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Dietary Inclusion of Organic Chromium on Production and Carcass Characteristics of Broilers*

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Abstract: An experiment was conducted to study the influence of dietary organic chromium on production and carcass characteristics of broilers for a period of six weeks with one hundred and twenty eight commercial, straight run day-old broiler chicks. These chicks were randomly grouped into four treatments with four replicates of eight chicks each. The treatment groups consisted of basal diet (T_1), 250 (T_2), 500 (T_3) and 750 (T_4) µg organic chromium per kilogram basal diet. The results revealed no significant difference in body weight gain, feed consumption, feed conversion ratio, and livability between treatment groups from first week to the end of the experimental period. The carcass yields did not differ between treatment groups. The abdominal fat-pad thickness was significantly ($P<0.05$) reduced in chromium-supplemented groups. However, moisture and ether extract content of breast and thigh muscle did not differ significantly between the treatment groups. However, the breast and thigh muscle protein levels were significantly ($P<0.05$) increased in 500 and 750 µg organic chromium supplemented groups compared to control. Breast and thigh muscle cholesterol was significantly lower ($P<0.05$) in chromium-supplemented groups as compared to the control group. Based upon the study, the supplementation of organic chromium in broiler ration did not improve the production performance. However, it may be used to produce lean meat.

Key words: Organic chromium, broilers, production performance, lean meat

Introduction

Trace minerals such as chromium, zinc and manganese in poultry diet play an important role in production performance. Chromium is recognized as essential for carbohydrate, lipid and protein metabolism in birds as it forms an active component of glucose tolerance factor (GTF), which makes the metabolic action of insulin more effective (Schwartz and Mertz, 1957). Chromium is one of the transition elements and occurs in valencies of +2, +3 and +6. The hexavalent chromium (Cr^{+6}) is inorganic and found to be toxic with poor absorption (0.5-3.0 per cent), while trivalent chromium (Cr^{+3}) is organic form has 25-30 per cent bioavailability (Mowat, 1994).

In broilers, dietary supplementation of trivalent organic chromium could result in improved growth rate, feed efficiency, meat yield and carcass quality with reduced carcass fat (Gursoy, 2000). Having several beneficial effects in broilers, organic chromium can be included in the broiler ration effectively since most diets are primarily composed of ingredients from plant origin which are usually low in chromium (Giri *et al.*, 1990). The present study was carried out to evaluate the performance of broilers by organic chromium supplementation.

Materials and Methods

One hundred and twenty eight commercial, straight run day-old broiler chicks belonging to a single hatch were purchased from a local hatchery, wing banded, weighed and randomly allotted into four treatment groups with four replicates of eight chicks each. The experimental diet was formulated according to the standards prescribed in Bureau of Indian Standards (B.I.S, 1992) and fed with basal diet (T_1), basal diet with 250 (T_2), 500 (T_3) and 750 (T_4) µg organic chromium for a period of six weeks.

The chicks were reared in broiler cages in a gable roofed, open sided house. All the chicks were provided with uniform floor, feeder and waterer space and were reared under standard managemental conditions throughout the experimental period of six weeks. Data on body weight and feed consumption were recorded every week and mortality was recorded at occurrence. From the above data, body weight gain, feed conversion ratio and livability were calculated. At the end of the experiment, three males and three females totally six birds per treatment group were randomly picked up and slaughtered. The pre-slaughter weight, eviscerated carcass weight, giblets weight, ready-to-cook carcass

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Table 1: Mean body weight gain (g), cumulative feed consumption (g/bird) and cumulative feed conversion ratio (± S.E.) of broilers from 1 to 6 weeks of age as influenced by dietary inclusion of organic chromium

Age	T1	T2	T3	T4
Body weight gain (g)				
I week	76.78±1.46	80.81±3.42	79.19±2.60	79.41±2.01
II Week	278.27±14.31	284.17±12.20	287.69±13.40	288.19±14.08
III week	556.52±16.43	569.25±14.95	552.33±9.25	576.02±5.52
IV Week	990.23±19.75	1024.50±28.36	997.14±20.20	1030.97±15.40
V week	1420.89±20.30	1479.68±25.02	1440.24±32.02	1487.39±14.71
VI Week	1873.34±27.41	1936.59±35.34	1885.89±41.56	1931.06±27.47
Cumulative feed consumption (g/bird)				
I week	87.43±0.46	93.43±1.11	92.59±1.24	89.89±2.45
II Week	393.51±4.87	409.46±1.78	399.98±7.25	404.04±6.34
III week	899.76±4.87	915.71±1.78	906.23±7.25	907.17±6.34
IV Week	1620.03±3.68	1663.79±30.65	1653.26±26.26	1658.84±13.99
V week	2375.93±5.07	2457.73±33.71	2426.67±35.95	2431.65±26.01
VI Week	3257.34±5.89	3351.23±47.49	3315.98±49.60	3333.26±39.72
Cumulative feed conversion ratio				
I week	1.13±0.02	1.15±0.05	1.16±0.03	1.13±0.01
II Week	1.41±0.03	1.44±0.05	1.39±0.04	1.40±0.02
III week	1.61±0.05	1.60±0.04	1.64±0.02	1.57±0.01
IV Week	1.63±0.03	1.62±0.02	1.65±0.01	1.60±0.01
V week	1.67±0.02	1.66±0.02	1.68±0.01	1.63±0.01
VI Week	1.74±0.03	1.73±0.02	1.76±0.02	1.72±0.02

percentage and abdominal fat pad thickness were recorded. The thigh and breast muscle samples were collected from each carcass and stored at –20°C for estimation of moisture, protein, ether extract and total meat cholesterol.

The data collected on various parameters were subjected to completely randomized design as per the methods suggested by Snedecor and Cochran (1989). Angular transformation was applied to percentages wherever needed before carrying out statistical analysis.

Results

Production parameters: The mean body weight gain, mean cumulative feed consumption and feed conversion ratio from 1 to 6 weeks of age of broilers as influenced by dietary inclusion of organic chromium are presented in Table 1.

Statistical analysis revealed no significant difference in body weight gain between the treatment groups. The body weight gain at sixth week of age was 1936.59, 1931.06, 1885.89 and 1873.34 g in T_2, T_4, T_3 and T_1, respectively. Analysis of data on cumulative feed consumption revealed no significant difference between treatment groups from first week to sixth week of age. The cumulative feed consumption was 3351.23, 3333.26, 3315.98 and 3257.34 g in T_2, T_4, T_3 and T_1, respectively at sixth week of age. The feed conversion ratio revealed no significant difference due to dietary inclusion of organic chromium and the mean feed conversion ratio of T_4, T_2, T_1 and T_3 were 1.72, 1.73, 1.74 and 1.76, respectively. Livability was 100 per cent in all the treatment groups as there was no mortality observed throughout the experimental period.

Carcass characteristics: The mean carcass yields, abdominal fat-pad thickness, muscle moisture, protein, ether extract and total cholesterol levels of broilers at 6 weeks of age as influenced by dietary inclusion of organic chromium are presented in Table 2.

The carcass yields viz. pre-slaughter weight, New York dressed weight, eviscerated weight, ready-to-cook percentage and giblets weight of broilers at 6 weeks of age did not differ significantly between the treatment groups by inclusion of organic chromium. Analysis of data on abdominal fat-pad thickness of broilers showed a significant ($P<0.05$) reduction in organic chromium supplemented groups as compared to control group. The mean abdominal fat-pad thickness was 0.26, 0.25 and 0.23 mm in T_2, T_3 and T_4, respectively which were lower ($P<0.05$) than the value observed in control group (0.33 mm).

Analysis of data revealed the breast and thigh muscle protein percentage showed a significant ($P<0.05$) difference between treatment groups. Significantly higher muscle protein levels of 25.78 and 25.62 per cent were recorded in breast muscle of birds supplemented with 750 µg and 500 µg of organic chromium per kg diet, respectively. Similarly, significantly higher thigh muscle protein percentage of 24.40 and 24.32 were observed in birds received 500 µg and 750 µg organic chromium in diet, respectively. The control group recorded the lowest breast and thigh muscle protein content of 23.34 and 22.53 per cent, respectively. The other group T_2 recorded intermediate muscle protein level in both breast (24.58 percent) and thigh (23.56 percent) muscle protein content at six weeks of age, with no significant difference from T_1.

The mean breast and thigh muscle moisture and ether

Table 2: Mean carcass yields, abdominal fat-pad thickness, muscle moisture, protein, ether extract and cholesterol (± S.E.) of broilers at 6 weeks of age as influenced by dietary inclusion of organic chromium

Parameters	T1	T2	T3	T4
Carcass yields				
Pre-slaughter live weight (g)	2102.81±56.86	2110.81±80.06	2083.68±77.15	2186.00±76.24
New York dressed weight (g)	1963.00±60.74	2006.37±68.41	1906.25±79.78	2024.00±63.76
Eviscerated weight (g)	1508.68±44.84	1584.43±60.56	1473.18±55.25	1575.31±53.00
Ready-to-cook (%)	76.22±1.31	77.82±0.34	76.24±0.27	76.37±0.44
Giblets (%)	5.80±0.17	5.34±0.21	5.52±0.12	5.60±0.15
Fat-pad thickness (mm)	0.33^{a}±0.04	0.26^{b}±0.01	0.25^{b}±0.02	0.23^{b}±0.01
Muscle Moisture (%)				
Breast	70.43±2.17	70.71±1.79	67.50±1.31	67.77±1.83
Thigh	71.25±0.74	68.95±1.50	69.22±1.98	66.04±0.93
Muscle Protein (%)				
Breast	23.34^{b}±0.40	24.58^{ab}±0.81	25.62^{a}±0.37	25.78^{a}±0.30
Thigh	22.53^{b}±0.46	23.56^{ab}±0.39	24.40^{a}±0.42	24.32^{a}±0.22
Muscle Ether Extract (%)				
Breast	5.52±0.09	5.39±0.24	5.13±0.41	5.09±0.29
Thigh	6.01±0.22	5.89±0.22	5.71±0.32	5.72±0.31
Muscle Cholesterol (mg per cent)				
Breast	77.62^{a}±4.19	67.32^{b}±2.05	67.27^{b}±2.95	64.49^{b}±3.53
Thigh	106.06^{a}±2.57	97.65^{b}±2.34	96.14^{b}±2.52	96.99^{b}±2.34

Value given in each cell is the mean of six observations. ^{a,b}Means within a column with no common superscript differ significantly (P<0.05)

extract at 6 weeks of age did not differ significantly between the treatment groups by supplementing organic chromium. Analysis of variance of data on breast and thigh muscle total cholesterol showed a significant (P<0.05) reduction in organic chromium supplemented groups than control group. The birds supplemented with 750 µg organic chromium per kg diet (T_4) recorded lowest breast muscle cholesterol level of 64.49 mg per cent while control group (T_1) had significantly (P<0.05) high breast meat cholesterol level of 77.62 mg per cent. The other two treatment groups recorded the intermediate levels, which were also significantly (P<0.05) lower than control group. Similarly, the broilers fed diet with 500 µg organic chromium per kg diet (T_3) had significantly (P<0.05) less thigh muscle cholesterol (96.14 mg per cent) followed by T_4 (96.99 mg per cent) and T_2 (97.65 mg per cent) as compared to control group (106.06 mg per cent). However, the total cholesterol in breast and thigh muscle did not significantly differ between chromium-supplemented groups.

Discussion

Production parameters: Statistical analysis of data on body weight gain revealed no significant difference among the treatment groups due to dietary inclusion of organic chromium. The non significant difference in body weight gain between chromium supplemented and control groups were also reported by Motozono *et al.* (1998) who reported addition of chromium picolinate at the rate of 0, 200 and 400 ppb to the broiler diet did not significantly affect the sixth week body weight. Similarly, Kalaycioglu *et al.* (1999), Uyanik *et al.* (2000) expressed the same opinion on inclusion of chromium in broiler diet. Lee *et al.* (2003) observed that supplementation of chromium with basal diet at 0, 200,400 and 800 ppb chromium picolinate did not affect growth performance of broilers.

On the contrary, Kim *et al.* (1996b) observed highest (P<0.05) body weight gain in broilers fed diet containing 100 per cent NRC recommended crude protein with 200 ppb chromium picolinate. Similarly, Bhuvnesh Kumar *et al.* (2004) observed the growth rate tend to increase with increasing chromium level in diet with no significant difference in body weight and growth rate between the treatment groups.

The analysis of variance of data on mean cumulative feed consumption and feed conversion ratio revealed no significant difference between treatment groups. This finding favourably compared with those earlier reports of Motozono *et al.* (1998) who reported that inclusion of chromium picolinate at 0, 200 and 400 ppb had no effect on feed intake and feed conversion ratio in broilers at six weeks of age. Sahin *et al.* (2001) and Amatya *et al.* (2004) expressed similar opinion about the inclusion of organic chromium in chicken diet. However, Zhang *et al.* (2002) observed significantly increased FCR by 6.2 per cent when broilers fed diet with 800 µg/kg chromium.

Livability was 100 per cent in all treatment groups throughout the experimental period. This finding is in agreement with report of Kim *et al.* (1996b) who observed no mortality in broilers fed with 100 per cent NRC recommended crude protein diet with 200 ppb chromium picolinate.

Carcass characteristics: Carcass yields viz. pre-slaughter, New York dressed, eviscerated, ready-to-cook percentage and giblets weight at 6 weeks of age did not differ significantly due to dietary inclusion of organic chromium. This report is in agreement with findings of Motozono *et al.* (1998) who reported that the dietary chromium supplementation did not influence the weight of skin-on breast and thigh meat and percentage of these meats per body weight. Contrary to this finding Anderson *et al*. (1989) reported that chromium supplementation increased the breast yield in broilers.

The analysis of data on abdominal fat-pad thickness of broilers showed a significant ($P<0.05$) reduction in organic chromium supplemented groups as compared to control group. The lowest abdominal fat-pad thickness was recorded in T_4 followed by T_3 and T_2, which were significantly lower as compared to T_1 at six weeks of age. However, the abdominal fat-pad thickness did not differ significantly between chromium supplemented groups and thickness was decreased as the level of organic chromium This is in agreement with the earlier findings of Motozono *et al*. (1998) who reported that supplementation of broiler diet with chromium picolinate at 200 and 400 ppb had a tendency to depress the abdominal fat content with increase in dietary chromium content. Similarly, Kwon *et al*. (1999) also recorded significantly lesser abdominal fat weight of broilers, when the diet was supplemented with organic chromium at 5 mg/kg diet; Lien *et al*. (1999) at 1600 and 3200 µg/kg organic chromium in broiler diet. Lien *et al*. (1999) also reported that supplementation of 400 µg/kg of chromium increased lipogenesis capacity but decreased the abdominal fat content. This contradictory result may be attributed to the stimulating effect on protein synthesis by a supplement of chromium.

The breast muscle protein percentage was significantly ($P<0.05$) higher in broilers received basal diet with 750 µg of organic chromium (T_4) and 500 µg of organic chromium (T_3) as compared to control group (T_1). The breast muscle protein content of broilers received basal diet with 250 µg organic chromium supplementation did not differ from the value observed in control group as well as from those values observed in 750 µg and 500 µg chromium supplemented groups.

The protein percentage in thigh muscle depicted a similar trend as that of the breast muscle. These are in agreement with the earlier findings of Ward *et al*. (1993) who concluded that 200 ppb of chromium picolinate increased the carcass protein in 3 weeks old broiler chicks. The same opinion was expressed by Kim *et al*. (1996a) when chicks fed diet with either 200 or 400 ppb chromium showed highest muscle protein content. Amatya *et al*. (2004) observed a non significant increase in protein accretion in broiler meat when chromium was supplemented with 0.2 mg/kg broiler diet. However, Motozono *et al*. (1998) reported that muscle protein content was not affected by dietary chromium supplementation at 200 and 400 ppb in broilers.

The moisture and ether extract content of breast and thigh muscle did not differ significantly between treatment groups though a numerical decrease was observed in the breast and thigh muscles of T_3 and T_4 as compared to T_1. Ward et *al*. (1993); Hossain (1995); Kim *et al*. (1996a); Hossain *et al*. (1998); Motozono *et al*. (1998) and Lien *et al*. (1999) had recorded less fat content in muscle of broilers fed diet with chromium at different levels.

Significant increase in muscle protein content may be attributed to the stimulating effect of protein synthesis by a supplement of chromium (Lien *et al*., 1999), as a cofactor of insulin promoting insulin activity and enhancing the amino acid uptake into muscular cells for protein synthesis (Chen *et al*., 2001).

Analysis of data on breast and thigh meat cholesterol showed a significant ($P<0.05$) difference between control (T_1) and chromium supplemented groups (T_2, T_3 and T_4). However, there was no difference among chromium-supplemented groups. The observed breast muscle cholesterol values were higher than earlier reports of Bakalli *et al*. (1995) and Pesti and Bakalli (1996) who recorded 57.22 mg per 100 gm wet tissue and 53.3 mg per 100 g at 42 days of age, respectively. However, this breast muscle cholesterol values of chromium supplemented groups are nearer to the values observed by Raj Manohar (2000) who recorded 63.61 mg per cent at 43 days of age in broilers. Control group (T_1) had 106.06 mg per cent thigh muscle cholesterol which coincide with the values of Raj Manohar (2000) who observed 108.73 mg per cent thigh muscle cholesterol at 43 days of age in broilers. However, chromium supplemented groups had lesser thigh muscle cholesterol ranged from 96.14 to 97.65 mg per cent.

From the above study, it was concluded that dietary supplementation of organic chromium did not improve the production performance and carcass yields though it decreased the muscle cholesterol, improved the muscle protein and hence may be used to produce the lean meat.

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