32^{b}	103.01 ± 1.61^{ab}	106.69 ± 0.42^{a}	102.66 ± .32^{b}	**
Feed conversion					
40-44wk	3.42 ± 0.08	3.35 ± 0.05	3.28 ± 0.09	3.24 ± 0.06	NS
44-48 wk.	3.34 ± 0.10	3.23 ± 0.06	3.24 ± 0.11	3.15 ± 0.08	NS
48-52 wk	3.53 ± 0.10	3.45 ± 0.17	3.37 ± 0.13	3.42 ± 0.17	NS
40-52wk	3.52 ± 0.14	3.32 ± 0.06	3.25 ± 0.02	3.20 ± 0.04	NS
Mortality rate %					
40-52wk	8.33	4.16	2.78	1.39	

a,b,c = Overall mean having different letters exponents within row are significant different (P≤0.05).

Egg production traits:

Egg production (egg number, weight, mass and egg production %) are presented in Table (3). The data revealed that hens fed Cr significantly (P≤0.05) higher egg number and egg production than control group during total period (40-52 weeks of age). The values of egg production were increased by 4.89, 6.68 and 5.83 % for hens fed 600, 1200 or 1800µg/Cr /kg, respectively than the control groups. These results are in agreement with that reported by Sahin *et al.* (2002a) who reported that 400 µg/kg of diet Cr picolinate supplementation increased egg production by 11% in laying hens reared at a low ambient temperature (6.9°C). Chromium has been shown to increase performance in poultry in several studies (Sahin *et al.*, 2002b , Lien *et al.*, 1999 , Sands and Smith, 1999 and Steele and Rosebrough, 1981). Hens fed Cr significantly improved in egg weight when compared with control only during 40-44 weeks of age. Also, the results showed an increase (P≤0.05) in egg mass in hens fed diets supplemented with Cr during total experimental period when compared with the control group. The increase percentages in egg mass were 9.46, 15.55 and 12.87% at 40-52 weeks of age for hens fed 600, 1200 or 1800µg/Cr /kg, respectively as compared to the control groups. Kim *et al.* (1997) revealed that highest egg production; egg weight and egg mass were for groups supplemented with Cr 800 ppb and 16% CP (P≤0.05).

Table (3): Effect of chromium supplementation on egg number, egg weight, egg production% and egg mass of Matrouh laying hens during the experimental periods.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr	Sig.
Egg number (hen/period)					
40-44wk	16.97 ± 0.17^{b}	17.93 ± 0.35^{ab}	18.45 ± 0.47^{a}	18.22 ± 0.33^{a}	*
44-48 wk.	16.25 ± 0.29^{b}	17.25 ± 0.40^{ab}	18.02 ± 0.44^{a}	17.62 ± 0.26^{a}	*
48-52 wk	15.75 ± 0.50	16.65 ± 0.53	17.57 ± 0.53	17.33 ± 0.67	NS
40-52wk	48.97 ± 0.85^{c}	51.83 ± 0.73^{b}	54.03 ± 0.47^{a}	53.17 ± 0.44^{ab}	**
Egg weight (g)					
40-44wk	46.78 ± 0.23^{b}	47.31 ± 0.14^{ab}	47.80 ± 0.35^{a}	47.20 ± 0.17^{ab}	*
44-48 wk.	51.57 ± 0.26	51.66 ± 0.21	52.09 ± 0.41	51.89 ± 0.65	NS
48-52 wk	51.37 ± 0.17	51.69 ± 0.12	51.71 ± 0.14	51.31 ± 0.50	NS
40-52wk	49.91 ± 0.17	50.22 ± 0.11	50.53 ± 0.23	50.14 ± 0.22	NS
Egg mass(g/ hen/ period)					
40-44wk	793.76 ± 9.99^{b}	848.25 ± 15.48^{a}	881.43 ± 19.42^{a}	859.62 ± 12.65^{a}	**
44-48 wk.	837.87± 13.08^{b}	891.38 ±22.47^{ab}	938.57 ± 24.63^{a}	914.25 ± 18.91^{a}	*
48-52 wk	810.13± 27.14	859.76 ± 27.34	908.15 ± 26.94	876.24 ± 33.42	NS
40-52wk	2385.75± 75.15^{c}	2611.38 ±47.27^{b}	2756.62 ± 22.98^{a}	2692.70±19.12^{ab}	*
Egg production%(Hen-Day)					
40-44wk	60.07 ± 0.61^{b}	64.05 ± 1.24^{a}	65.89 ± 1.69^{a}	65.06 ± 1.18^{a}	*
44-48 wk.	59.46 ± 1.03	61.61 ± 1.43	64.35 ± 1.57	62.92 ± 0.94	NS
48-52 wk	56.96 ± 1.78	59.46 ± 1.9	58.05 ± 2.07	58.81 ± 1.97	NS
40-52wk	58.83 ± 1.02^{b}	61.71 ± 0.87^{a}	62.76 ± 1.04^{a}	62.26 ± 0.24^{a}	*

a,b,c = Overall mean having different letters exponents within row are significant different (P≤0.05).

Egg Quality:

Results in Table (4) pointed out that the added Cr did not affect egg components (yolk wt %, albumen wt % and shell wt %). In this respect, Piva *et al.* (2003) indicate that short-term feeding of laying hens with a diet high in Cr does not influence egg quality and does not result in abnormal levels of Cr in the yolk. Also, no significant effect was observed due to dietary treatments on egg weight and egg shape index during the total period. There was a significant (P≤0.05) linear decrease in the egg yolk cholesterol levels due to supplementation of chromium to laying hens diets as compared with control. Lien *et al.* (2004) observed that Egg yolk cholesterol was significantly reduced by supplementary copper (Cu) and chromium (0, 800 and 1600 micro g/kg diet as chromium picolinate) and there was an interaction between Cu and Cr supplementation. The highest value of Haugh unit score was observed for 1200 µg/Cr /kg which considered to be a good indicator for albumen quality (Hurnik, *et al.* 1978). Sahin *et al.* (2002a) found that supplemental chromium linearly increased egg weight (P≤0.01), egg shell thickness, egg specific gravity (P≤0.05) and Haugh unit (P≤0.01). Eggshell thickness increased with increasing Cr levels in the hen diets.

Table (4): Effect of chromium supplementation on egg quality traits of Matrouh laying hens.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr	Sig.
Egg shape index%	77.01 ± 1.59	74.71 ± 1.27	77.04 ± 0.79	76.37 ± 1.55	NS
Albumen weight %	55.11 ± 1.48	52.30 ± 0.72	52.37 ± 1.41	53.06 ± 0.77	NS
Yolk weight%	32.29 ± 0.98	33.61 ± 0.52	34.09 ± 0.94	33.56 ± 0.82	NS
shell weight%	12.61± 0.69	14.10± 0.48	14.54 ± 0.66	13.38 ± 0.49	NS
Haugh units	75.10 ± 2.41 c	82.55 ± 1.85 b	87.90 ± 1.12 a	81.07 ± 1.39 b	**
Shell thickness	0.356± 0.007 c	0.377± 0.012 bc	0.390± 0.008 ab	0.402± 0.008 a	**
Yolk cholesterol mg/dl	493.75±18.18 a	377.34±17.40 b	355.66±23.99 b	330.08±19.55 b	**

a,b,c = Overall mean having different letters exponents within row are significant different (P≤0.05).

Carcass characteristics:

Results presented in Table (5) revealed no significant differences among dietary treatments in the carcass traits except for carcass (%) and abdominal fat (%). Chromium supplementation to layer hen diets significantly increased (P≤0.05) carcass % and significantly decreased (P≤0.05) abdominal fat (%) especially at more than 600µg/Cr /kg diet. Layer hens fed the control diet had the highest value of abdominal fat (4.15 %) whereas, hens fed diet 1800 µg Cr/kg diet had the lowest corresponding value of abdominal fat being (2.64 %) as compared with the control or the other groups. These results agreed with those reported by Sahin *et a*l. (2002a) and Ibrahim (2005). Moreover, Uyank *et al.* (2005) and Ezzat *et al.* (2006) reported that chromium supplementation to quail diets significantly decreased (P≤0.05) abdominal fat (%) compared with the control group. Toghyan *et al.* (2006) indicated that Cr supplementation (500, 1000 or 1500 ppb) increased carcass yield and decreased abdominal fat.

Table (5): Effect of chromium supplementation on carcass characteristics of Matrouh laying hens at the end of experimental.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr	Sig.
Pre-slaughter weight(g)	1770.00 ±29.10	1791.67 ±29.49	1863.33 ±49.37	1805.00 ±49.58	NS
Carcass (%)	71.11 ± 0.45 b	74.56 ± 0.72 a	73.98 ± 0.60 a	73.53 ± 1.17 a	*
Gizzard (%)	1.64 ± 0.07	1.62 ± 0.04	1.74 ± 0.14	1.78 ± 0.09	NS
Liver (%)	3.30 ± 0.27	2.54 ± 0.11	2.98 ± 0.29	3.02 ± 0.28	NS
Heart (%)	0.41 ± 0.03	0.42 ± 0.02	0.50 ± 0.05	0.44 ± 0.03	NS
Giblets (%)	5.35 ± 0.25	4.58 ± 0.08	5.23 ± 0.19	5.24 ± 0.28	NS
Abdominal fat (%)	4.15 ± 0.33 a	3.48 ± 0.13 ab	2.95 ± 0.26 bc	2.64 ± 0.17 c	**

a,b,c = Overall mean having different letters exponents within row are significant different (P≤0.05).

Blood components:

Serum glucose, total protein, albumin, globulin, cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), total lipids and tri-glycerdes concentrations are shown in Table (6). There was a significant (P≤0.05) linear decrease in the serum glucose levels due to supplementation of chromium to laying hens diets as compared with control. The least serum glucose level was for 1800 μg Cr/kg diet. The decrease in serum glucose was about, 17.04, 21.95 and 31.90 % for hens fed 600, 1200 or 1800 μg/Cr/kg, respectively than the control group. These results were in agreement with those obtained by Sahin *et al.* (2002b) who reported that serum glucose concentration decreased ($P \leq 0.01$) when dietary Cr was added at levels of 0, 200, 400, 800 or 1200 μg Cr /kg of laying Japanese quail diet. Increasing concentration of corticosterone paralleled the increase in serum glucose concentration. This result was probably due to the greater catabolic effect (or concentration) of corticostrone, yielding more glucose in the serum. Lien *et al.* (1999) and Kroliczewska *et al.* (2004) found that glucose clearance rate in groups with dietary chromium supplementation markedly increased ($P \leq 0.01$) for broiler chicks. There was no significant ($P \leq 0.05$) effect of chromium on serum globulin in laying hens under heat stress. The highest ($P \leq 0.05$) values of each of total protein, albumin concentrations were recorded in serum of all groups received the Cr supplemented diet. These results are in agreement with those obtained by Sahin *et al.* (2002b), who observed that total protein and albumin concentrations increased linearly with increasing level of Cr supplementation. Also, Uyanik *et al.* (2002) reported that 20 mg Cr/kg diet supplemented Cr in broiler diets increased serum protein and Ibrahim (2005) found that blood parameters of broiler chicks indicated a significant increase in plasma total protein levels with increasing dietary level of supplemental Cr compared to the control group. In contrary, the decrease in serum cholesterol was about, 20.11, 27.43 and 30.4 (%) for Matrouh layer hens fed 600, 1200 or 1800 μg Cr /kg, respectively than the control group. These results are in agreement with those obtained by Lien *et al*, (2004), El-Kaiaty *et al.* (2005) and Ibrahim (2005) who reported that increased supplemental Cr (10, 20, 30, 40 and 50 mg Cr/kg diet) in broiler diets decreased cholesterol concentration. The results of this study showed a significant ($P \leq 0.05$) decrease in low density lipoprotein cholesterol (LDL) values and increased high in density lipoprotein cholesterol (HDL) values in groups received Cr as compared to the control. The same results were reported by Uyanik *et al.* (2002), Lien *et al.* (2004) in broiler and Ezzat *et al.* (2006) in Japanese quail. Similar trend was observed with serum total lipids, where the increase in serum total lipids were 46.85, 49.55 and 76.28 (%) for hens fed 600, 1200 or 1800μg/Cr /kg, respectively than the control group. These data agreed with that reported by Anderson (1995), who found that Cr increased plasma total lipid concentration. However, the increase in serum tri-glycerdes concentrations was about, 17.79, 22.00 and 21.36 (%) for hens fed 600, 1200 or 1800μg/Cr /kg, respectively than the control group. A similar effect due to Cr supplementation was reported by Riales and Albrink (1981) and Abraham *et al.* (1992).They showed a tendency for triglycerides to rise by Cr supplementation but this was not significant. Chromium is generally accepted as the active component in the glucose tolerance factor (GTF), which increases the sensitivity of tissue receptors to insulin, resulting in increased glucose uptake by cells. Research suggests Cr involvement in carbohydrate metabolism including glucose uptake, glucose utilization for lipogenisis, and glycogen formation (Anderson *et al.*, 1991). It was hypothesized that increased glucose uptake should increase oxidation of glucose which would be otherwise converted to fatty acids and stored as triglycerides in adipose tissues.

Table (6): Serum biochemical traits of Matrouh laying hens at 40-60 weeks of age as affected by different levels of supplemented with deferent levels of chromium.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr	Sig.
Glucose mg/dl	103.28 ± 3.11[a]	85.68 ± 2.94[b]	80.62 ± 3.91[b]	70.33 ± 1.25[c]	**
Total protein g/dl	4.72± 0.11[b]	6.67± 0.27[a]	7.03 ± 0.33[a]	7.02 ± 0.30[a]	**
Albumin g/dl	3.40 ± 0.25[b]	4.08 ± 0.19[ab]	4.57 ± 0.23[a]	4.56 ± 0.27[a]	**
Globulin g/dl	1.32 ± 0.28	2.59 ± 0.31	2.45 ± 0.53	2.46 ± 0.36	NS
Serum cholesterol mg/dl	170.90 ± 7.75[a]	136.52±6.63[b]	124.02 ±5.62[b]	118.95 ± 5.07[b]	**
HDL mg/dl	70.96 ± 3.04[c]	77.81± 3.05[c]	93.28± 3.55[b]	112.10 ± 5.00[a]	**
LDL mg/dl	15.64 ± 1.70[a]	11.28 ± 1.21[b]	7.75 ± 0.27[b]	5.82 ± 0.24[b]	**
Total lipids g/dl	0.74 ± 0.08[b]	1.09 ± 0.12[a]	1.11 ± 0.06[a]	1.30 ± 0.09[a]	**
Tri-Glycerdes mg/dl	144.92 ± 5.52[b]	170.70 ± 7.50[a]	176.80 ± 4.03[a]	175.88 ± 4.93[a]	**

a,b,c = Overall mean having different letters exponents within row are significant different ($P \leq 0.05$).

Economic Efficiency (EE):

Economic efficiency study of Matroh local layer hens fed the experimental diets are summarized in Table (7). Addition of Cr to diets at levels of 600, 1200, and 1800 µg /kg diet improved EE compared to control. These improvements in EE were 4.48, 5.65 and 11.52 (%) than the control value, respectively. From economic stand point, it was clear that group received 1800 µg Cr /kg diet gave the highest EE value compared to the control. These results are in agreement with those of Ibrahim (2005) who reported that the addition of Cr to diet at levels of 10, 20, 30, and 40 mg/kg improved EE compared with control group in broiler. Ezzat *et al.* (2006) found that addition of Cr to diets at levels of 400, 800, and 1200 µg /kg diet significantly increased ($P \leq 0.05$) EE compared to control. These improvements in EE were 5.69, 12.50, 13.43 and 13.62 (%) than the control value respectively in Japanese quail at 6 weeks of age. The results of the current study suggest that supplementation of chromium Matroh local layer hens diets especially at a level of 1800 µg Cr/kg diet improvement growth, mortality rate and economic efficiency than the control. There are other positive effects, including reduced abdominal fat and increased carcass (%). Chromium may be one of the most important trace minerals in layers hen feed formulation in the new millennium.

Table (7): Input/output analysis and commercial efficiency of Matrouh hens fed the Experimental diets.

Item	Control	600µg/kg Cr	1200µg/kg Cr	1800µg/kg Cr
Egg number	48.97	51.83	54.03	53.17
Price/egg (LE)	0.30	0.30	0.30	0.30
Total revenue hen (LE)	14.69	15.55	16.21	15.95
Total feed intake/ hen(kg)	8.35	8.65	8.96	8.62
Price/Kg feed (LE)	0.95	1	0.95	0.95
Total feed cost/ hen (LE)	7.93	8.22	8.51	8.19
Net revenue/hen (LE)[1]	6.76	7.33	7.7	7.76
Economic effeciency (EEE)	0.85	0.89	0.9	0.95
Relative EE[2] (%)	100	104.48	105.65	111.52

[1] Net revenue per unit of total feed cost

[2] Relative economic efficiency (%) of the control

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تأثير عنصر الكروميوم علي بعض المقاييس الإنتاجية والفسيولوجية لدجاج مطروح البياض خلال موسم الصيف الحار بمصر

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صممت هذه التجربة لتقييم كفاءة إضافة الكروميوم في تخفيف التأثيرات السالبة للإجهاد الحراري على إنتاج وجودة البيض وخصائص النبيحة وبعض المقاييس الفسيولوجية لدجاج مطروح البياض. غذي الدجاج علي أربع علائق الأولي (المقارنة بدون إضافة) والثانية والثالثة والرابعة علي علائق مضاف إليها الكروميوم بمستوي ٦٠٠، ١٢٠٠ أو ١٨٠٠ ميكروجرام/كجم عليقه علي التوالي.

استخدم في هذه التجربة عدد ٢١٦ دجاجه عمرها من ٤٠ حتى ٥٢ أسبوع. وقسمت عشوائيا إلى أربع مجاميع متساوية (٥٤ دجاجة/مجموعه) في ثلاث مكررات (١٨ دجاجة /مكررة).

وبينت النتائج إن الطيور المغذاة علي ١٢٠٠ ميكروجرام كروميوم/ كجم عليقه سجلت أعلي زيادة في وزن الجسم والغذاء المأكول مقارنة بمجموعة المقارنة خلال الفترة الكلية للتجربة. إضافة الكروميوم لغذاء الدجاج البياض لم يسفر عن اختلاف معنوي في تحويل الغذاء تحت الإجهاد الحراري مقارنة مع مجموعة المقارنة في مختلف الفترات التجريبية. انخفض معدل النفوق للدجاج البياض تحت الإجهاد الحراري وكان مستوي ١٨٠٠ ميكروجرام كروميوم/ كجم غذاء ادني معدل للنفوق.

زاد إنتاج البيض لدجاج مطروح بنسبة ٦،٦٨، ٤،٨٩، ٥،٨٣٪ المغذي علي ٦٠٠، ١٢٠٠ أو ١٨٠٠ ميكروجرام كروميوم/ كجم عليقه على التوالي أكثر من مجموعة المقارنة. زاد وزن البيض بإضافة الكروميوم خاصة عند مستوي ١٢٠٠ ميكروجرام كروميوم/ كجم غذاء مقارنة مع مجموعة المقارنة خلال الفترة الأولي من التجربة في حين لم يكن هناك تأثير معنوي بعد ذلك. زادت كتلة البيض بنسبة ٩،٤٦، ١٥،٥٥، ١٢،٨٧ ٪ خلال الفترة الكلية لدجاج مطروح المغذي علي ٦٠٠، ١٢٠٠ أو ١٨٠٠ ميكروجرام كروميوم/ كجم عليقه على التوالي أكثر من مجموعة المقارنة. لم يكن هناك تأثير معنوي للمعاملات على وزن مكونات البيضة (الصفار ٪، البياض ٪ والقشرة ٪). نقص كلسترول صفار البيض نقصا معنويا بإضافة الكروميوم لغذاء الدجاج البياض عند المقارنة مع مجموعة المقارنة. لوحظ أن أعلى قيمة من وحدات هاو كانت للمجموعة المغذاة علي ١٢٠٠ ميكروجرام

كروميوم/ كجم عليقه وسمك قشرة البيض تبع نفس الاتجاه حيث زاد مع زيادة مستويات الكروميوم في الغذاء. أدي إضافة الكروميوم في غذاء الدجاج البياض إلي زيادة معنوية للذبيحة ٪ وانخفاضا معنويا لدهن البطن٪ مقارنة بمجموعة المقارنة. بينما كان هناك انخفاض معنويا (عند مستوي ٠,٠١) في مستويات جلوكوز السيرم وقيم الكولسترول منخفض الكثافة في المجاميع التي غذيت علي الكروميوم مقارنه مع مجموعه المقارنة. وزاد البروتين الكلي والألبيومين والكولسترول عالي الكثافة في المجاميع التي غذيت علي الكروميوم مقارنه مع مجموعه المقارنة. وزادت الليبيدات الكلية معنويا (عند مستوي ٠,٠١) ٤٦,٨٥، ٤٩,٥٥، ٧٦,٢٨٪ وكذلك زادت جلسريدات السيرم الثلاثية بنسبة ١٧,٧٩، ٢٢,٠٠، ٢١,٣٦٪ لدجاج مطروح المغذي علي ٦٠٠ ، ١٢٠٠ أو ١٨٠٠ ميكروجرام كروميوم/ كجم عليقه علي التوالي مقارنة بمجموعة المقارنة. كما تحسنت الكفاءة الاقتصادية مع إضافة مستويات الكروميوم المختلفة مقارنه مع مجموعه المقارنة. ولذلك يوصي بإضافة ١٢٠٠ ميكروجرام كروميوم/ كجم عليقه لتحسن أداء الدجاج وعدد وإنتاج وجودة البيض وكذلك تحسن الكفاءة الاقتصادية للعلائق وتقليل وزن دهن الجسم وجلوكوز وكولسترول الدم خلال موسم الصيف الحار بمصر.