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Effect of Chromium Methionine Supplementation on Performance and Serum Metabolites in Broiler Chickens Thermoneutral and Under Heat-Stress Conditions

Research Article

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ABSTRACT

The effects of chromium methionine supplementation on performance and serum metabolites were evaluated in broiler chickens. Two experiments were conducted at 22 °C, thermoneutral, (TN) and 33±2 °C, heat stressed (HS) conditions. Two hundred and eighty eight male broiler chicks (Ross 308) were allocated to four treatments in a completely randomized design. Treatments with 0 (control), 200, 400 or 800 ppb of chromium methionine for 42-d experimental period carried out. Serum metabolites and performance were determined. Supplementing the diet of TN and HS conditions broilers with chromium methionine improved feed intake (FI) and body weight (BW) (P<0.05), but Feed conversion ration (FCR) of broilers was not affected by different levels of supplemental chromium. Chromium methionine increased serum HDL contents, but decreased glucose, (GLU), cholesterol (CHL), triacylglycerol (TG) and LDL concentrations (P<0.05) in both TN and HS temperature. The results of these experiments indicated that supplementation of chromium methionine in the ration improved performance and influenced serum metabolites on thermoneutral and heat-stressed broiler.

KEY WORDS broiler chickens, chromium methionine, heat-stress, performance, serum metabolites, thermoneutral.

INTRODUCTION

Chromium has been the focus of numerous studies involving livestock animals and poultry, NRC (1997). Chromium (Cr) is considered essential for maintenance of normal glucose tolerance and chromodulin, a cofactor of certain enzymes which is necessary for stabilization of proteins and nucleic acids (Hayirli, 2005). Heat stress has been associated with decreases in broiler weight gain, feed intake, feed efficiency, egg production, and nitrogen retention and protein digestibility (Sahin and Kucuk, 2003). Diet supplemented with 200 to 400 µg/kg chromium picolinate did not affect growth and carcase composition. Dietary supplement of 200 to 400 µg/kg trivalent chromium decreases blood glucose, cholesterol (Press *et al*. 1990). In general, dietary chromium supplementation has been shown to positively affect the growth rate, feed efficiency and carcass traits of broilers and turkeys (Cupo and Donaldson, 1987; Lien et al. 1999; Sahin et al. 2002). Researchers reported that Cr supplements may decrease carcass fat (Kim et al. 1996) or plasma cholesterol (Press et al. 1990) of broiler chickens. Related studies in humans and other animals have indicated that a dietary supplement of chromium could reduce serum glucose, TG, total cholesterol (Evans, 1989; Wang *et al.* 1989; Press *et al.* 1990). The objectives of the present study were to assess the effects of dietary supplementation with chromium methionine on performance and serum metabolitesm of thermoneutral and heat-stressed broiler.

MATERIALS AND METHODS

Two experiments were conducted at 22 °C, thermoneutral (TN) and 33±2 °C, heat stressed (HS) conditions. Two hundreds and eighty eight male broiler chicks (Ross 308) were used for each experiment. The birds were assigned according to their initial body weights to 4 treatment groups consisting of six replicates of 12 birds each. Treatments supplemented with 0 (control), 200, 400 and 800 ppb Cr in the form of Cr methionine. The chicks (TN and HS) feeding a maize-soybean meal starter diet (219 g protein, 3050 kcal $MEkg^{-1}$) up to 21 days and a grower diet (200 g protein, 3200 kcal $MEkg^{-1}$) up to 42 days. The basal diet in mash form is formulated to meet or exceed the nutrient requirements of broiler chickens (NRC, 1994). BW, FI and FCR were measured in different period. Table 1 lists the diet formulations.

Table 1 Composition of experimental diets

Ingredient	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
CP (%)	21.92	20
Ca (%)	0.95	0.9
Available phosphorus (%)	0.42	0.35
Methionine + Cystine (%)	0.85	0.72
Lys (%)	1.20	1.07
Chromium analyzed (ppm)	3.39	3.85

1. Vitamin premix provides the following per 2.5 kg: vitamin A, 9000000IU; vitamin D3 ,2000000IU; vitamin E 36000 mg; vitamin k3 ,2000 mg; vitamin B2, 600mg; vitamin B6,2940 mg; vitamin B12,15 mg; vitamin H2,100 mg; B.H.T,1000mg;chorine, 250000 mg; niacin, 29700 mg; Ca-pantothenate, 9800 mg; vitamin B12, 0.01mg; folic acid, 1000 mg; thiamine, 1750 mg.
2. Mineral premix provides the following per 2.5 kg: manganese 99200mg, iron 50000 mg, zinc 84700 mg, copper 10000 mg, iodine990 mg, selenium 200 mg, choline chloride 250000 mg.

Laboratory analyses

At 6 wks, after 11 h of fasting blood samples were collected from 12 birds (two per replicate) randomly chosen from each treatment. Samples were centrifuged at 3500 g for 15 min and sera were collected. Serum samples were then decanted into three aliquots and stored at -20 °C for later analysis of serum glucose (GLU), high-density lipoprotein (HDL), cholesterol (CHL), triacylglycerol (TG), low-density lipoprotein (LDL) using commercial enzymatic kits (Wako Pure Chemicals Industries, Ltd., Richmond, VA). All samples were analyzed in duplicate within each assay.

Statistics

All data (pen means) were analyzed by analysis of variance procedures appropriate for a completely randomized design using the GLM procedures of SAS (2002). Significant differences (P<0.05) among treatment means were determined using Duncan's new multiple range test.

RESULTS AND DISCUSSION

Effects of supplemental chromium on performance of broilers are summarized in Table 2.

Table 2 Effect of supplemental chromium methionine on performance of broilers

	Chromium supplemented levels (ppb)				
Item	0	200	400	800	SEM
BW (g)					
TN					
21 d	560.51[b]	593.64[a]	595.38[a]	601.84[a]	8.80
42 d	1507.98[b]	1641.47[a]	1726.39[a]	1746.93[a]	26.00
BW (g)					
HS					
21 d	556.51[b]	594.84[a]	598.44[a]	609.38[a]	9.80
42 d	1500.98[b]	1638.47[a]	1720.39[a]	1740.93[a]	32.00
FI (g/d)					
TN					
0-21 d	51.43	52.06	51.43	52.74	7.80
21-42 d	110.83[b]	126.50[ab]	127.83[ab]	133.18[ab]	6.90
0-42 d	91.40	91.95	91.99	94.26	8.50
FI (g/d)					
HS					
0-21 d	50.43	51.06	50.43	51.74	7.31
21-42 d	111.06[b]	124.25[ab]	125.59[ab]	132.26[a]	5.58
0-42 d	80.69	88.09	88.03	92.75	7.65
FCR (g/g)					
TN					
0-21 d	7.1	69.1	7.1	8.1	4.0
21-42 d	2.0	2.0	3.2	1.2	7.0
0- 42 d	93.1	85.1	92.1	99.1	5.0
FCR (g/g)					
HS					
0-21 d	73.1	60.1	9.1	7.1	04.0
21-42 d	2.0	2.0	2.0	2.2	06.0
0-42 d	90.1	85.1	94.1	92.1	04.0

a, b Means within the same row are significantly different (P<0.05).

BW and FI increased (P<0.05) in broilers fed all dietary levels of Cr (TN, HS). FCR of broilers was not affected by different levels of supplemental chromium. Table 3 lists the effects on serum traits. Serum glucose, cholesterol and triacylglycerol (TG) decreased in the birds which received dietary levels of chromium supplements of CrMet (P<0.05). Table 4, supplementation of the diet with chromium could increase the HDL concentration and also reduced serum LDL contents (P<0.05).

Table 3 Effects of supplemental chromium methionine on blood serum metabolites of GLU, CHL, TG

	Chromium supplemented levels (ppb)				
Item	0	200	400	800	SEM
TN					
GLU (mg/DL)	287.41^{a}	267.32^{b}	266.45^{b}	266.02^{b}	6.20
CHL (mg/DL)	112.5^{a}	101.16^{b}	100.91^{b}	100.52^{b}	1.80
TG (mg/DL)	102.32^{a}	96.33^{b}	94.20^{b}	91.2^{b}	4.10
HS					
GLU (mg/L)	298.5^{a}	293.3^{b}	280.9^{b}	263.8^{b}	5.70
CHL (mg/dL)	117.33^{a}	107.86^{b}	106.32^{b}	104.16^{b}	2.80
TG (mg/dL)	104.25^{a}	97.32^{b}	96.45^{b}	97.082^{b}	3.20

a, b Means within the same row are significantly different (P<0.05).

Table 4 Effect of supplemental chromium methionine on the lipoprotein profile and cholesterol component of broilers

	Chromium supplemented levels (ppb)				
Items	0	200	400	800	SEM
TN					
HDL	48.91^{b}	51.06^{a}	51.9^{a}	52.07^{a}	1.70
LDL	35.66^{a}	29.05^{b}	28.66^{b}	27.81^{b}	1.00
HS					
HDL	46.052^{b}	48.06^{a}	50.55^{a}	56.33^{a}	5.20
LDL	42.7^{a}	34.02^{b}	32.29^{b}	31.03^{b}	5.30

a, b Means within the same row are significantly different (P<0.05).

The relevance of the trace element chromium (Cr) to human and animal nutrition has been known for more than 40 years, which increases the sensitivity of tissue receptors to insulin, resulting in increased glucose uptake by cells, (Anderson *et al.* 1991). Also Insulin can stimulate anabolism and inhibit catabolism, subsequently increasing the blood glucose uptake and utilization by cells (Rosebrough and Steele, 1981).

The results of this investigation, BW and FI increased (P<0.05) in broilers fed all dietary levels of Cr. (Table 2). No significant difference was observed among treatments in terms of BW and FI during the entire experimental periods. Effect of chromium supplementation on growth performance in broiler chickens has been variable (NRC, 1997). Kim *et al.* (1996) reported that 100 to 800 µg/kg chromium picolinate in the diet did not affect growth of broilers.

Also, research has shown that Cr as ChromiumPicolinate improved growth performance of broilers during heat stress, but this response to Cr may be because of the heat stress challenge Sahin *et al.* (2002). In mammalian studies, supplements of 200 µg/kg of Crpic tended to enhance the growth rates in pigs (Lindeman *et al.* 1995; Moonsie-Shageer and Mowat, 1993). Serum cholesterol, glucose and (TG) was reduced by CrMet in the birds which received dietary levels of chromium supplements (P<0.05), but not significant between groups (Table 3).

A decrease in glucose level may be attributable to the effect of chromium on insulin, serum glucose, cholesterol and (TG) concentrations decreased when dietary chromium was increased.

A decrease in glucose level maybe attributable to the effect of chromium on insulin. It is reported that CrPic is able to increase the rate of insulin internalization and uptake of glucose into rat skeletal muscle cells (Evans and Bowman, 1992).

Thus, an increase in insulin internalization would be in accordance with the observed reduction in circulating concentrations of insulin and glucose, (Amoikon *et al.* 1995). Increased glucose uptake is expected to increase oxidation of glucose which would otherwise be converted to fatty acids and stored as triglycerides in adipose tissues.

Also, related studies in human have indicated that a dietary supplement of Chromium can decrease serum glucose, cholesterol, concentrations (Evans and Bowman, 1992). Some reports have shown that plasma or serum triglyceride concentrations may be decreased in chickens fed Cr supplement (Bakhiet and El Badwi, 2007).

In the present study, supplementation of the diet with chromium did increase the HDL concentration and also reduced serum LDL contents, but no significant effect between groups (P<0.05) was detected. Insulin can stimulate glucose utilization for acetyl-CoA and NADPH formation and increase the activities of pyruvate dehydrogenate, (Denton *et al.* 1979). Chromium picolinate significantly raised high-density lipoprotein (HDL) concentrations, Komorowski *et al.* (2001).

Dietary chromium thus reduces body cholesterol and glycerol contents in birds (Cupo and Donaldson, 1987). Insulin has been shown to increase liver low density lipoprotein (LDL) receptors, thereby increasing LDL uptake of hepatocytes and reducing the blood LDL content and concomitantly the high density lipoprotein(HDL) proportion is increased (Brindley and Salter, 1991).

Also, McCarty (1991) reported that the uptake of Crpic by humans can increase the HDL content. This contradictory result may be attributed to the stimulating effect on protein synthesis by a supplement of chromium.

CONCLUSION

The results of this study confirmed that a supplement of chromium methionine improved the performance and influenced serum metabolites in thermoneutral heat-stress broiler.

REFERENCES

Amoikon E.K., Fernandez J.M., Southern L.L., Thompson Jr D.L., Ward T.L. and Olcott B.M. (1995). Effects of chromium tripicolinate on growth, glucose tolerance, insulin sensitivity, plasma metabolites, and growth hormone in pigs. *J. Anim. Sci*. **73,** 1123-1130.

Anderson R.A., Polanski M.P., Breyden N.A. and Canary J.J. (1991). Supplemental chromium effects on glucose, insulin, glucagon and urinary chromium losses in subjects consuming controlled low-chromium diets. *Am. J. Clin. Nutr*. **54,** 909-916.

Bakhiet A.O. and ElBadwi S.M. (2007). Effects of dietary chromium supplementation on the performance and some serum parameters in bovans-type chicks. *J. Pharmacol. Toxicol*. **2,** 402-406.

Brindley D.N. and Salter A.M. (1991). Hormonal regulation of the hepatic low density lipoprotein: relationship with the secretion of very low density lipoprotein. *J. Lipid. Res*. **30,** 349-360.

Cupo M.A. and Donaldson W.E. (1987). Chromium and vanadium effects on glucose metabolism and lipid synthesis in the chick. *Poult. Sci*. **66,** 120-126.

Denton R.M., Rosen O.M. and Rubin C.S. (1979). Regulation of pyruvate metabolism in mammalian tissue. *Essa. Bio*. **15,** 37-77.

Evans G.W. (1989). The effect of chromium picolinate on insulin controlled parameters in humans. *Int. J. Bioph. and Medical Res*. **11,** 163-180.

Evans G.W and Bowman T.D. (1992). Chromium picolinate increases membrane fluidity and rate of insulin internalization. *J. Inorg. Biol*. **46,** 243-250.

Hayirli A. (2005). Chromium nutrition of livestock species. *Nut. Abs. Rev*. **75(5),** 1-14.

Kim Y.H., Han In K., Choi Y.J., Shin I.S., Chae B.J. and Kang T.H. (1996). Effects of dietary levels of chromium picolinate on growth performance, carcass quality and serum traits in broiler chicks. *Am. A. J. Anim. S*ci. **9,** 341-347.

Komorowski J.R., Dela Harpe J., Cefalu W.T., Zhang Z.H., Wang Z.Q. and Greenberg D. (2001). LA-cp rats show improved lipid profiles in response to diets containing chromium picolinate and biotin, *Appetite*. **36,** 230.-233

Lien T.F., Horng Y.M. andYang K.H. (1999). Performance, serum characteristics, carcass traits and lipid metabolism of broilers as affected by supplementation of chromium picolinate. *Brit. Poult. Sci*. **40,** 357-363.

Lindermann M.D., Wood C.M., Harper A.F., Kornegay E.T. and Anderson R.A. (1995). Dietary chromium picolinate additions improve gain feed and carcass characteristics in growing finishing pigs and increase litter size in reproducing sows. *J. Anim. Sci*. **73,** 457-465.

Mccarty M.F. (1991). The case for supplemental chromium and a survey of clinical studies with chromium picolinate. *J. Appl. Nutr*. **43,** 58-66.

Moonsie-Shageer S. and Mowat D.N. (1993). Effect of level of supplemental chromium on performance serum constituents and immune status of stressed feeder calves. *J. Anim. Sci*. **71,** 232-238.

National Research Council. (1997). The Role of Chromium in Animal Nutrition, National Academy Press, Washington, D.C.

Press R.I. (1990). The effect of chromium picolinate on serum cholesterol and Apo lipoprotein fractions in human subjects. *Western J. Medi*. **152**, 41-45.

Rosebrough R. W and Steele N. C. 1981. Effects of supplemental dietary chromium or nicotinic acid on carbohydrate metabolism during basal, starvation, and refeeding periods in poultrt. *Poult. Sci*. **60,** 407-417.

Sahin K. and Kucuk O. (2003). Heat stress and dietary vitamin supplementation of poultry diets. *Nutr. Abs. Rev*. **73(7),** 41-50.

Sahin K., Sahin N., Onderci M., GURSU M.F. and Cikim G. (2002). Optimal dietary concentration of chromium for alleviating the effect of heat stress on growth, carcase qualities, and some serum metabolites of broiler chickens. *Bio. Trace Ele. Res*. **89,** 53-64.

Statistical Analysis System Institute. (2002). SAS_User’s Guide: Statistics Cary, NC, Statistical Analysis System Institute Inc, United State American.

Wang M.M., Fox E.A., Stocker B.J., Menendez C.E. and Chan S.B. (1989). Serum cholesterol of adults supplemented with brewer’s yeast or chromium chloride. *Nutr. Res*. **9,** 989-998.