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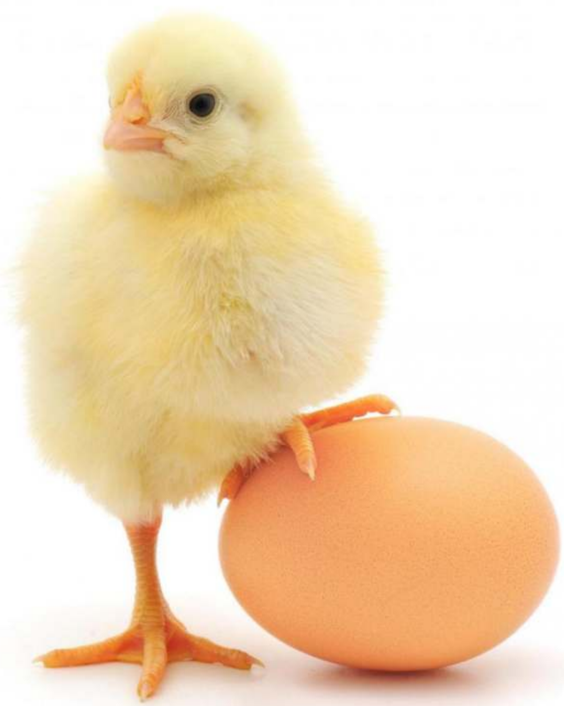

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Performance, Carcass Traits and Hematological Parameters of Heat-Stressed Broiler Chicks in Response to Dietary Levels of Chromium Picolinate

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Abstract: The objectives of this study were to investigate the effects of different levels of chromium picolinate on performance, carcass traits and hematological values of broilers in heat stress condition. Two hundreds and forty male broiler chicks (Ross 308) were allocated to four treatments in a completely randomized design. Treatments supplemented with 0 (control), 500, 1000 or 1500 ppb chromium in the form of chromium picolinate. Each treatment consisted of 4 pens with 15 birds in each pen. The experiment was conducted during summer and all birds were kept under temperature of 33±3°C. Feed intake and body weight were measured at 21 and 42 days of age. At 21 and 42 days of age blood samples were collected from the wing vein of three birds per replicates to determine hematological values. Twelve chicks were slaughtered from each treatment at 42 days of age, and abdominal fat pad, liver, heart, gall bladder and pancreas were removed, weighed and expressed as a percentage of live body weight. Body weight of broilers fed supplemental chromium for 21 and 42 days increased significantly ($P<0.05$). Body weight gain and feed intake of broilers fed supplemental chromium increased ($P<0.05$). Feed conversion of broilers was not affected by different levels of supplemental chromium. Chromium supplementation increased carcass yield and decreased abdominal fat contents. The hemoglobin, MCH, MCHC were increased by 1000 ppb chromium supplementation. The results from this study suggest that, supplemental chromium, alleviated heat stress related depression in performance, carcass traits and hematological values of broiler chicks.

Key words: Broiler, chromium picolinate, performance, hematology, heat stress

Introduction

High ambient temperature reduces feed intake, live weight gain, and feed efficiency (Siegel, 1995), thus negatively influence the performance of broilers. One of the methods for alleviate the effect of high environmental temperature on the performance of broilers is dietary manipulations. In this respect, trivalent chromium is used in the poultry diet because of the reported benefits of chromium supplementation in broiler under heat stress (sahin *et al.*, 2002, 2003), also because of the fact that stress condition increase chromium metabolisation from the tissues that is irreversibly excreted through the urine (Borel *et al.*, 1984; Mertz, 1992; Anderson, 1994).

Trivalent chromium is a well known essential trace element for human and animals (Schwartz and Mertz, 1959). Trivalent chromium improves insulin effectiveness by enhancing its binding to receptors and the sensitiveness of the target cell (Anderson, 1997).This element is also involved in carbohydrate, lipid, protein and nucleic acid metabolic function (Steele and Rosebrough, 1981; Okada *et al.*, 1984; Ohba *et al.*, 1986; McCarty, 1991). Research on animals has confirmed that chromium from organic complex such as chromium picolinate, nicotinate and high chromium yeast is absorbed more efficiently, about 25-30 % more than inorganic compounds like chromium chloride ($CrCl_3$), which are poorly absorbed (1-3 %) regardless of does or dietary chromium status (Underwood and Suttle, 1999; Mowat, 1994; Olin *et al.*, 1994).

National Research Council (NRC, 1989) has recommended an intake of 50 to 200 ppb of trivalent chromium for adult humans. However, an appropriate recommendation on the chromium requirement of poultry has not been made (NRC, 1994,1997) and most poultry diets are basically composed of plant origin ingredients, which have usually low content of chromium (Giri *et al.*, 1990). The objectives of this study were to evaluate the effects of dietary Cr from Cr picolinate on performance, carcass traits and hematological parameters in broilers reared under heat stress condition.

Materials and Methods

Birds and managements: Two hundreds and forty one-day-old male broiler chicks (Ross 308) purchased from a commercial supplier were used in this experiment. On day 5, the chicks were individually weighed and randomly allocated to four treatment groups. Four replicate groups of fifteen birds with similar average initial weight and weight range were assigned to each of four treatments. The dietary treatments consisted of the

Table 1: Composition of the basal diets

Ingredients (%)	Starter	Finisher
Corn	51.88	56.19
Soybean meal, CP 44%	39.8	34.6
Soybean oil	4.47	5.75
Dicalcium phosphate	1.56	1.18
Calcium carbonate	1.22	1.35
Salt	0.4	0.35
Vitamin premix[1]	0.25	0.25
Mineral premix[2]	0.25	0.25
DL-Methionine	0.17	0.08
Calculated composition		
Metabolizable energy (Kcal/Kg)	3050	3200
Crude protein (%)	21.92	20
Calcium (%)	0.953	0.9
Available phosphorus (%)	0.429	0.35
Methionine + Cystine (%)	0.858	0.72
Lysine (%)	1.205	1.077
Chromium analyzed (ppb)	3.45	3.96

[1]Vitamin premix contains followings in 2.5 kg: vitamin A, 9000000 IU; vitamin D_3, 2000000 IU; vitamin E, 18g; vitamin k_3, 2g; thiamine 1.8 g; riboflavin, 6.6 g; panthothenic acid, 10 g;vitamin B_6, 3 g; vitamin B_{12}, 15 mg; niacin, 30 g; biotin, 100 mg; folic acid, 1g; choline chloride, 250 g; Antioxidant 100 g. [2]Mineral premix contains followings in 2.5 kg: manganese, 100 g; zinc, 100 g; iron, 50 g; copper, 10 g; Iodine 1g; selenium 200 mg.

basal diet supplemented with 0 (control), 500, 1000 and 1500 micro gram of Cr/kg of diet from chromium picolinate (contain 12.27% Cr). Respective amounts of chromium were first blended thoroughly with 10 g dicalcium phosphate in a mechanical blender, then was mixed with small amounts of the basal diets, then with a larger amount of the basal diet until the total amount of the respective diets were homogeneously mixed. The birds were fed a maize-soybean meal starter diets until 21 d of age followed by a finishing diet from day 21 to day 42. Ingredients and chemical composition of the starter and finisher basal diets are shown in Table 1. The basal diets were formulated to meet or exceed the nutrient requirements of broiler chickens (NRC, 1994). Chromium contents were 670 and 890 ppb in starting and finishing basal diets, respectively, as measured by atomic absorption spectrometer with a graphite furnace (Perkin-Elmer, AAnalyst 600, USA).The diets and fresh water were provided *ad libitum*. Birds were kept in floor pens. During the experiment, house's temperature was measured four times a day (0600, 1200, 1800, and 2400). The mean value of daily temperature in the house was 33±3°C. The experiment was conducted between July 11th to Aug 20th.

Body weight was determined at 21 and 42 days of age. Feed consumption, weight gain and feed conversion were measured in different periods. At 42 days of age three birds were chosen randomly from each replicate, slaughtered and abdominal fat pad, liver, heart, gall bladder and pancreas were removed, weighed and expressed as a percentage of live body weight.

Collection of blood samples: At 21 and 42 days of age blood samples were collected from the wing vein of three birds per replicates into anticoagulant (EDTA) treated tubes for determination of hematological parameters.

Analytical procedures: The PCV (packed cell volume) was determined using a hematocrit. Red blood cell (RBC), white blood cell (WBC) and thrombocyte counts were determined by a haemocytometer method using Natt-Herrick solution. Hemoglobin (HBG) was determined by the cyanmethemoglobin method. The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were computed according to Campbell (1988).

Statistical analyses: The experiment data were analyzed using SAS statistical program (SAS, 1997). General linear model was used to analyze variance, and significant differences (P<0.05) among treatment means were determined using Duncan's new multiple range test.

Results

The effects of supplemental chromium on performance of broilers are summarized in Table 2. Chromium supplementation significantly (P<0.05) increased body weight of broilers either for 21 and 42 days of age. Supplement of 1500 ppb Cr to broiler diets significantly increased feed consumption at 5 to 21 and 5 to 42 days of age (P<0.05). Weight gain was significantly (P<0.05) increased in Cr supplemental groups. Feed conversion of broilers was not affected by different levels of supplemental Cr (P>0.05). Table 3 shows the effects of Cr supplementation on carcass traits. Carcass yield of broilers fed supplemental Cr increased (P<0.01). However, abdominal fat decreased (P<0.01) as dietary Cr increased. Liver, gall bladder, Heart and pancreas was not affected by Cr supplementation (P<0.05).The effects of supplemental dietary Cr on hematological parameters at the 21st and 42nd days of the experiment are given in Table 4 and 5 respectively. MCH significantly increased (P<0.05) in broiler fed 1000 ppb Cr supplementation, whereas the WBC, RBC, PCV, HGB, MCV, MCHC and thrombocytes not significantly tended to increase in supplemental Cr groups at 21 days of age (P>0.05). The HGB, MCH and MCHC were significantly (P<0.05) enhanced by supplemental 1000 ppb Cr at 42 days of age.

Discussion

In the present study, supplementation with Chromium, particularly, at 1500 ppb of Cr from Cr picolinate of corn-soybean meal diets containing a basal levels of 3.45 and 3.96 mg/kg Cr increased body weight, weight gain and feed intake of broilers reared under heat stress

Table 2: Effect of supplemental chromium on performance of broilers

	Control (C)	Chromium supplemented levels (ppb)			Pooled SE	Significance C vs Cr
		500	1000	1500		
Body weight (g)						
21 days	671[b]	696[a]	693[a]	702[a]	6.2	P<0.05
42 days	2170[b]	2258[a]	2243[a]	2263[a]	24.2	P<0.05
Weight gain (g/d)						
5-21 days	37.8[b]	39.1[ab]	38.4[ab]	39.4[a]	0.496	P<0.05
21-42 days	71.4[b]	74.4[a]	73.8[a]	74.3[a]	1.19	P<0.05
5-42 days	58.6[b]	61[a]	60.6[a]	61.1[a]	0.919	P<0.05
Feed intake (g/d)						
5-21 days	49.4[b]	51.2[ab]	51.1[ab]	52.1[a]	0.614	P<0.05
21-42 days	140.4	146.7	143	146	2.57	NS
5-42 days	97.6[b]	102.2[ab]	100.3[ab]	103.8[a]	1.46	P<0.05
Feed : gain (g:g)						
5-21 days	1.31	1.31	1.33	1.32	0.025	NS
21-42 days	1.97	1.97	1.94	1.96	0.057	NS
5-42 days	1.66	1.67	1.65	1.70	0.041	NS

[a-b] Means within the same row without common superscripts differ significantly (P<0.05). NS: Not significant

Table 3: Effect of supplemental chromium on the carcass traits of broilers

Carcass traits* (%)	Control (C)	Chromium supplemented levels (ppb)			Pooled SE	Significance C vs Cr
		500	1000	1500		
Carcass	71.9[b]	73.4[a]	73.4[a]	72.9[a]	0.302	P<0.01
Abdominal fat	2.41[a]	2.11[b]	1.88[b]	1.83[b]	0.12	P<0.01
Liver	2	1.98	1.88	2.01	0.056	NS
Heart	0.42	0.39	0.38	0.41	0.017	NS
Pancreas	0.189	0.204	0.203	0.206	0.008	NS
Gall bladder	0.099	0.090	0.093	0.093	0.007	NS

[a-b] Means within the same row without common superscripts differ significantly (P<0.05). NS: Not significant

*: Percentage of live weight

condition (Table 2). It is well known that the growth rate and feed efficiency decrease when ambient temperature goes above the thermoneutral zone (Ensminger *et al.*, 1990) and decrease in growth rate was partly, the result of the decrease in feed intake (Hurwitz *et al.*, 1980). In addition, stress increase chromium excretion (Anderson, 1994) and thus may exacerbate a marginal Cr deficiency or an increased Cr requirements. Similar to results of the present study, Sahin *et al.* (2002) reported that increase supplemental chromium (200, 400, 800 or 1200 µg/kg Cr picolinate) resulted in an increase in body weight, feed intake and feed efficiency in broilers reared under heat stress. Lien *et al.* (1999) reported that 1600 and 3200 µg/kg Cr picolinate supplementation in a broiler diets increased feed intake and improved live weight gain. Kim *et al.* (1996) also observed that 1600 µg/kg Cr picolinate supplementation increased the weight gain and feed intake without affecting feed conversion in broilers. In addition, Sahin *et al.* (2003) found that decrease in live weight gain and feed efficiency in broiler reared under heat stress was alleviated by dietary chromium and vitamin C supplementation. The results of this study indicate that Cr supplementation increased carcass yield and decreased abdominal fat (Table 3). It has been shown that Cr supplementation causes significant changes in the chemical composition of animal carcasses (Lukaski, 1999). In accordance with our results, increasing carcass yield and decreasing abdominal fat content in broilers has been reported for diets supplemented with Cr picolinate (Sahin *et al.*, 2002, 2003) or Cr yeast (Hossain *et al.*, 1998; Debski *et al.*, 2004). It is well known that Cr is involved in protein metabolism (Anderson, 1987).Chromium is thought to have a role in nucleic acid metabolism as an increase in stimulation of amino acid incorporation into liver protein in vitro was observed (Weser and Koolman, 1969). Also Cr plays an important role as integral component of the glucose tolerance factor (GTF), which potentiate the action of insulin, and regulate fat metabolism. At low insulin level glucose 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. In addition to increasing the number of actual insulin receptors present in target cells, Cr also has been demonstrated to increase the actual binding of insulin to its receptors. This latter action may involve Cr ability to regulate phosphorytation/dephosphorylation reactions, which turn insulin action on and off (Anderson, 1998).

Table 4: Effect of supplemental chromium on hematological parameters of broilers at 21 days of age

Hematological parameters	Control (C)	Chromium supplemented levels (ppb)			Pooled SE	Significance C vs Cr
		500	1000	1500		
WBC ($\times 10^3$/mm^3)	6.31	7.66	7.20	7.22	0.794	NS
RBC ($\times 10^6/\mu$L)	2.31	2.31	2.30	2.32	0.056	NS
Hemoglobin (g/dl)	12.9	13.3	13.4	13.4	0.277	NS
PCV (%)	29.1	30.8	30.9	30.6	0.599	NS
MCV (fl)	133.6	135.8	134.3	133	0.863	P<0.09
MCH (pg)	56.3^{b}	58.5^{a}	58.5^{a}	58^{ab}	0.587	P<0.05
MCHC (%)	42.5	43.2	43.3	43.3	0.407	NS
Thrombocyte ($\times 10^3$/mm^3)	32.5	32.3	35.1	35.2	1.61	NS

$^{a-b}$Means within the same row without common superscripts differ significantly (P<0.05). NS: Not significant

Table 5: Effect of supplemental chromium on hematological parameters of broilers at 42 days of age

Hematological parameters	Control (C)	Chromium supplemented levels (ppb)			Pooled SE	Significance C vs Cr
		500	1000	1500		
WBC ($\times 10^3$/mm^3)	4.87	5.96	5.96	5.81	0.475	NS
RBC ($\times 10^6/\mu$L)	2.76	2.79	2.8	2.77	0.047	NS
Hemoglobin (g/dl)	13^{b}	13.4^{ab}	14.1^{a}	13.1^{b}	0.287	P<0.05
PCV (%)	31.5	31.1	32.2	31	0.492	NS
MCV (fl)	116.3	115.3	117.9	118.5	1.875	NS
MCH (pg)	47.8	48.1	50.7	48.4	0.789	P<0.05
MCHC (%)	40^{c}	42.8^{ab}	44.4^{a}	41.5^{bc}	0.734	P<0.01
Thrombocyte ($\times 10^3$/mm^3)	42.5	42.3	45.5	46.1	1.93	NS

$^{a-c}$Means within the same row without common superscripts differ significantly (P<0.05). NS: Not significant

The results from the present study show that, hemoglobin increased significantly and hematocrit tended to increase in broilers fed 1000 ppb supplemental Cr (Table 4 and 5). Wilson (1971) reported that hematology may be used to diagnose both quantitative and morphologic physiological alterations that might be associated to heat stress, such as changes in hematocrit and hemoglobin. According to Kubena *et al.* (1972) exposure of chickens to high temperatures causes a decrease in blood hematocrit and hemaglobin values. Moonsie-Shageer and Mowat (1993) reported that Cr supplementation increased hematocrit of stressed feeder calves. Research on Cr and it's hematological effect in broiler are very limited and it seems that present study is the first study about it. In conclusion, the results of this study indicate that supplement of chromium picolinate was beneficial on the growth performance, carcass traits and some hematological values.

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