Global Journal of Science Frontier Research
Chemistry
Volume 12 Issue 5 Version 1.0 Year 2012
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effect of Inorganic Chromium Supplementation on the Intestinal Mucosa Development of Heat-Stressed Broilers

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Abstract - Ninety (90) 7 day-old broilers under conditions of heat stress were randomly assigned to 3 dietary treatments of 3 replicates each. There were 10 birds in each replicate. The 3 diets were: Diet 1 – Control diet (without Chromium supplementation); Diet 2 - 0.15mg/kg Chromium supplementation and Diet 3 - 0.25mg/kg Chromium supplementation. The inorganic Chromium source was Chromium chloride. The aim of the study was to evaluate the effect(s) of heat stress on the intestinal mucosa of broilers. The study lasted 7 weeks and data on performance (feed intake, weight gain and feed conversion ratio) and intestinal morphology (villus height and crypt depth) were taken. Data taken were subjected to statistical analysis of variance (ANOVA) procedure of SAS 2010. Significant differences were observed in the weight gain with the birds fed diet 3 having the highest mean value of 45.00g/day and the least value of 40.00g/bird for birds the on control diet. However, birds fed diet 3 (0.25mg/kg) had the least significant feed conversion ratio 2.00 when compared with birds on control diet (2.25) and diet 2 (2.14). The villus height in the ileum of birds on Diet 3 was significantly ($p < 0.05$) taller than that of birds on the other diets while the villus height in the jejunum of birds on Diet 1 was significantly ($p < 0.05$) taller than that of birds on the other diets.

Keywords : *Broiler, Chromium chloride, heat-stress, villus height, crypt depth.*

GJSFR-B Classification : *FOR Code: 030699*

Strictly as per the compliance and regulations of :

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Keywords : Broiler, Chromium chloride, heat-stress, villus height, crypt depth.

I. Introduction

High ambient temperatures coupled with high humidity levels as experienced in the tropics can be devastating to commercial broilers. It has been shown that heat stress has detrimental effects on the performance of broilers reducing the growth rate and feed intake and also affecting the feed efficiency, carcass quality and health of the birds (Temim *et al.*, 2000; Har *et al.,* 2000). Chronic heat stress increases the time to reach market weight and also increases mortality rate. Chromium supplementation has been observed to alleviate the adverse effects of heat stress in broilers. Although Chromium is not currently considered an essential trace mineral for poultry, research data provide evidence that suggests a nutritional and physiological role for this micronutrient (Mertz, 1967). The National Research Council has recommended Chromium at 300μg/kg in diets of lab animals (NRC, 1995), however currently there are no NRC recommendations for Chromium in poultry diets (NRC 1994).

Toghyani *et al.* (2006) reported an increase in body weight gain and feed intake of broilers under heat stress conditions when supplemented with Chromium. The authors also observed an increase in carcass yield and decrease in abdominal fat contents. Sahin *et al.* (2002a) reported an increase in feed intake, feed efficiency and body weight of broilers under heat stress with supplementation of Chromium. Increase in carcass yield and decrease in abdominal fat content in broilers was observed when supplemented with Chromium picolinate or high Chromium yeast (Debski *et al.*, 2004). Zhang *et al.* (2002) reported that Chromium supplementation improved FCR in broilers by 6.2%. Rosebrough and Steele (1981) observed that turkeys fed a diet supplemented with Chromium had greater liver glycogen levels as a result of the increased activity of the enzyme glycogen synthetase and also that Chromium increased glucose transport by increasing insulin activity. Kim et al. (1995) reported increased HDL cholesterol and decreased total cholesterol in Chromium-supplemented broilers. Anandhi et al. (2006) observed a significant reduction in breast and thigh muscle cholesterol levels and an increase in breast and thigh muscle protein levels in broilers supplemented with organic Chromium. There is a however a dearth of research data on the effect(s) of Chromium on the intestinal mucosa morphology development of broilers therefore the aim of this study was to investigate the effect of 2 levels of Chromium supplementation on the intestinal mucosa development in broilers.

II. Materials and Methods

Ninety (90) day old broilers were brooded for one week after which they were randomly allotted to 3

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dietary treatments of 3 replicates with 10 birds per replicate. The experimental design was Completely Randomized Design. The temperature of the house during the experiment was 32.3 ±3°C. The treatments were 1 – control diet without Chromium chloride, 2 – diet with 0.15mg/kg Chromium chloride and 3 – diet with 0.25mg/kg Chromium chloride. The experiment lasted 7 weeks. Feed was offered to the birds ad libitum and data on feed intake and weight gain were taken on a weekly basis. At the end of the period, three birds per replicate was slaughtered after a period of fasting (12 hours) and samples of the ileum and jejunum were taken from each bird. The specimens were fixed in 10% formalin after which they were dehydrated in 100% ethanol. The specimens were then cleared with xylene and embedded in paraffin. A microtome was used to make 4μm cuts that were mounted on glass slides and stained using the H and E (Haematoxyline and Eosin) method. Five readings each of villus height and crypt depth were taken per specimen. This was done with a light microscope (Olympus). Villus height was measured from the apical to the basal region which corresponded to the superior portion of the crypts. Crypts were measured from the basis until the region of transition between the crypt and the villus. All data were subjected to analysis of variance (ANOVA) procedure of SAS, 2010.

Table 1 : Gross Composition of broiler diets Supplemented With Different Levels Of Chromium Chloride.

Ingredients (kg)	Diet 1 Control	Diet 2 (0.15mg/kg)	Diet 3 (0.25mg/kg)
Maize	58.00	58.00	58.00
Groundnut Cake	21.00	21.00	21.00
Palm kernel cake	1.00	1.00	1.00
Fish meal	2.00	2.00	2.00
Soyabean meal	14.60	14.60	14.60
Bone meal	2.40	2.40	2.40
Premix(Broiler starter)	0.30	0.30	0.30
Salt	0.30	0.30	0.30
Lysine	0.30	0.30	0.30
Methionine	0.20	0.20	0.20
Chromium Chloride (mg/kg)	0.00	0.15	0.25
Total	**100.00**	**100.00**	**100.00**
Calculated Nutrient			
Crude Protein (%)	23.00	23.00	23.00
Metabolisable Energy (kcal/kg ME)	3,019.27	3,019.27	3,019.27
Crude fibre (%)	3.30	3.30	3.30

III. Results

The gross compositions of the experimental diets are shown in Table 1. The diets were formulated to meet the nutritional requirements of broilers as recommended by NRC, 1994. Table 2 shows the performance characteristics of the birds. Final weight, weight gain and feed conversion ratio differed significantly among birds on the different dietary treatments with birds on diet 3 having the highest values. Feed intake however did not differ significantly. Table 3 shows the results of the morphology of the intestinal mucosa of the birds on the different dietary treatments. The morphological indices evaluated were the villus height and crypt depth in the ileum and jejunum. Ileal villus height (545.35μm) of birds on Diet 3 was significantly ($p < 0.05$) taller than that of birds on the other diets. The jejunal villus height (519.65μm) of birds on Diet 1 was significantly ($p < 0.05$) taller than that of birds on the other diets. Birds on Diet 1 had significantly ($p < 0.05$) deeper ileal crypts (84.13μm) than birds on the other diets. The crypt depth inthejejunum of the birds were however not significantly affected by the dietary treatments.

Table 2 : Performance Characteristics Of Broiler Birds Fed Diets Supplemented With Different Levels Of Chromium Chloride

Parameters	Diet 1 Control	Diet 2 (0.15mg/kg)	Diet 3 (0.25mg/kg)	SEM
Final weight (g)	2006.00 [c]	2020.00 [b]	2056.00 [a]	12.34
Weight gain (g/day)	40.00 [c]	42.14 [b]	45.00 [a]	3.68

Feed Intake (g/day)	90.00	90.00	90.00	3.54
Feed Conversion Ratio	2.25[c]	2.14[b]	2.00 [a]	0.21

[ab] Means within the same row without common superscripts differ significantly ($p<0.05$)

Table 3 : Intestinal mucosa morphology of broilers fed diets supplemented with different levels of Chromium Chloride.

Parameter	Diet 1 (Control)	Diet 2 (0.15mg/kg)	Diet 3 (0.25mg/kg)	SEM
Villus height (Ileum)	367.21[b]	529.15[a]	545.35[a]	8.97
Villus height (Jejunum)	519.65[a]	457.18[b]	460.24[b]	10.56
Crypt depth (Ileum)	84.13[a]	58.47[b]	60.22[b]	5.32
Crypt depth (Jejunum)	78.93	74.48	80.69	4.43

[abc] Means within the same row with different superscripts differ significantly ($p<0.05$)

IV. Discussion

This study showed that Chromium supplementation particularly at 0.25mg/kg improved the performance of the broilers in terms of the final weight, weight gain and feed conversion ratio. This is in line with the reports of Sands and Smith (1999). The authors reported that chromium supplementation has been found to improve the body weight gain and feed efficiency in broilers under heat stress. The better performance observed in birds on Diet 3 may be attributed to better metabolism of nutrients by Cr supplementation as dietary Chromium supplementation has been shown to positively affect growth rate and feed efficiency in growing poultry (Kheiri and Toghyani, 2009).

With regard to the intestinal mucosa development, the study showed that birds on Chromium-supplemented diets had significantly ($p < 0.05$) taller villi in the ileum than birds on the control diet. This is in line with the report of Sandikci et al. (2004). The authors reported that environmental conditions like heat stress could significantly modify intestinal histological parameters; they observed a significant reduction of the villus height in the duodenum, jejunum and ileum from quails exposed to heat stress. This explains why birds on the control diet had the shortest ileal villus height while those on Chromium-supplemented diets had higher ileal villus height. This also explains why the Chromium-supplemented birds especially those on diet 3 (25mg/kg) had higher mean values of final weight and weight gain than birds on the control diet as failure to preserve the morphometric integrity of the digestive system in stressed birds compromise the absorption of nutrients (Noy and Sklan, 1999) therefore altering the growth, development and performance of birds.

The jejunal villus height and ileal crypt depth were not affected by the heat stress as it was observed that birds on the control diet had taller jejunal villus height and deeper ileal crypts than birds on the Chromium-supplemented diets. The jejunal crypt depth values too showed no significant differences. It could be that the Chromium levels were not high enough to alleviate the effect of heat stress on the parameters in question. This however corroborates the findings of Marchini *et al.* (2011). The authors investigated the effects of heat stress on the body weight, intestinal length, mucous area, crypt depth, villus height and percentage of cells in proliferation activity in male broiler chickens and found out that heat stress did not influence the of PCNA positive cells, the area of the mucosa, crypt depth and villus height in the jejunum and ileum.

V. Conclusion

In conclusion, Chromium supplementation of broiler diets exerted some benefits on the performance characteristics. Further studies are however required to investigate the optimum inclusion levels of Chromium in broiler diets and its influence on the intestinal mucosa development.

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