Egypt. Poult. Sci. Vol. (39)(I): (99-115) (2019) **(1809-1037)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF DIFFERENT SOURCES OF CHROMIUM ON PRODUCTIVE PERFORMANCE OF JAPANESE QUAIL UNDER HEAT STRESS CONDITIONS

M. I. El-Kelawy

Dep. of Poult. Prod., Fac. of Agric., New Valley Univ.

Corresponding author: Mahmoud I. El-Kelawy Email**:** m.elkelawy@gmail.com

Received: 29/ 01/ 2018 Accepted: 17 /02 / 2019

ABSTRACT: This experiment was conducted to evaluate the influence of different sources of Cr on growth performance, economical efficiency and blood constituents in heat-stressed Japanese quails. A total of 280 Japanese quails at 2 weeks of age were distributed into four groups with seven replicates (10 in each). The quails were kept under heat stress conditions (34.1 ºC temperature and 41.7% relative humidity) during the day light between 14 and 49 days of age. The first group fed basal diet without supplementation and saved as control group, while the 2nd, 3rdand 4th groups were fed basal diet supplemented with 200 ppm/kg diet of Cr chloride (CrCl3), chromium yeast (Cr-Yeast) or chromium picolinate (Cr-Pic), respectively. Body weight and feed intake were recorded. Body weight gain, feed conversion ratio, production index and economical efficiency were calculated.

The results showed that chromium supplementation improved BWG, FCR, carcass percentage, economical efficiency, production index, nutrient digestibility and antioxidant properties and decreased abdominal fat. Fed Japanese quails on diet supplemented with Cr-Pic resulted in the greatest BWG, FCR, economical efficiency and production index followed by those fed basal diet supplemented with Cr-yeast then CrCl3. Chromium administration significantly reduced plasma glucose, triglycerides, total cholesterol and LDL and increased HDL. Plasma total protein levels increased due to inclusion of Cr-Pic or Cr-Yeast into chick diets. Different sources of Cr supplementation significantly increased Lymphocytes and decreased Heterophile /Lymphocytes ratio than the control group. It can be concluded that chromium (either organic or inorganic) supplementation to diet had a beneficial effect on productive performance, economical efficiency and production index of Japanese quails. However, Japanese quails on diet supplemented with Cr-Pic resulted in the greatest productive performance, economical efficiency and production index followed by those fed basal diet supplemented with Cr-yeast then CrCl3.

Key words: Japanese quails - chromium sources - growth performance - heat stress

INTRODUCTION

Breeding of quail has rapidly increased in the last years. The quail has become a chicken competitor as a source of animal protein (Jaap, 1964). The low ability of poultry to withstand heat stress (HS) is a major problem in tropic and subtropics regions. The high temperature in Egypt during the summer lead to some of behavioral and physiological responses in birds (Faisal et al., 2008). Heat stress can decrease the feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) (Habibian et al., 2016) and meat yield (Zhang et al., 2012 and Zeferino et al., 2016); and reducing the secretion of digestive enzymes as well as absorption of nutrients (Liu et al., 2016).

Some ways are reported to reduce the negative effects of HS, including environmental, nutritional management and feed additives such as vitamins C, E and chromium (Cr) (Attia et al., 2011, Khan et al., 2012). Chromium is an essential for the natural metabolism of carbohydrates, fats and proteins in animals (Pechova and Pavlata, 2007). Also, chromium is essential for glucose metabolism and configure glucose tolerance factor, which works with insulin to transfer glucose to cells and increase the use of glucose (El-Hommosany, 2008)

Many studies support Cr supplementation in the poultry diet to improve performances during HS (Sahin et al., 2002a and Moeini et al., 2011). Inclusion of chromium in broiler diets reduces the negative effects of stress and enhances immunity (Ebrahimzadeh et al., 2012), BWG, FCR (Toghyani et al., 2006) and carcass characteristics (Toghyani et al., 2012). Also, Inclusion of chromium picolinate (Cr-Pic) in diet lead to improve the production performance of broilers fed low protein diets (Khan et al., 2014). Most poultry feedstuffs are composed of plant sources, which are limited in Cr contented (Giri et al., 1990). Moreover, El-Hommosany (2008) observed that addition of Cr in Japanese quail diet increased FI, body weight (BW) as well as improved FCR and carcass traits. Also, Sahin et al. (2010) described that Cr-Pic supplementation to Japanese quail diets resulted in better FI, FCR and BWG compared to control. Organic Cr are over than ten times higher bio-available than inorganic Cr (Lyons, 1994). Chromium propionate is an organic Cr absorbed with higher efficiently than some other organic Cr sources (Clodfelder et al., 2004). Therefore, the aim of this work was to study the influence of different sources of Cr on growth performance, blood constituents, dressing percentages during growing period of Japanese quail under heat stress conditions.

MATERIAL AND METHODS

The present study was carried out at Poultry Experimental Station, Faculty of Agriculture, New Valley University, during the period from Mid of April to June 2018.

Two hundred and eighty of unsexed one-day-old Japanese quails were randomly distributed into 4 experimental groups (70 birds/group), with seven replicates (10 birds / replicate) and were kept in floor pens until 2 weeks of age. All birds were wing banded and housed in wire cages (40×50×25 cm). The ambient temperatures and relative humidity were recorded daily inside the pen at experimental sites at 09:00 am, 12:00 pm, 3:00 pm and 6:00 pm throughout the study period (Table 1). Quail were fed basal diets and were supplemented with the following treatments: The 1st treatment group was saved as control and fed basal diet without addition, while the 2nd, 3rd and 4th groups were fed basal diet supplemented with 200 ppm/kg diet of Cr chloride (CrCl3), chromium yeast (Cr-Yeast) or chromium picolinate (Cr-Pic), respectively. All quail were fed the experimental diets from 14 to 49 days of age. Feed and water were provided ad libitum to birds at all times. The birds were kept under the same environmental and managerial conditions. The light regime used was about 16 h /day (artificial light). Basal diet was formulated according to NRC (1994) as presented in Table 2.

Quails were weighed individually at regularly intervals to calculate body weight gain (BWG). Feed intake (FI) was recorded at same intervals as well as total period for each replicate and feed conversion ratio (FCR, g feed/g gain) were calculated.

Production index (PI) was measured throughout the experimental period (14-49d of age), according to Attia et al. (2012) as follows: -

$$\text{Production index} = \frac{\text{BW (kg) x SR}}{\text{PP x FCR}} \text{x } 100$$

Where:

BW = Body weight (kg) SR = Survival rate (100% - mortality)

PP = Production Period (days) FCR = Feed conversion ratio (kg feed / kg gain)

Economical evaluation for all experimental treatments was made as below.

$$\text{Economic efficiency} = \frac{\text{Total revenue} - \text{Total cost}}{\text{Total cost}} \times 100$$

Where:

Total revenue = BW × Meat Price

Total cost = Feed cost + Addition cost + Other cost

Relative economic efficiency=(Economic efficiency/control economic efficiency)*100

Apparent digestibility of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE) and crude fiber (CF) was done according to (Aggoor et al., 2000). At 49 d of age, six quail chicks (3 males and 3 females) from each group were slaughtered after 8 hours fasting, processed and the weight of carcass and internal organs were taken and expressed as (%) of live BW. The DM, CP and EE of feed and excrement were determined according to (AOAC, 2004) and expressed on dry matter basis.

At slaughtering, six blood samples were collected in tubes from each group. The blood samples were divided into two parts, the 1st part was collected in heparinized tubes while the 2nd part was collected in non-heparinized tubes to obtain serum. Plasma and /or serum were separated by centrifugation of the blood at 3000 rpm for 20 minutes and stored at – 20°C for later analysis. Blood biochemical constituents were determined using commercial diagnostic kits purchased from Diamond Diagnostic company (23 EL-Montazah St. Heliopolis, Cairo, Egypt) and hematological traits were performed as cited by (ELnaggar et al., 2016)

Statistical analysis

Data obtained were analyzed using the GLM procedure of Statistical Analysis System (SAS, 2002), using one-way ANOVA as in the following model:

$Y_{ik} = \mu + T_i + e_{ik}$

Where, Y is the dependent variable; μ is the general mean; T is the effect of experimental treatments; and e is the experimental random error. Before analysis, all percentages were subjected to logarithmic transformation ($\log_{10} x + 1$) to normalize data distribution. The differences among means were determined using Duncan's new multiple range test (Duncan, 1955).

RESULTS

Growth performance: Data presented in Table 3 showed the effect of feeding Japanese quails on diets containing different sources of Cr, on the average values of BW, BWG, FI, feed conversion ratio, economical efficiency, production index and viability rate heat stressed quail chicks. Initial BW of quail chicks was similar for all treatments. Chromium supplementation improved BW at 28 and 49 d of age and BWG during periods 14-28, 29-49 and 14-49 d of age of heat stressed quails compared with control group. Moreover, quails fed basal diet supplemented with Cr-Pic had significantly greater BW and BWG followed by those fed basal diet supplemented with Cr-yeast then CrCl3 compared to the control group at same periods. The feed intake and survival rate were numerically higher for the Cr supplementation groups than the control group. However, chicks fed basal diet supplemented with Cr-Pic had significantly better FCR and production index followed by those fed basal diet supplemented with Cr-yeast and CrCl3 compared to the control group during period 14-49 d of age.Organic Cr supplementation improved economical efficiency of Japanese quails during 14-49 day of age compared with other groups. Moreover, Japanese quails fed basal diet supplemented with Cr-Pic had significantly higher relative economic efficiency (142%) followed by those fed basal diet supplemented with Cr-yeast (125%) then CrCl3 (119%) compared to the control group (100%) during 14-49 d of age.

Apparent digestibility of nutrients:
Japanese quails fed diets supplemented with Cr-organic or Cr-inorganic showed significantly greater ($P \leq 0.01$) values for dry matter, crude protein, ether extract and crude fiber digestibility than the control group, without significant differences between Cr-sources (Table 4).

Carcass characteristics:
Effect of different sources of Cr on relative weight of carcass characteristics and body organ at 49 day of age are shown in Table 5. Basal diet supplemented with both of Cr-organic and Cr-inorganic significantly increased the percentage of carcass weight and decreased abdominal fat compared to control diet (basal diet). However, there were no significant effects of different Cr sources on inner body organs including such as liver, gizzard, heart, spleen, pancreas, proventriculus, intestine length and intestine weight.

Biochemical constituents of plasma:
The blood plasma biochemical parameters of Japanese quails fed diet supplemented with different sources of Cr at 49 day of age are shown in Table 6. Plasma glucose concentration was significantly lower in Japanese quails fed diets with different Cr sources than those fed the control diet. However, Cr-Pic supplementation significantly increased plasma total protein than the control group and CrCl3 without significant differences between Cr-Pic and Cr-Yeast in plasma total protein concentration. There was no significant effect of the different sources of Cr supplementation on blood plasma renal and liver functional parameters including urea, creatinine, urea/ creatinine, ALT, and AST of heat stressed Japanese quails.

Basal diet supplemented with both of Cr-organic and Cr-inorganic significantly reduced triglycerides, total cholesterol and

LDL and increased HDL compared to control diet (basal diet). However, there were no significant effects of different Cr sources on total lipids (Table 6). Heat stressed Japanese quails fed basal diet supplemented with organic Cr groups had significantly higher total antioxidant capacity (TAOC) and glutathione (GSH) activity compared with those fed the control diet. In addition, Japanese quails fed basal diet supplemented with different sources of Cr had significantly higher glutathione peroxidase (GPX) activity compared with those fed the control diet. Moreover, Cr-Pic and CrCl3 could significantly increase serum superoxide dismutase (SOD) activity compared with the control (Table 6).

Hematological criteria

There was no significant effect of the different sources of Cr supplementation on the hematological criteria and white blood cells and differential leukocytes counts of Japanese quails except Lymphocytes and Heterophile/ Lymphocytes ratio. Where, different sources of Cr supplementation significantly increased Lymphocytes and decreased Heterophile /Lymphocytes ratio than the control group without significant differences between different sources of Cr (Table 7).

DISCUSSION

Growth performance:

It is well-known that growth performance and feed efficiency worsen when the ambient temperature exceed the thermo neutral zone (Ensminger et al., 1999) and that a decrease in growth rate is partly the result of a decrease in FI (Hurwitz et al., 1980). Also, Heat stress increases the secretion of chromium (Anderson, 1994) and thus may increase Cr requirements. In the current study, Cr administration improved the growth performance of Japanese quails chicks variables by increased BWG, FI, improved FCR and similarly decreased mortality rate. Similar to our results, of Cr in broiler diets under HS leads to an improve in BW and FCR (Sahin et al., 2002a and Ebrahimzadeh et al., 2013) and increase FI (Toghyani et al., 2006 and 2012). Sahin et al. (2003) reported that the addition of Cr reduces the negative effects of heat stress on growth and FCR of broiler chickens. Also, Aslanian et al. (2011)found that male broiler fed organic Cr had higher BW than control diet during the finishing (21-42d) phase. Furthermore, Norain et al. (2013) reported that Cr supplementation resulted in a significantly ($P<0.05$) higher average final live BW, BWG and FCR of Cr-supplemented broiler chickens compared to those of control group. Also, Chromium supplementation significantly ($P<0.05$) increased the BWG, total FI, improved FCR and decreased the mortality rate, when compared with heat-stressed quails (Abdelhady et al. 2017). Chromium supplementation of broiler diets under HS conditions has improved BWG and FCR in a number of studies (Sands and Smith, 1999; Sahin et al., 2002a and Jahanianand Rasouli,2015). Insulin sensitivity decreases with increased corticosterone levels during heat or other types of stress (Zhao et al., 2009), and may explain the performance responses to Cr in heat stressed birds. Also, the FCR were improved by using Cr-Pic (Sahin et al., 2002a), CrCl3 (Uyanik et al., 2002), and Cr-Yeast (Kroliczewska et al., 2004). Chromium additions significantly improved the growth performance, economical efficiency and production index of broilers (Awad, 2012). In the current study, Cr administration improved the nutrient digestibility of Japanese quails chicks. Similarly, Awad (2012) found that Cr supplementation significantly improved the OM and CP digestibility of broilers. Chicks fed organic Cr had significantly better OM and CP digestibility than those fed inorganic source.

Carcass characteristics:

Results obtained herein show that, Cr addition significantly increases carcass dressing percentage and decreased abdominal fat. Similarly, chicks supplemented with Cr-Pic (Sahin et al., 2002a and 2003) and Cr-Yeast (Debski et al., 2004) had higher carcass and lower abdominal fat than control. Also, Sands and Smith (1999) reported that Cr-Pic supplementation under HS or thermo neutral condition improves live performance and percentage yield of carcass. Also, Norain et al. (2013) found that broiler chickens fed organic Cr had significantly higher carcass dressing percentage than those fed control diet. Suksombat and Kanchanatawee (2005) reported that organic Cr (Cr-Yeast or Cr-Pic) improved carcass percentage of broilers. The reduction in abdominal fat may be due to fat synthesis inhibition or fat mobilization or the two together (Suksombat and Kanchanatawee, 2005). There were no significant effects of Cr on relative weights of Thymus and Bursa. Similar results were observed by El-Hommosany (2008) and Al-Bandr et al. (2010).

Biochemical constituents of plasma:

In the current study, Cr administration reduced the plasma glucose of heat stressed Japanese quail chicks. Similarly, Al-Bandr et al. (2010), Al-Mashhadani et al. (2010) and Haq et al. (2018) found that Cr-yeast additions decreased serum glucose levels. Moreover, Aslanian et al. (2011) revealed that addition of Cr methionine decreased glucose levels in blood significantly. Also, Sahin et al. (2002b) showed that inclusion of Cr-Pic in broiler diets decreased glucose and increased insulin levels in plasma. Moreover, serum glucose levels decreased with Cr supplementation in broiler diets (Moeini et al., 2011). This result is well accepted since Cr stimulates glucose metabolism via potentiates insulin hormone action (Jeejebhoy et al., 1977). Supplementation of organic Cr in quail diets decreased glucose level in blood (Abdelhady et al. 2017) which is in agreement with (Sahin et al., 2002a; El-Hommosany, 2008) who stated that Cr is essential for glucose metabolism and configure glucose tolerance factor, which works with insulin to transfer glucose to cells and increase the use of glucose, therefore, an improvement was found in BWG, FCR and carcass qualities. Inclusion of Cr-Pic or Cr-Yeast into Japanese quail diets resulted in increased total proteins levels in plasma. These data are similar with those found by Sahin et al. (2002b), Al-Bandr et al. (2010) and Al-Mashhadani et al. (2010).The high total protein levels in plasma may be because high protein synthesis and greatly growth rate in the tissues of the organic Cr supplemented groups (Cr-Yeast and Cr-Pic) compared to un-supplemented groups, where anabolism Overridden catabolism of the protein (Sahin et al., 2002a). There were no significant effects of Cr on plasma albumin level. These data are similar to those found by Al-Bandr et al. (2010).

In the current study, Cr administration significantly reduced triglycerides, cholesterol and LDL and increased HDL. Similarly, Aslanian et al. (2011) observed that addition of Cr organic decreased the cholesterol and LDL levels, whereas HDL levels was increased in blood. Addition of Cr decreased the total cholesterol, LDL cholesterol and triglycerides, and increased HDL cholesterol (Suksombat and Kanchanatawee, 2005; Abdelhady et al., 2017).

The present results showed that Cr source did not affect plasma renal and liver functional parameters as well as total lipids of heat stressed Japanese quails. These data are similar to those found by Mustafa (2007) and Al-Bandr et al. (2010) who revealed that there were no significant effects of Cr on either plasma uric acid or creatinine levels.

Different sources of Cr supplementation significantly increased Lymphocytes and decreased Heterophile /Lymphocytes ratio than the control group. In addition, there was no significant effect of the different sources of Cr supplementation on the hematological criteria and white blood cells. Similar results were reported by Uyanik et al. (2002) who found that heterophil/lymphocyte ratio was reduced, and lymphocyte counts was increased by Cr supplementation. In addition, Toghyani et al. (2007) observed that heterophil to lymphocyte ratios decreased in chickens fed 1000 and 1500 ppb supplemental Cr. Moreover, Norain et al. (2013) found that Cr supplementation resulted in increased lymphocytes and decrease heterophil/lymphocyte ratio of heat-stressed chickens. Also, Javed et al. (2003) indicated that non-significant differences between treatments and control groups in Hgb concentration and RBC's were obtained.

Our results have confirmed that adding Cr can improve antioxidant properties of poultry and alleviate oxidative damage caused by HS. In this respect, Li et al. (2018) who found that at 14th day dietary supplementation of Cr could significantly decrease serum MDA level compared with HS group. At 21th day, serum SOD levels in Cr-Pic group were significantly higher than those in HS group. Moreover, at 35th day, adding Cr-Pic tended to alleviate the decrease of serum T-AOC levels caused by HS. Besides, Cr-Pic would remarkable improve serum SOD levels compared to the control. Supplementation of Cr increased the activities of antioxidant enzymes (GSHPx, GSH Rx, and RBCC), revealing that Cr addition gradually reduced oxidative stress with increase in its levels in diet of broiler (Rao et al., 2012).

CONCLUSION

It can be concluded that chromium supplementation to diet (either organic or inorganic) had a beneficial effect on productive performance, economical efficiency and production index of Japanese quails. However, Japanese quails fed on diet supplemented with Cr-Pic resulted in the greatest productive performance, economical efficiency and production index followed by those fed basal diet supplemented with Cr-yeast then CrCl3.

Table (1): Ambient temperature (°C) and relative humidity (%) during the experimental period.

Time	Ambient temperature (°C)				Relative humidity (%)			
	9 am	**12 pm**	**3 pm**	**6 pm**	**9 am**	**12 pm**	**3 pm**	**6 pm**
Minimum	24.0	25.0	31.3	23.5	17.0	15.0	15.0	14.0
Maximum	31.0	41.3	43.0	38.9	82.0	68.0	75.0	86.0
Average	28.4	35.7	38.4	33.7	51.1	38.7	38.0	38.8
	34.1 (°C)				41.7 (%)			

Table (2): Ingredients and calculated analysis (%) of the basal diet

Ingredients, (g/kg)	**%**
Yellow corn	45.00
Soybean meal (44%CP)	47.20
Wheat bran	1.40
Sunflower oil	3.00
Limestone	0.45
Dicalcium phosphate	2.05
Vit&Min Premix*	0.30
NaCl	0.30
DL-methionine	0.30
Total	100.00
Determined[1] and calculated[2] composition (% as fed basis)	
Nutrient	Supplied
Dry matter[1]	86.12
Dry matter[2]	86.90
ME (kcal/kg)[2]	2879
Crude protein[1]	23.82
Crude protein[2]	24.99
Ether extract[1]	3.89
Ether extract[2]	3.77
Crude fiber[1]	3.92
Crude fiber[2]	3.66
Calcium2	0.79
Total phosphorus2	0.86
Available phosphorus[2]	0.50
Lysine[2]	1.40
Methionine[2]	0.67
TSAA, %[2]	1.06
Cr (mg/kg diet)[1]	3.17

*Vitamins and minerals mixture provide per kilogram of diet: Vit. A, 12000 IU; Vit. E, 10 IU; $k_{3,}$ 3mg; Vit.D_3, 2200 ICU; Ca pantothenate,10 mg; riboflavin, 10 mg; niacin, 20 mg; Choline chloride, 500 mg; Vit. B_{12}, 10μg; Vit. B_6, 1.5 mg; Folic acid, 1 mg; Thiamine 2.2 mg; D-biotin, 50μg. Trace mineral (milligrams per kilogram of diet) Mn, 55; Zn, 50; Cu, 10; Fe, 30; Se, 0.1 and Ethoxyquin 3mg.

Table (3): Effect of different sources of chromium on growth performance, and economical efficiency of heat stressed Japanese quails during the growth period (days 14 to 49 of age).

Treatment	Control	CrCl3	Cr-Yeast	Cr-Pic.	SEM	Sig.
Body weight (g) at age						
14d of age	63.8	64.1	63.7	64.1	0.733	0.993
28d of age	130c	135b	138b	146a	1.57	0.003
49d of age	224d	236c	244b	256a	1.97	0.004
Body weight Gain (g)						
14-28d of age	66.1c	70.8b	74.4b	81.8a	1.394	0.002
29-49d of age	93.9d	101c	106b	110a	1.306	0.001
14-49d of age	160d	172c	180b	192a	1.55	0.009
Feed intake (g/bird)						
14-28d of age	194	201	200	199	5.8	0.912
29-49d of age	439	451	457	459	9.6	0.5
14-49d of age	633	652	658	659	11.43	0.43
Feed conversion ratio (g Feed/ g gain)						
14-28d of age	2.942	2.849	2.702	2.45	0.122	0.091
29-49d of age	4.68a	4.47ab	4.33b	4.17b	0.100	0.023
14-49d of age	3.96a	3.80b	3.66b	3.43c	0.077	0.002
Economical efficiency						
EE	0.586c	0.696bc	0.732ab	0.830a	0.041	0.006
REE	100	119	125	142	--	--
Production index	10.6c	12.2b	13.1b	15.0a	0.374	0.004
Survival rate	92.0	96.0	96.0	98.0	2.236	0.319

[a,b,c] Means in the same column followed by different letters are significantly different at ($P \leq 0.05$); CrCl3= chromium chloride; Cr-Yeast= chromium yeast; Cr-Pic= chromium picolinate; Sig.= significantly SEM= Standard error of mean; EE= Economical efficiency; REE= Relative economical efficiency.

Table (4): Effect of different sources of chromium on apparent digestibility of nutrients (%) of heat stressed Japanese quails during the growth period (days 14 to 49 of age).

Treatment	Control	CrCl3	Cr-Yeast	Cr-Pic.	SEM	Sig.
Apparent digestibility,%						
Dry matter	73.7b	77.3a	77.2a	79.0a	0.85	0.005
Crude protein	66.4b	69.3a	68.9a	70.2a	0.44	0.001
Ether extract	73.8b	78.3a	79.4a	79.2a	0.96	0.004
Crude fiber	32.9b	38.4a	37.5a	39.5a	1.22	0.006

[a,b,c] Means in the same column followed by different letters are significantly different at ($P \leq 0.05$); CrCl3= chromium chloride; Cr-Yeast= chromium yeast; Cr-Pic= chromium picolinate; Sig.= significantly SEM= Standard error of mean.

Table (5): Effect of different sources of chromium on relative weight of carcass characteristics at 49 day of age of heat stressed Japanese quails.

Treatment	Control	CrCl3	Cr-Yeast	Cr-Pic.	SEM	Sig.
Carcass characteristics						
Carcass %	64.8b	68.6a	68.3a	68.8a	0.806	0.009
Liver %	1.47	1.58	1.64	1.59	0.055	0.304
Gizzard %	1.46	1.56	1.53	1.54	0.031	0.154
Heart %	0.832	0.788	0.774	0.765	0.02	0.187
Giblets %	3.76	3.93	3.94	3.88	0.066	0.296
Spleen %	0.044	0.048	0.042	0.051	0.005	0.552
Pancreas %	0.21	0.182	0.193	0.191	0.011	0.396
Proventriculus %	0.516	0.536	0.526	0.532	0.026	0.814
Fat %	0.421a	0.276b	0.267b	0.251b	0.027	0.001
Intestine weight %	2.44	2.57	2.46	2.48	0.083	0.368
Bursa	0.087	0.088	0.076	0.09	0.006	0.127
Thyroid	0.007	0.009	0.008	0.01	0.002	0.811

[a,b,c] Means in the same column followed by different letters are significantly different at ($P \leq 0.05$); CrCl3= chromium chloride; Cr-Yeast= chromium yeast; Cr-Pic= chromium picolinate; Sig.= significantly SEM= Standard error of mean.

Table (6): Effect of different sources of chromium on blood Plasma biochemical parameters at 49 day of age of heat stressed Japanese quails.

Treatment	Control	CrCl3	Cr-Yeast	Cr-Pic.	SEM	Sig.
Plasma biochemical parameters						
Glucose (mg/dl)	182a	169b	167b	166b	2.61	0.001
Total protein (mg/dl)	5.98b	6.06b	6.53ab	7.02a	0.244	0.043
Albumin (mg/dl)	2.68	2.6	2.66	2.7	0.151	0.991
Globulin (mg/dl)	3.3	3.46	3.87	4.32	0.318	0.221
A/G ratio	0.827	0.771	0.717	0.654	0.094	0.759
Renal and Liver functional						
Urea (mg/dl)	21.4	19.1	21.8	20.2	1.43	0.677
Creatinine (mg/dl)	0.832	0.856	0.906	0.818	0.036	0.466
Urea/Creatinine	25.7	22.3	24	24.9	1.49	0.492
ALT (U/L)	59	58.4	59.9	58.6	0.942	0.389
AST (U/L)	19.3	19.7	18.1	18.5	0.705	0.527
Plasma Lipid Profile						
Total lipids (mg/dl)	389	380	366	370	14.87	0.815
Triglycerides (mg/dl)	173a	160ab	156b	151b	4.43	0.024
Cholesterol (mg/dl)	171a	155b	154b	155b	3.86	0.025
HDL (mg/dl)	39.1b	49.6a	47.9a	49.2a	1.41	0.001
LDL (mg/dl)	97.5a	73.2b	74.5b	75.5b	3.81	0.001
Plasma antioxidants enzymes						
TAOC (mg/dl)	419b	436ab	448a	459a	7.72	0.018
GPX (mg/dl)	0.344b	0.393a	0.394a	0.415a	0.01	0.014
GSH (mg/dl)	757c	778bc	800ab	816a	7.75	0.004
SOD (mg/dl)	192b	204a	201ab	209a	3.38	0.025

[a,b,c] Means in the same column followed by different letters are significantly different at ($P \leq 0.05$); CrCl3= chromium chloride; Cr-Yeast= chromium yeast; Cr-Pic= chromium picolinate; Sig.= significantly SEM= Standard error of mean; AST=aspartate amino transferase; ALT=alanine amino transferase; HDL=high-density lipoprotein; LDL=low-density lipoprotein; TAOC=total antioxidant capacity; GPX =glutathione peroxidase; GSH= glutathione; SOD=superoxide dismutase

Table (7): Effect of different sources of chromium on hematological criteria at 49 day of age of heat stressed Japanese quails.

Treatment	Control	CrCl3	Cr-Yeast	Cr-Pic.	SEM	Sig.
Hematological criteria						
RBC's (10^6/cmm^3)	1.47	1.66	1.5	1.59	0.07	0.292
Hemoglobin (g/100ml)	14.3	14.8	14.2	14.1	0.76	0.945
PCV, %	33.2	37.8	34.7	35.8	1.15	0.066
MCH (Ug)	98.2	89.2	95.3	91	6.49	0.847
MCHC, %	43.2	39.2	40.9	40.1	2.58	0.835
MCV	227	227	232	227	8.43	0.991
White blood cells and differential leukocytes counts						
WBC's (10^3/cmm^3)	24.9	27.9	26.2	27.5	0.92	0.209
Lymphocytes (%)	29.9b	34.2a	35.2a	36.2a	0.97	0.002
Monocytes (%)	16.3	16.1	16.0	16.3	0.53	0.943
Basophils, (%)	0.934	1.043	0.934	0.81	0.17	0.576
Eosinophils(%)	12.6	12.7	12.9	13.1	0.54	0.968
Heterophile (%)	40.2	35.9	34.9	33.6	1.69	0.104
H/L ratio	1.354a	1.055b	0.992b	0.947b	0.07	0.008

^{a,b,c} Means in the same column followed by different letters are significantly different at ($p \leq 0.05$);CrCl3= chromium chloride; Cr-Yeast= chromium yeast; Cr-Pic=chromium picolinate; Sig.= significantly; SEM= Standard error of mean; RBC's = red blood cell; PCV= packed cell volume; MCH= mean corpuscular hemoglobin; MCV= Mean cell volume; MCHC= Mean Corpuscular Hemoglobin Concentration; WBC's= white blood cell.

REFERENCES

Abdelhady, D.H; Moshira A. El-Abasy, M.A.; Atta, M.S.; Ghazy, E.W.; Abuzed, T.K and El-Moslemany, A.M. 2017. Synergistic Ameliorative Effects of Organic Chromium and Selenium Against Heat Stress in Japanese Quails: Performance, Immunological, Hematological, Biochemical And Antioxidant Studies. AJVS, 55 (2): 113-123.

Aggoor, F.A.; Attia, Y.A. and Qota, E.M. 2000. A study on thee nergetic efficiency of different fat sources and levels in broiler chick vegetable diets. J. Agric.Sci. Mans.Univ.,25:801-820.

Al-Bandr, L.K.; Ibrahim, D.K. and Al-Mashhadani, E.H. 2010. Effect of supplementing different sources of chromium to diet on some physiological traits of broiler chickens. Egypt. Poult. Sci. Vol (30) (II): 397-413.

Al-Mashhadani E.H.I.; Ibrahim D.K. and Al-Bandr L.K. 2010. Effect of Supplementing Different Levels of Chromium Yeast to Diet on Broiler Chickens Performance. Int. J. Poult. Sci., 9 (4): 376-381.

Anderson, R.A. 1994. Stress effects on chromium nutrition of humans and farm animals. Pages 267–274 in

Biotechnology in Feed Industry. T. P. Lyons and K. A. Jacques, ed. Univ. Press, Nothingam, England.

AOAC, 2004. Official methods of analysis. 18th ed., Association of Official Analytical Chemists, Washington, DC, USA.

Aslanian, A.; Noori, K.; Dizaji, A.A.; Shahryar, A.; Rouhnavaz, S. and Maheri, N. 2011. Evaluate the effect of chromium methionine on performance and serum metabolite in growing-finishing male broiler. J. Basic Appl. Sci. Res., 1(11): 2442-2448.

Attia, Y.A.; El-Tahawy, W.S.; Abd Al-Hamid, A.E.; Hassan, S.S.; Nizza, A. and El-Kelawy, M.I. 2012. Effect of phytate with or without multienzyme supplementation on performance and nutrient digestibility of young broiler chicks fed mash or crumble diets. Ital J Anim Sci., 11:303-308.

Attia, Y.A.; Hassan, R.A.; Tag El-Din, A.E. and Abou-Shehema, B.M. 2011. Effect of ascorbic acid or increasing metabolizable energy level with or without supplementation of some essential amino acids on productive and physiological traits of slow-growing chicks exposed to chronic heat stress. J Anim Phys Anim Nutr 95:744–755.

Awad, A.Sh. 2012. Effect of different sources and levels of chromium on productive performance, meat quality and plasma biochemical constituents of broiler under heat stress. MSc. Thesis, Fac. Agri., Damanhour Uni., Egypt.

Clodfelder, B.J.; Chang, C. and Vincent, J.B.; 2004. Absorption of the biomimetic chromium cation triaqua-μ3-oxo-μ- hexapropiona to tri chromium(III) in rats. Biol. Trace Elem. Res. 98:159–169.

Debski,B.;Zalewski, W.;Gralak,M.A. andKo- sla.T.2004. Chromium yeast supplementation of broilers in an industrial farming system. J. Trace Elem. Med. Biol.18:47–51.

Duncan, D.B.1955. Multiple range and multiple "F" test. Bio- metrics.11,1-42.

Ebrahimzadeh, S.K.; Farhoomand, P.; Noori, K. 2012. Immune Response of Broiler Chickens Fed Diets Supplemented with Different Level of Chromium Methionine under Heat Stress Conditions. Asian-Aust. J. Anim. Sci 25: 256-260.

Ebrahimzadeh, S.; Farhoomand, P. and Noori, K. 2013. Effects of chromium methionine supplementation on performance, carcass traits, and the Ca and P metabolism of broiler chickens under heat-stress conditions. J. Appl. Poult. Res. 22 :382–387

El – Hommosany, Y.M. 2008. study of the physiological changes in blood chemistry, Humoral immune response and performance of quail chicks feed supplemental chromium. Int. J. of Poultry. Sci. 7 (1): 40-44.

ELnaggar, Asmaa Sh.; Abdel-Latif, Mervat A.; El-Kelawy, M.I. and Abd EL-Hamid, H.S. 2016. Productive, physiological and immunological effect of rosemary leaves meal (Rosemarinus officinalis) supplementing to broiler diet. Egypt. Poult. Sci., 36 (3): 859-873.

Ensminger, M.E.; Oldfield, J.E. and Heinemann, W. 1999. Feeds and Nutrition. The Ensminger Publ. Co., Clovis, CA.

Faisal, B.A.; Abdel–Fattah, S.A.;. El-Hommosany, Y.M.; Nermin, M.A.; Maie, F.M.A.; 2008. Immunocompetence, hepatic heat shock protein 70 and physiological responses to feed restriction and heat stress in two body weight lines of

Japanese quail. International Journal of Poultry Science 7 (2), 174-183.

Giri, J. Usha, K.A. and Sunita, T. 1990. Evaluation of the selenium and chromium content of plant foods. Plant Foods Hum Nutr 40: 49-59.

Habibian, M.; Ghazi, S. and Moeini, M.M. 2016. Effects of dietary selenium and vitamin E on growth performance, meat yield and selenium content and lipid oxidation of breast meat of broilers reared under heat stress. Biol. Trace. Elem. Res., 169:142-152.

Haq, Z.; Jain, R.; Mahajan, A.; Ganai, I.M.; Khan, N. and Mudasir, S. 2018. Dietary supplementation of chromium yeast alone and in combination with antioxidants for designing broiler meat. J. Entomol. Zool. Stud. 6(1): 766-770.

Hurwitz, S.; Weiselberg, M.; Eisner, U.; Bartov, I.; Riesenfeld, G.; Sharvit, M.; Niv, A. and Bornstein, S. 1980. The energy requirements and performance of growing chickens and turkeys, as affected by environmental temperature. Poult. Sci. 59:2290–2299.

Jaap, R.G. 1964. Poultry Science in the common science market. World Poultry Sci. J. 20, 166-174.

Jahanian, R. and Rasouli, E. 2015. Dietary chromium methionine supplementation could alleviate immunosuppressive effects of heat stress in broiler chicks. J. Anim. Sci. 93; 3355–3363.

Javed, M.T.; Ahmad, F.; Rafique, N.Z. and Bashir, M. 2003. Effects of higher levels of chromium and copper on some haematological parameters and serum proteins in broilers. Pakistan Vet. J. 23 (1): 31 – 35.

Jeejebhoy, K.N.; Chu, R.C.; Marliss, E.B.; Greenberg, G.R. and Bruce – Robertson. A.1977. chromium deficiency, glucose intolerance, and neuropathy reversed by chromium supplementation, in a patient receiving long-term total parenteral nutrition. Am. J. Clin. Nutr. 30: 531 – 538.

Khan, R.U.; Rahman, Z.U.; Nikousefat, Z.; Javadi, M.; Tufarelli, V.; Dario, C.; Selvaggi, M. and Laudadio, V. 2012. Immunomodulating effects of vitamin E in broilers. World Poult Sci J 68:31–40

Khan, R.U.; Naz, Sh.; Dhama, K.; Saminathan, M.; Tiwari, R.; Jeon, G.J.; Laudadio, V. and Tufarelli, V. 2014. Modes of Action and Beneficial Applications of Chromium in Poultry Nutrition, Production and Health – A Review. Int. J. Pharmacol 10: 357-367.

Kroliczewska,B.;Zawaduzki,W.; Dobrzanski,Z. and Kaczmarek-Oliwa, A. 2004. Change in selected serum pa- rameters of broiler chicken fed supplemental chromium. J. Anim. Physiol. Nutr. 88:393–400.

Li, R.; Zhou, Y.; Li, Y.; Guo, L; Zhang, Y. and Qi, Z. 2018. Effects of chromium picolinate supplementation on growth performance, small intestine morphology and antioxidant status in ducks under heat stress conditions. Int. J. Morphol., 36(1):226-234.

Liu, L.; Fu, C.; Yan, M.; Xie, H.; Li, S.; Yu, Q. and He, J. 2016. Resveratrol modulates intestinal morphology and jejunal mucosa HSP70/90, NF-êB and EGF expression in black-boned chicken exposure to circular heat stress. Food. Funct., 7(3):1329-38. DOI: 10.1039/c5fo01338k

Lyons,T.P.1994. Biotechnology inthefeedindustry: 1994andbe- yond. Pages 1–50inProceedings ofAlltech's 10th Annual Sym- posium,Biotechnology intheFeedIndustry. P.Lyons,andK.A. Jacques, ed.NottinghamUniv.Press, Nottingham,UK.

Moeini, M.M.; Bahrami, A.; Ghazi S. and Targhibi, M.R. 2011. The effect of different levels of organic and inorganic chromium supplementation on production performance, carcass traits and some blood parameters of broiler chicken under heat stress condition. Biol. Trace Element Res., 144: 715-724.

Mustafa, N.M. 2007. Effect of organic and inorganic selenium or chromium on productive performance and immunity of broilers, M. V. Sc. Thesis, Fac. Vet. Med; Cairo Uni.

Norain, T.M.; Ismail, I.B.; Abdoun, K.A. and Al-Haidary, A.A. 2013. Dietary Inclusion of Chromium to Improve Growth Performance and Immune-Competence of Broilers Under Heat Stress, ITAL. J. ANIM. SCI., 12:4, e92

NRC. 1994. Nutrient Requirements of Poultry, 9thRev. Ed. National Academy Press, Washington, DC.,USA.

Pechova, A. and Pavlata, L. 2007. Chromium as an essential nutrient: a review. Vet Med-Czech 52: 1-18.

Rao, S.V.; Raju, M.V.; Panda, A.K.; Poonam, N.S.; Murthy, O.K. and Sunder, G.S. 2012. Effect of dietary supplementation of organic chromium on performance, carcass traits, oxidative parameters, and immune responses in commercial broiler chickens. Biol. Trace Elem. Res., 147(1-3):135-41.

Sahin, K., Sahin, N. and Kucuk, O. 2002b. Effects of dietary chromium and ascorbic acid supplementation on digestion of nutrients, serum antioxidant status, and mineral concentrations in laying hens reared at low ambient temperature. Biol. Trace. Elem. Res. 87: 113 – 124.

Sahin, K.; Sahin, N. and Kucuk, O. 2003. Effects of chromium, and ascorbic acid supplementation on growth, carcass traits, serum metabolites, and antioxidant status of broiler chickens reared at a high ambient temperature. Nutr. Res. 23:225–238.

Sahin, K.; Sahin, N.; Onderci, M.; Gursu, F. and Cikim, G. 2002a. Optimal dietary concentration of chromium for alleviating the effect of heat stress on growth, carcass qualities and some serum metabolites of broiler chickens. Biol. Trace Elem. Res., 89: 53-64.

Sahin, N.; Akdemir, F.; Tuzcu, M.; Hayirli, A.; Smith, M.O. and Sahin, K. 2010. Effects of supplemental chromium sources and levels on performance, lipid peroxidation and proinflammatory markers in heat-stressed quails. Anim. Feed Sci. Technol., 159: 143-149.

Sands, J.S. and Smith, M.O. 1999. Broilers in heat stress conditions: Effects of dietary manganese proteinate or chromium picolinate supplementation. J. Appl. Poultry Res. 8:280–287.

SAS Institute, 2002. SAS/STAT User's guide statistics. SAS institute INC., Cary. NC, USA.

Suksombat, W. and Kanchanatawee, S. 2005. Effects of Various Sources and Levels of Chromium on Performance of Broilers. Asian-Aust. J. Anim. Sci. 18, 11 : 1628-1633.

Toghyani,M.; Shivazad, M.; Gheisari, A.A. andZarkesh. S.H. 2006. Performance, carcass traits and hematological parameters of heat-stressed broiler chicks in response to dietary levels of chromium picolinate. Int.J.Poult.Sci.5:65–69.

Toghyani, M.; Toghyani, M.; Shivazad, M.; Gheisari A. and Bahadoran, R. 2012. Chromium supplementation can alleviate the negative effects of heat stress on growth performance, carcass traits and meat lipid oxidation of broiler chicks without any adverse impacts on blood constituents. Biol. Trace Elem. Res., 146: 171-180.

Toghyani, M., Zarkesh, S.H.; Shivazad, M. and Gheisari, A.A. 2007. Immune responses of broiler chicks fed chromium picolinate in heat-stressed condition. J. Poult. Sci 44: 330-334.

Uyanik,F.;Atasever,A.; Ozdmar,S. andAydin.F. 2002. Effects of dietary chromium chloride supplementation on performance, some serum parameters, and immune re- sponse in broilers. Biol.Trace Elem. Res. 90:99–115.

Zeferino, C.P.; Komiyama, C.M.; Pelicia, V.C.; Fascina, V.B.; Aoyagi, M.M.; Coutinho L.L. and Moura, A.S.A.M.T. 2016. Carcass and meat quality traits of chickens fed diets concurrently supplemented with vitamins C and E under constant heat stress. Anim.,10: 163-171.

Zeweil, H.S. 1996. Enzyme supplements to diets of growing Japanese quails. Egypt. Poult. Sci. J., 16:535-557.

Zhang, Z.Y.; Jia, G.Q.; Zuo, J.J.; Zhang, Y.; Lei, J.; Ren, L. and Feng, D.Y. 2012a. Effects of constant and cyclic heat stress on muscle metabolism and meat quality of broiler breast fillet and thigh meat. Poult. Sci., 91: 2931-2937.

Zhao, J.P.; Lin, H.; Jiao, H.C. and Song, Z.G. 2009. Corticosterone suppresses insulin- and NO-stimulated muscle glucose uptake in broiler chickens (Gallus gallus domesticus). Comp. Biochem. Physiol. Part C. 149:448–454.

Japanese quails - chromium sources - growth performance - heat stress

الملخص العربي

تأثير مصادر مختلفة من الكروم على الأداء الإنتاجي للسمان الياباني تحت ظروف الإجهاد الحراري.

محمود ابراهيم الكيلاوى

قسم انتاج الدواجن كليه الزراعه جامعه الوادى الجديد

أجريت هذه التجربة لتقييم تأثير مصادر مختلفة من الكروم على أداء النمو والكفاءة الاقتصادية ومكونات الدم في السمان الياباني المجهد حراريا. تم توزيع عدد 280 طائر سمان ياباني عمر أسبوعين في أربع مجموعات (المجموعة 70 طائر) بكل مجموعة سبعة مكررات (10 طيور في كل منها). تم الاحتفاظ بالسمان تحت تأثير الإجهاد الحراري (درجة حرارة 34.1 درجة مئوية و 41.7٪ رطوبة نسبية) خلال النهار بين 14 و 49 يوم من العمر. تغذت المجموعة الأولى على العليقة الأساسية بدون أي إضافة (كنترول) ، بينما تغذت المجاميع التجريبية الثانية والثالثة والرابعة على العليقة الأساسية مضافا إليها 200 جزء في المليون / كجم من العليقة كروم غير عضوي (CrCl3) وكروم خميرة عضوي (Cr-Yeast) وكروم بيكولينات عضوي (Cr-Pic) ، على التوالي. تم تسجيل وزن الجسم واستهلاك العلف وحساب الزيادة في وزن الجسم ومعامل التحويل الغذائي ودليل الإنتاج والكفاءة الاقتصادية.

أوضحت النتائج أن إضافة الكروم أدت إلى تحسين الزيادة في وزن الجسم ومعامل التحويل الغذائي ونسبة الذبيحة والكفاءة الاقتصادية ودليل الإنتاج ومعامل هضم المركبات الغذائية وخصائص مضادة للأكسدة وإلى انخفاض نسبة الدهون في منطقة البطن .سجل السمان الياباني المغذى على عليقة تحتوي علىCr-Pic أفضل زيادة في وزن الجسم ومعامل التحويل الغذائي والكفاءة الاقتصادية ودليل الإنتاج ، يليها المغذاه على عليقة تحتوي على Cr-yeast ثم التي تحتوي على CrCl3 . خفضت إضافة الكروم بشكل كبير من مستوى الجلوكوز في البلازما والدهون الثلاثية والكولسترول الكلي والكولسترول منخفض الكثافة، بينما زاد مستوى T4والكولسترول عالي الكثافة (HDL) في بلازما دم السمان الياباني. ارتفع معنويا تركيز البروتينات الكلية نتيجة إدراج Cr-Pic أو Cr-Yeast في عليقة السمان الياباني. كما أدت المصادر المختلفة من الكروم لزيادة معنوية في الخلايا الليمفاوية وخفض نسبة Heterophile / Lymphocytesعن المجموعة الكنترول.

الاستنتاج: إضافة الكروم (سواء العضوي أو غير العضوي) إلى علائق السمان الياباني كان له تأثير مفيد على الأداء الإنتاجي ، والكفاءة الاقتصادية ودليل الإنتاج. ومع ذلك ، فإن السمان الياباني المغذى على علائق تحتوي على الكروم العضوي Cr-Pic أعطى أفضل أداء إنتاجي وكفاءة اقتصادية ودليل إنتاج تليها تلك المغذاه على عليقة تحتوي على Cr-yeast ثم التي تحتوي على CrCl3