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Effects of Dietary Chromium Supplementation on the Performance and Some Serum Parameters in Bovans-type Chicks

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Abstract: This study was conducted to investigate the effect of increasing dietary levels of inorganic chromium ($CrCl_3 \cdot 6H_2O$) on the performance and some serum parameters of chicks. One hundred 1-day-old Bovans-type chicks were randomly distributed to four groups. The control group received no supplemental chromium. 0.2, 0.3 and 0.4 mg chromium (Cr) kg^{-1} diet from chromium chloride were added to other three groups. Each experimental group consisted of five replicates each of five birds and the supplementation was continued for 35 days. Blood samples were collected for the determination of serum concentration of proteins, albumin, glucose, total cholesterol, High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) cholesterol, triglycerides and the activities of spartate aminotransferase (AST) and Alkaline Phosphatase (ALP). Chromium by the doses used had no effect on weight gain. Supplementation with Cr decreased the serum total cholesterol, LDL cholesterol ($p<0.05$), triglycerides ($p<0.05$) and glucose ($p<0.05$) concentrations whereas serum HDL and cholesterol were increased. Serum total protein concentration, AST and ALP activities slightly but not significantly increased in all Cr. treated groups.

Key words: Broilers, chromium, performance, serum, parameters

INTRODUCTION

Chromium has been reported to be an abundant element in the earth's crust and it is an essential trace element for humans and animals. Studies have confirmed that chromium plays a critical role in carbohydrate and lipid metabolism both in mammals and birds. The beneficial effect of chromium in human and animal health was documented for its role as an integral component of the Glucose Tolerance Factor (GTF) (Schwartz and Mertz, 1959).

Chromium trivalent (Cr^{3+}) and hexavalent (Cr^{+6}) forms are of biologic importance. The hexavalent chromium crosses the cell membrane and becomes reduced to trivalent chromium, which is then involved in various cellular reactions (Klaassen *et al*., 1986).

Chromium supplementation in diet has been related to increased protein deposition (Seerley, 1993; Ward *et al*., 1995), with decrease in muscle fat (Ward *et al*., 1995). It also affects body mass and feed conversion ratio and helps to reduce the negative influence of environmental and nutritional stress in birds (Hossain *et al*., 1998).

Dietary Cr^{3+} improves insulin effectiveness by enhancing its binding to receptors and the sensitiveness of the target cells. De bski *et al*. (2001) noticed that supplemented with an organic source of Cr^{3+} had lower blood glucose concentration in broilers.

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In the case of chromium deficiency, the receptor cannot bind insulin, resulting in a rise of glucose concentration which stimulates a release of more insulin to balance the blood glucose level.

Chromium was shown to be a protective factor against heart disease, achieving a regression of cholesterol induced arteriosclerosis in rabbits (Abraham *et al*., 1991). The dietary requirement of livestock for chromium has not been defined yet. However, it is well known that strenuous exercise, transportation and other stress conditions may increase the requirement for chromium due to the increase of its excretion (mainly in urine).

There is considerable information available on the use of chromium in lower levels, but not at higher levels that affect growth. The use at studied dose levels was planned to discover any toxicity effects on broiler performance and serum parameters.

This study was conducted to investigate the effect of increasing dietary levels of inorganic chromium ($CrCl_3$•$6H_2O$) on the performance and some serum parameters of Bovans-type chicks.

MATERIALS AND METHODS

One day-old Bovans chicks were obtained from Coral Company Ltd., Khartoum and reared in pens within the premises of the College of Veterinary Medicine and Animal Production, Sudan University of Science and Technology, Khartoum North. The chicks were allowed free access to drinking water and feed. The pens were illuminated at night and early morning throughout the experimental period. The chicks were allotted at random to 4 groups. Each experimental group consisted of five replicates of five birds each and the supplementation was continued for 35 days. Group 1 was the control and fed normal basal diet (Table 1). Basal feed was commercial feed (National Feed) purchased from a local market with a composition as shown in Table 2. Experimental feed was also prepared by using the same feed mixed with various levels of compounds under study. 0.2, 0.3 and 0.4 mg chromium (Cr) kg^{-1} diet from chromium chloride were added to other three groups; group 2, 3 and 4, respectively.

Average body weight and body weight gain were recorded weekly for each group. The chicks in each group were slaughtered and blood samples were collected from each of the killed chicks for serum analysis.

Table 1: Percent composition of basal diet fed

Ingredients	(%)
Sorghum	58
Soya bean	4
Sesame cake	14
Ground nut cake	12
Wheat bran	5
Marble dust	1
Dicalcium phosphate	1
Superconcentrates	5
Total	100

Table 2: Chemical composition of basal feed

Chemical analysis	(g kg^{-1})
Protein	200.0
Fat	45.0
Carbohydrate	420.0
Fiber	50.0
Lysine	12.0
Ash	55.0
Calcium	10.0
Phosphorus	5.0
Sodium	1.5
Methionine + Cystine	7.0
Methionine	4.0

Note: ME = 11.995 MJ kg^{-1}

Sera were analyzed for the activities of aspartate aminotransferase (AST) and Alkaline Phosphatase (ALP) and for the concentration of proteins, albumin, glucose, total cholesterol, High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL), triglycerides and uric acid using commercial kits (Linear Chemicals, Barcelona, Spain).

The significance of differences between means was compared at each time point using Duncan's multiple range test after ANOVA for one-way classified data (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

During the experimental period no clinical signs were observed in broilers receiving chromium in all doses. This was similar to earlier studies made by Steel and Rosebrough (1981) and Ahmad *et al*. (2004) who reported no clinical signs in broilers fed chromium chloride through feed. It can be inferred that these studied levels of Cr were not hazardous to broilers, as no behavioural alterations were observed.

The effects of dietary Cr on body weight and body weight gain of the chicks are shown in Table 3. The chicks did not show weight gain on all groups during the course of the experiment. These results were in contrast to those of Steel and Rosebrough (1981) as they reported an increase in weight gain in turkey poults. Hossain *et al*. (1998) also observed an increase in carcass mass of broilers. Lein *et al*. (1999) had observed improvement in mass gain in broilers supplemented with chromium. These previous studies suggest that chromium cause an increase in live mass when given at lower levels, while when fed at much higher levels and in combination they had a non-significant effect.

In groups 2, 3 and 4, there were decreased in the concentration of serum total cholesterol, LDL cholesterol ($p<0.05$), triglycerides ($p<0.05$) and glucose ($p<0.05$) whereas serum HDL and cholesterol were increased. Serum total protein concentration and aspartate aminotransferase (AST) and Alkaline Phosphatase (ALP) activity slightly but not significantly increased in all Cr treated groups (Table 4).

These results was supported by the findings of Debski *et al*. (2004) who found significant decrease in serum total cholesterol concentration in birds fed diet with Cr-yeast and significant decrease in concentration of lipids in the dissected muscles of broilers supplemented with Cr-yeast. Chen *et al*. (2001) noticed that growing turkeys, at 18 weeks of age, receiving 1 mg kg^{-1} of chromium nicotinate, had reduced serum cholesterol and increased breast and thigh muscle weights. Also Kroliczewska *et al*. (2004) reported similar results that agreed with the present study.

Table 3: Average final body weight (g) and body weight gain (g) in chicks treated with chromium.

Group	Final body weight (kg)	Weight gains (g)
Group 1 (control)	1.520	1400
Group 2 (0.2 mg kg^{-1} Cr)	1510	1390
Group 3 (0.3 mg kg^{-1} Cr)	1500	1380
Group 4 (0.3 mg kg^{-1} Cr)	1495	13845

Table 4: Serobiochemical changes in Bovans chicks fed diet containing chromium

Group Parameters	Group 1 Control	Group 2 2 (0.2 mg kg^{-1} Cr)	Group 1 2 (0.3 mg kg^{-1} Cr)	Group 1 2 (042 mg kg^{-1} Cr)
Total protein (g dL^{-1})	3.71±1.02	4.22±0.11^{NS}	4.15±0.13^{NS}	4.10±1.02^{NS}
Albumin (g dL^{-1})	1.81±1.32	1.72±1.1^{NS}	1.70±0.9^{NS}	1.79±1.03^{NS}
Total cholesterol (mg dL^{-1})	126.30±11	114.00±10.1*	105.50±9.7*	94.50±8.5*
LDL+VLDL cholesterol				
Calculated (mg dL^{-1})	88.00±10	74.00±2.5*	59.60±2.1*	44.50±9.1*
HDL cholesterol (mg dL^{-1})	38.00±8.2	40.00±1.5*	45.90±2.1*	50.00±3.9*
Triglyceride (mg dL^{-1})	43.10±2.7	37.30±3.4*	31.90±13.1*	30.20±10.6*
Glucose (mg dL^{-1})	386.60±52.6	248.90±23*	196.60±63*	183.15±63*
Uric acid (mg dL^{-1})	4.50±0.35	4.20±0.21^{NS}	5.70±0.25*	6.50±0.35*
AST (iu)	25.50±1.3	32.50±1.35^{NS}	36.80±1.24^{NS}	39.10±1.51^{NS}
ALP	27.00±1.35	33.00±1.42^{NS}	32.00±1.54^{NS}	32.00±17^{NS}

Values are expressed as means±SE; NS = not significant; * $p<0.05$

These results was supported by the findings of De bski *et al.* (2004) who found the total cholesterol concentration in blood serum was significantly lower in birds fed diet with Cr-yeast. A significantly lower concentration of lipids in the dissected muscles of broilers was noticed in the group supplemented with Cr-yeast. Chen *et al.* (2001) noticed that growing turkeys, at 18 weeks of age, receiving 1 mg kg^{-1} of chromium nicotinate, had reduced serum cholesterol and increased breast and thigh muscle weights. Also Kroliczewska *et al.* (2004) reported similar results that agreed with the present study.

In broiler chickens, an optimal dietary concentration of chromium, given as Cr-picolinate, has been shown to alleviate detrimental effects of heat stress Sahin *et al.* (2002). Immobilised broilers revealed an increased concentration of serum cortisol and decreased concentrations of glucose and triacylglycerols, (Remage-Healey and Romero, 2001). Sahin *et al.*, 2001a and b) observed that the addition of Cr-picolinate caused a decrease of serum cortisol concentration. It has an impact on specific insulin binding in the liver of broilers (Dupont *et al.*, 1999). Burton *et al.* (1993) noticed an improvement of hormonal responses in lactating cows supplemented with chromium.

Uyanik *et al.* (2005) studied the effects of various levels of dietary chromium supplementation on performance, carcass traits, blood chemistry and tissue distribution of chromium (Cr^{3}+) in quails. Their results supported the present study; that chromium supplementation decreased carcass fat percentage, serum low-density lipoprotein (LDL) and glucose and had no effect on performance, but reduced serum glucose, LDL and fat percentage of carcass.

Chen *et al.*, 2001 results recorded that the dietary chromium supplementation did not significantly influence other serum constituents, including insulin, HDL, VLDL+LDL, HDL-C, VLDL-C+LDL-C, total protein, albumin and gamma-globulin at 18 and 22 weeks of age. The serum triacylglycerol (TG) and uric acid contents were significantly increased, while glycerol and alpha-globulin were significantly reduced by 3 mg kg^{-1} chromium supplementation. However, 1 mg kg^{-1} chromium supplementation significantly reduced serum cholesterol and glycerol at 18-weeks old. At 22 weeks of age, 1 mg kg^{-1} chromium supplementation significantly increased serum glucose and decreased the uric acid concentration whereas 3 mg kg^{-1} chromium supplementation significantly increased the creatinine concentration and decreased beta-globulin concentration.

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