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GROWTH PERFORMANCE, DIGESTIBILITY, CARCASS TRAITS AND SOME BLOOD CONSTITUENTS OF JAPANESE QUAILS AS AFFECTED BY SUPPLEMENT OF CHROMIUM IN GROWING RATIONS

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ABSTRACT:

The present study aimed to the effects of chromium (Cr) supplementation with different levels on growth performance, digestibility nutrients, carcass characteristics, some blood constituents and economic efficiency of the growing Japanese quail.

A total number of 450 one-day-old Japanese quail's chicks was used divided randomly into five experimental groups. Each group was distributed by 3 replicates pens containing (30 birds in each) until 6 weeks of age. The 1st group fed the basal experimental diet without supplementation (as control), while the other groups were fed on diets supplemented with 200, 400, 800, and1200 µg chromium (Cr)/kg ration as chromium picolinate (Cr pic.), respectively.

The results showed that the addition of chromium in the diets of growing Japanese quail resulted in an improvement ($P<0.05$) in body weight, and weight gain of group which received 1200 µg Cr/kg diet as compared to control one at the first three and six weeks of age. Moreover, at the same level addition of chromium in quail diets significantly ($P\leq0.05$) improved the feed conversion, protein efficiency ratio and efficiency of energy utilization when compared with those fed unsupplemental diet, during the experimental periods (0-3 and 0-6 weeks of age). However, the addition up to 800 µg /kg of Cr in the diets improved significantly ($P<0.05$) the digestibility of organic matter and nitrogen free extract, while crude protein, crude fibre and ether extract digestibility were insignificantly affected. The results, also demonstrated that the abdominal fat decreased as the levels of chromium increased while, carcass percentage was increased. Serum total cholesterol, glucose were significantly ($P<0.05$) decreased by Cr supplementation. On the other hand total lipid, total tri-glycerides and high density lipoprotein cholesterol (HDL %) showed the inverse trend.

The highest value of economic efficiency (EE) was obtained for quails fed on diets supplemented by Cr up to 800 µg /kg.

The results from this study demonstrate that a supplementation up to 800 µg /kg of Cr in the ration improved the growth performance, digestibility, carcass characteristics and blood constituents of the growing Japanese quail.

Key words: Japanese quails, growth, digestibility, chromium, blood constituents

INTRODUCTION

Animal nutrition subcommittees have not yet made final recommendations on minimum dietary Cr requirements for any farm animals or poultry species. Chromium is not currently considered an essential trace element for poultry, although this micronutrient may play a nutritional and physiological role. Moreover, the NRC has recommended 300µg Cr/kg diet for laboratory animals (NRC, 1994). Therefore, many researchers have suggested that Cr should become a key ingredient in nutritional supplements, official bodies such as the National Research Council (NRC) in USA.

Most poultry diets are basically composed of plant original ingredients, which have usually low content of chromium (Giri et al., 1990). Chromium (Cr), is a trace mineral that is widely distributed throughout the body. It is involved in lipid, carbohydrate, protein and nucleic acid metabolism (Nielsen, 1994). Chromium is most associated with carbohydrate metabolism, being necessary for optimal insulin function and glucose uptake by insulin-sensitive cells (Anderson, 1985). Chromium deficiency leads to glucose intolerance and Chromium supplementation of the diets of elderly humans has resulted in improved glucose tolerance (Mertz, 1993).

Generally, chromium is accepted to be the active component in glucose tolerance factor (GTF), which increases the sensitivity of tissue receptors to insulin, resulting in increased glucose uptake by cells (Mertz, 1967and 1969)

The use of chromium has been suggested to have positive impacts on farm profitability, and many animal health benefits, including increased longevity; enhanced reproduction, improved immune response and lean broilers, growth performance, carcass, blood parameters and carcass quality (Motozono *et al.*,1998). Dietary chromium supplementation has been shown to positively affect growth rate and feed efficiency as obtained by Cupo and Donaldson (1987) on chickens; Lien *et al*., (1999) on broilers and Sahin *et al.*, (2001) on laying hens.

Lien *et al.* (1999) reported that 1600 and 3200 µg/Cr Pic supplementation in a broiler diets increased feed intake and improved live weight gain. Kim *et al.* (1996) also observed that 1600 µg/Cr picolinate supplementation increased the weight gain and feed intake without affecting feed conversion in broilers. It has been shown that Cr supplementation cause significant changes in the chemical composition of animal carcasses (Lukaski, 1999). With regarded to, increasing carcass yield, abdominal fat content and decreasing (%) in broilers has been reported for diets supplemented with Cr picolinate (Sahin *et al.*, 2002) or Cr yeast (Hossain *et al.*,1998 and Debski *et al.*,2004)

Therefore, the aim of this study was to throw more light in the effect of chromium supplementation on growth performance, digestibility, carcass characteristics, blood constituents and economic efficiency of the growing Japanese quail chicks.

MATERIALS AND METHODS

This study was carried out at Inshas Poultry Breeding Research Station, Animal Production Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt, from 12^{th} February to 25^{th} March 2005.

A total number of 450 one-day-old Japanese quail's chicks was distributed randomly into five experimental groups. Each group was represented by 3 replicates pens containing 30 birds for each until 6 weeks of age. The birds were fed the corn-soy diet formulated to full fill the quail nutrient requirements according to NRC (1994) .Corn-soy diet was containing 23.73% CP and 2900 Kcal ME/kg diet. The ingredient composition and chemical analysis of the basal diet are presented in Table 1. The dietary treatment were unsupplemented diet as control diet, 200**,** 400, 800, and1200 µg chromium (Cr)/kg diet as chromium picolinate (Cr pic.) which (contain 12.27% Cr). All the experimental diets as well as fresh water were constantly offered *ad libitum* throughout the experimental period. All birds were kept in batteries under similar conditions along the experimental period.

Individual body weight was recorded at one day and then at three and six weeks of age. Feed consumption during these periods was recorded. Live body weight, weight gain, feed conversion ratio (g feed / g gain), protein efficiency ratio (g gain /g crude protein) and efficiency of energy utilization (ME consumed Kcal /g gain) were also calculated and recorded during the experimental periods.

Six birds from each treatment were used in digestibility trails to evaluate the nutrients digestibility of the experimental diets. Birds were housed individually in metabolic cages and fed the tested diets. During the collection period (6 days) feed intake was measured and excreta output was collected daily, oven dried (70 C^0 for 24 hrs, weighed and ground). The representative samples were used for analysis. The chemical analysis of diets and excreta for DM, EE, CP, CF and ash were conducted according to A.O.A.C. (1990). For calculating CP digestibility, the fecal protein was determined according to Ekman *et al.* (1949) to obtain urinary organic matter; the figure of urinary nitrogen was computed by Galal (1968) as shown in Sturkie (1965)

At six weeks of age, six birds from each treatment were randomly chosen, weighed and then slaughtered. Blood samples were collected on the time of slaughtering from each bird. Blood was collected in tubes and used for the preparation of serum samples by centrifugation at 4000 rpm for 20 minutes and serum samples were stored at -20°C pending analysis to determination the total protein (Peters, 1968), albumin, (Doumas *et al.*, 1971), glucose (Keilin and Hartree, 1948), total lipids (Zollner and Kirsch, 1962) triglycerides (Fossati and Prencipe 1982), and cholesterol (Waston, 1960) by using available commercial kits Bio-Merieux, France. Serum globulin was calculated by the difference between serum total protein and albumin, (Sturkie, 1976).

After complete bleeding and feather removal, carcass, liver, gizzard, heart and abdominal fat were weighed and recorded as percentage of body weight.

At the end of this work, the economical efficiency of the experimental diet was calculated from the input-output analysis based upon the differences in both

Table (1): Composition and calculated analysis of experimental corn-soy diet during periods.

Ingredients	%
Yellow corn	50.53
Soybean meal (44%)	44.00
Plant oil	2.51
Bone meal	2.27
Vit &Min premix*	0.30
NaCl	0.25
DL-methionine	0.14
Total	**100**
Determined analysis **	
Dry matter (DM)	90.20
Organic matter (OM)	83.02
Crude protein (CP)	23.73
Ether extract	4.65
Crude fiber	4.25
N-Free extract	50.39
Ash	7.18
Calculated analysis**	
ME (Kcal/kg)	2900
Ca	0.81
P. Avail.	0.43
Lys	1.31
Meth	0.50
Cystine	0.38
Meth +Cys	0.88

*Vitamins and minerals premix at 0.3% of the diet supplies the following per kg of the diet: Vit. A:12000IU; Vit D 2000 IU; Vit E: 40 mg; Vit K3 4 mg; Vit B1 3 mg; Vit B2 6 mg; Vit B6 4 mg; Vit B12 .03 mg; Niacin 30 mg; Ca. Pantothenate 12 mg Folic acid 1.5 mg; Biotin .08 mg; Choline chloride 50% 700 mg; Mn 10 mg; Cu 10 mg; Fe 40 mg; Zn 70 mg; Se 0.2 mg; I 1.5 mg; Co 0.25 mg; $CaCo_3$ AD 3000 mg . **According to NRC (1994).

growth rate and feeding cost as described by Bayoumi (1980).

Data were statistically analyzed using SAS® software computer program (SAS, 1998) and the significant differences between means were detected according to Duncan (1955).

RESULTS AND DISCUSSION

1. Growth performance:

1.1. Body weight and weight gain

The impacts of supplementing different levels of chromium on body weight and weight gain for Japanese quail chicks are shown in Table 2. These results indicated that supplementing diets with chromium was significant increases (P < 0.05

and 0.01) in body weight and weight gain at different ages studies of quails which received 1200 µg Cr/kg diet as compared to control group at three and six weeks of age, receptively. Similar to those results by Mooney and Cromwell, (1997) and Sahin *et al*. (2002) who reported that increase supplemental Cr (200,400,800 or 1200 µg Cr picolinte) results in an increase body weight in broilers. Also, Ibrahim (2004) indicated that supplementing Cr at levels of 10,20,30,40 and 50mg Cr/kg diet increased significantly final body weight. These results indicated that no significant differences ($P<0.05$) in body weight and weight gain were observed groups received in 200**,** 400, and 800, µg Cr/kg diet compared to control group. These results supported the findings of Uyank *et al* (2005) who found that 20, 40, 60, 80, or 100 mg/kg Cr supplementation to quail diet had no effect on body weight. The observed increase in growth performance may be due to supplementing Cr confirmed the beneficial effects on physiological functions required for performance (Lukaski, 1996; Sands and Smith**,** 1999 and El- Kaiaty *et al.,* 2005) on broiler chicks. Also, Cr is involved in protein metabolism (NRC, 1997) and is thought to have a role in nucleic acid metabolism because it increased amino acid incorporation into liver protein in vitro as observed by Weser and Koolman (1969). The present results suggested that Cr supplementation up to level of 400 µg /kg diet tended to be improving body weight, and weight gain however, 1200 µg Cr/kg diet gave the highest body weight and weight gain could be recommended as a suitable supplemental level for Japanese quail chick's diets. These results are in agreement with those of Motozono *et al*. (1998) and Uyank *et al.* (2005) who reported that supplementation of the diet quail had no effect on body weight gain.

1.2. Feed intake and feed conversion ratio:

Table 2. indicated that the feed intake of the quail group fed diet supplemented with chromium at different levels was significantly ($P\leq0.05$) lower during the period from 0-3 and 0-6 weeks of age as compared with control group. However, the differences among them at 0-6 weeks were not significant effect of 1200 µg Cr/kg when as compared with the control group. These results obtained are in agreement with those of Sahin *et al*. (2002) who reported that increase supplemental Cr (200,400,800 or 1200 µg Cr) results in an increase feed intake and feed efficiency in broilers reared under heat stress. While, Uyanik *et al.* (2002) demonstrated that 20 mg/kg supplemental Cr in broiler diets resulted in 18.57% reduction in feed consumption. Obtained results showed that adding chromium in quail diets improved feed conversion ratio, this effect was significant ($P\leq0.05$) at early ages (0-3 and 0-6 weeks of age) but the improvement start to occur non-significant at late ages. Reports indicated that Cr supplementation to broiler diets significantly improved feed conversion (Sahin *et al.,* 2002 ; Uyanik *et al.,* 2002; Ibrahim, 2004; and El-Kaiaty *et al.,* 2005) who reported that supplemental Cr in broiler diets (1.5 and 2.5 mg Cr /kg) improved the feed conversion from 1-6 weeks of age.

1.3. Protein efficiency ratio and efficiency of energy utilization:

The results obtained in Table 2 indicated that, the addition of chromium in quail diets at different levels significantly ($P \leq 0.05$) improved the protein efficiency ratio and efficiency of energy utilization compared with those fed unsupplemented diet at 0-3 and 0-6 weeks of age. On the other hand during 3-6 weeks of age the treatments were insignificantly improved than the control ones. These results may be due to the most important function of Cr is probably its role in the Carbohydrates and Lipids metabolism (*Guerra et al.,* 2002), protein and Nucleic acids (Anderson and Kozlovsky, 1985) in many animals species.

2. Digestibility coefficients:

The effects of dietary supplementation on the digestibility coefficients of nutrients are summarized in Table 3. Results indicated that using the optimum level of chromium at 1200 μg Cr improved significantly ($P<0.05$) the digestibility value of organic matter, nitrogen free extract while the digestibility coefficients of the other nutrients were insignificantly affected. These resulted are in agreement with those of Sahin *et al.* (2001) who reported that digestibility of dry matter, organic matter, ether extract, crude protein, crude fibre and nitrogen free extract increased linearly ($P < 0.01$) and quadratically ($P < 0.01$) by supplemental dietary Cr picolinate in laying hens under cold conditions ($P < 0.01$). Also, they added that supplemental dietary Cr picolinate increased yield and nutrient digestibility in laying hens at low temperature.

3. Serum blood constituents

Supplementary Cr effects on serum total protein, albumin, globulin, total lipids, total cholesterol, high density lipoprotein (HDLC) and low density lipoprotein cholesterol (LDLC) values, glucose and tri- glycerdes are presented in Table 4.

Results of serum chemistry profile indicated that Cr supplementation had no significant effect on serum total protein, albumin and globulin in quail chicks at six of age. These results are in agreement with Mohamed and Afifi (2001) who reported that serum total protein and albumin did not affect by Cr concentration. El-Kaiaty *et a*l (2005) reported that supplemental Cr in broiler diets (1.5 and 2.5 mg Cr /kg) did not effect on total protein, albumin and globulin at different ages.

With regard to the value of total lipids and total tri-glycerides, were significantly ($P<0.05$ and $P<0.01$), respectively increased by increasing inclusion of chromium in the diets. These results agree with Ibrahim (2004) who observed that total lipids and total tri-glycerides in groups received the Cr supplemented diet (20, 30, 40, or 50 mg Cr/kg) improved by increasing level of Cr as compared to control group. Kim *et al.* (1995) found that serum tri-glycerides were affected by Cr supplementation. However, cholesterol, LDLC value and glucose significantly ($P< 0.01$) decreased as chromium levels increased in the experimental diets (Table 5) .While, HDLC value significantly ($P< 0.05$) increased by chromium levels increased in the experimental diets. These results attributed to those Lin *et al*., (1999) who showed that the supplementation of organic Cr could effectively decrease serum total cholesterol in laying hens and increase serum HDLC value as compared with control group. Lien *et al*., (1999) reported that dietary supplementation with Cr at levels of

Table (3): Digestibility coefficients (%) of Japanese quail at six weeks of age as affected by supplemented diets with different levels of chromium picolinate.

Digestibility coefficients	Chromium picolinate (µg Cr/kg ration)					Sig.
	0	200	400	800	1200	
Crude protein	84.760 ± 0.680	84.890 ± 0.723	84.900 ± 0.773	85.005 ± 0.904	85.220 ± 0.890	NS
Ether extract	82.897 ± 0.741	83.475 ± 0.977	83.219 ± 0.766	83.108 ± 0.825	83.077 ± 0.792	NS
Crude fiber	23.593 ± 0.601	23.832 ± 0.634	23.298 ± 0.685	24.159 ± 0.559	24.616 ± 0.632	NS
Organic matter	76.555 ± 0.670 [c]	77.297 ± 0.533 [bc]	77.773 ± 0.412 [ab c]	78.305 ± 0.434 [ab]	78.967 ± 0.430 [a]	*
Nitrogen free extract	82.976 ± 0.422 [c]	83.347 ± 0.463 [c]	83.908 ± 0.358 [b c]	84.579 ± 0.327 [ab]	85.399 ± 0.395 [a]	*

[a, b, c] Means in the same row with different superscripts are significantly (P<0.05).
NS: Not significant, * P <0.05, **P<0.01. Sig. : Significance

1600 and 3200 µg /kg significantly (P< 0.05) decreased serum glucose, cholesterol, LDLC value , while the same level significantly (P< 0.05) increased serum HDLC in broiler. Sahin *et al.*, (2002), Uyanik *et al.* (2002) and Ibrahium (2004) who reported that increased supplemental Cr in broiler diet decrease cholesterol and glucose concentration. 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.

4. Carcass characteristics:

Data presented in Table 5 showed no significant differences between the treated groups received Cr supplemented diet and control group of both heart, liver, gizzard, giblets and dressing percentages. While, carcass percentages were significantly increased (P<0.05) in groups received 800, and 1200 µg chromium as compared with the control group. Moreover, Cr supplementation to quail diets significantly (P<0.05) decreased abdominal fat percentages. However, Cr supplementation significantly (P<0.05) decreased abdominal fat percentages (Choct, 1999, Sahin *et a*l., 2002 and Ibrahim, 2004). Moreover, Uyank *et al.* (2005) reported that chromium supplementation in quail diets significantly decreased (P<0.05) abdominal fat percentages compared with the control group. Toghyani *et al*. (2006) indicated that Cr supplementation (500, 1000 or 1500 ppb) increased carcass yield and decreased abdominal fat.

5. Economic efficiency (EE)

The economic evaluation results of this study are summarized in Table 6. Addition of Cr in the diets at levels of 200, 400, 800, and 1200 µg /kg diet significantly (P<0.05) increased EE (%) compared to control one. These improvements in EE were 5.69, 11.52, 11.66 and 11.95 % than the control value,

Table (6): Input-output analysis and Economic efficiency of Japanese quail as affected by different levels of supplemented with different levels chromium picolinate from 0-6 weeks of age.

Items	Chromium picolinate (µg Cr/kg ration)					Sign.
	0	200	400	800	1200	
Body weight gain (kg)	0.188± 0.003^{b}	0.188 ± 0.002^{b}	0.191± 0.001^{b}	0.191± 0.001^{b}	0.198 ± 0.002^{a}	*
Price/ kg body weight	15	15	15	15	15	NS
Total revenue/ chick (LE)	2.820± 0.038^{b}	2.820 ± 0.027^{b}	2.865± 0.009^{b}	2.865± 0.018^{b}	2.970 ± 0.027^{a}	*
Total feed intake (kg)	0.700± 0.002^{a}	0.675 ± 0.002^{b}	0.666 ± 0.003^{b}	0.663 ±0.004^{b}	0.695 ± 0.009^{a}	**
Price/kg feed (LE)	1.652	1.656	1.660	1.667	1.672	NS
Total feed cost/ chick (LE)	1.156± 0.003^{a}	1.118 ± 0.003^{b}	1.106 ±0.004^{b}	1.105 ± 0.007^{b}	1.162± 0.014^{a}	*
Fixed cost/ chick (LE)	0.50	0.50	0.50	0.50	0.50	NS
Total cost chick (LE)	1.656± 0.003^{a}	1.618 ± 0.003^{b}	1.606 ± 0.004^{b}	1.605 ±0.007^{b}	1.662± 0.014^{a}	*
Net Revenue (LE)	1.164± 0.038^{c}	1.202 ± 0.024^{bc}	1.259 ±0.005^{ab}	1.260 ±0.018^{ab}	1.308± 0.024^{a}	*
Economic efficiency	0.703± 0.023^{c}	0.743± 0.014^{b}	0.784± 0.001^{a}	0.785± 0.013^{a}	0.787± 0.017^{a}	*
Relative economic efficiency	100.00	105.690	111.522	111.664	111.949	

$^{a, b, c}$ Means in the same row with different superscripts are significantly (P<0.05).
NS: Not significant, * P <0.05, **P<0.01. Sign.: Significance

respectively. These results are in agreement with Ibrahim (2004) 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.

Conclusion, the results of the current study suggest that supplementation of chromium in quail diets up to 800 µg Cr/kg diet caused to improve growth performance and economic efficiency values. There are other positive effects, including reduced abdominal fat and increased dressing %. Chromium may be one of the most important trace minerals in broiler feed formulation in the new millennium.

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الأداء الإنتاجي ومعاملات الهضم وصفات الذبيحة وبعض مكونات الدم للسمان الياباني وتأثره بإضافة الكرميوم في علائق النمو

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أجريت هذه الدراسة لمعرفة تأثير إضافة المستويات المختلفة من الكرميوم (بيكلونات الكرميوم) علي أداء النمو والهضم وبعض صفات الذبيحة ومكونات الدم للسمان الياباني النامي. استخدم عدد ٤٥٠ كتكوت سمان عمر يوم وقسمت عشوائيا إلى ٥ مجاميع تجريبية كل مجموعة بها ٣ مكررات بكل مكررة ٣٠ طائر واستمرت التجربة لمدة ٦ أسابيع. كانت المجموعة الأولي منها مجموعة تجريبية (كنترول) وباقي المجاميع غذيت علي العليقه التجريبية مضاف إليها أحد مستويات الكرميوم التالية ٢٠٠، ٤٠٠، ٨٠٠، ١٢٠٠ ميكروجرام /كجم عليقه علي التوالي. وكانت أهم نتائج التجربة ما يلي: أدي إضافة الكرميوم لعلائق السمان أي زيادة معنوي (عند مستوي ٠.٠٠١، ٠.٠٠٥) في وزن الجسم ومعدل النمو علي الترتيب للمجموعة المغذاة علي ١٢٠٠ ميكروجرام/ كجم مقارنة بالمجموعة التجريبية وذلك عند ٣،٦ أسابيع من العمر. وأدي إضافة المستويات المختلفة من الكرميوم إلى تحسن معنويا (عند مستوى ٠.٠١) للكفاءة التحويلية للغذاء والبروتين والطاقة الممثلة مقارنة بعليقه المجموعة التجريبية وذلك عند (٠–٣ ، ٠–٦) أسابيع من العمر. كذلك أوضحت النتائج أن استخدام المستويات العالية من الكرميوم أدي إلي تحسن معنويا (عند مستوى ٠.٠٠٥) لهضم المستخلص الخالي من الأزوت والمادة العضوية بينما لم يتأثر معنويا هضم البروتين الخام والألياف والدهن. وكذلك أوضحت النتائج نقصا معنويا لدهن البطن (عند مستوى ٠.٠٠٥) وزيادة معنوية للنسبة المئوية للذبيحة (عند مستوى ٠.٠١) مع زيادة مستويات الكرميوم في العليقة. كما بينت النتائج أن سيرم البروتين الكلي والألبومين والجلوبيولين لم يتأثر معنويا بأي من مستويات الكرميوم. بينما وجد نقص معنويا (عند مستوى ٠.٠١) للكلسترول الكلي والجلوكوز والكلسترول منخفض الكثافة بزيادة مستويات الكرميوم وعلي العكس من ذلك كانت الزيادة معنويا (عند مستوى٠.٠٠٥ ، ٠.٠١) للدهون الكلية والجلسريدات الثلاثية والكلسترول عالي الكثافة بزيادة المستويات المختلفة من الكرميوم.

التوصية: أدي إضافة الكرميوم بمستويات أعلي من ٨٠٠ ميكروجرام /كجم عليقه إلي تحسين صفات معدل أداء النمو والكفاءة الاقتصادية للسمان في الفترة من عمر يوم حتى ٦ أسابيع.