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Effect of dietary supplementation of organic chromium on feed intake, growth performance and economics in commercial broiler chickens

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Abstract
The present study was carried out to evaluate the effect of supplementation of organic chromium (CrPro) in the diet of broiler chickens. A total of two hundred, day old broiler chicks of Cobb-400 strain were divided into four treatment groups with 5 replicates of 10 chicks in each and were assigned to four iso-nutritive diets, viz., T_1: Control (Feed without CrPro supplementation), T_2: CrPro supplementation in feed @ 400 µg/kg, T_3: CrPro supplementation in feed @ 800 µg/kg and T_4: CrPro supplementation in feed @ 1200 µg/kg. The feeding experiment was carried out for 42 days and feed intake, weight gain, feed conversion ratio and economics of feeding were assessed. Supplementation of CrPro at different levels did not have any significant effect on total feed intake and final body weights of CrPro supplemented groups as compared to the control. The total body weight gain (g/bird) in T_4 group was significantly (P<0.05) higher than the control group (T_1). Feed conversion ratio of birds in T_2, T_3 and T_4 groups found numerically improved as compared to the control group (T_1). When profit over control in terms of rupees per bird was calculated, it were found to be 5.20, 4.14 and 2.65 more profit in T_4, T_3 and T_2, respectively. It is concluded that supplementation of organic chromium improves the performance of broilers when added at the rate of 1200 µg/kg broilers' ration.

Keywords: Broiler chickens, body weight, feed intake, organic chromium

1. Introduction
Poultry production sector in developing countries are facing some problems, ensuring feed availability at affordable price remains the key concern for the poultry industry with more than 70 percent of production cost being in the form of feed. Nevertheless, the quality of the feed also plays a major role in poultry production [1]. Micronutrients being vital components, unless the poultry diet is well formulated and balanced, it is likely that deficiencies will occur. The functions performed by minerals can only be fulfilled if sufficient amounts of the ingested minerals are absorbed and retained to keep pace with growth, development and reproduction and to replace minerals that are lost as products, such as meat or eggs. Natural feedstuffs such as corn, wheat, soybean meal, rice bran, etc. contain essential minerals. However, trace elements are often in a form which renders them unavailable to the bird or may not be in adequate concentrations. Hence, most of the trace minerals must be added to the diet for optimal growth and production. Twenty two mineral elements are believed to be essential for animal life, out of which, chromium (Cr) is also considered as a trace mineral [2]. Following the ban on the use of antibiotics as growth promoters in animal nutrition by the European Union (EU) in 2006, the nutritionists and researchers attempted other alternatives to enhance the performance of broiler chicken. One such alternative is the use of Cr as a feed additive in the broiler production.
Chromium, which exists in nature mostly is in the trivalent form (Cr^{+3}), thought to be essential for activating certain enzymes and for stabilizing proteins and nucleic acids. Its primary role in metabolism of carbohydrate, lipid, protein and nucleic acid [3], to potentiate the action of insulin [4], one of the most important anabolic hormones, through its presence in an organo-metallic molecule called glucose tolerance factor [5]. Dietary chromium supplementation has been shown to positively affect the growth rate, feed efficiency and carcass characteristics in broilers [6, 7, 8, 9]. Bioavailability of organic source of chromium is ten times higher than inorganic sources. Therefore, present study was planned to evaluate the beneficial effect of organic chromium supplementation at a different level on performance of broiler chickens.

2. Materials and Methods

The present experiment was carried out at Poultry unit of Instructional Livestock Farm Complex, College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh. Total 200 day-old broiler chicks of cobb-400 strain with average body weight of 45 g were wing banded and distributed randomly into four groups having five replicates of 10 birds in each by completely randomized design and were assigned to four iso-nutritive diets, *viz.*, T_1: Control (Feed without CrPro supplementation), T_2: CrPro supplementation in feed @ 400 µg/kg, T_3: CrPro supplementation in feed @ 800 µg/kg and T_4: CrPro supplementation in feed @ 1200 µg/kg. Organic chromium (KEMTRACE Chromium dry powder) was procured from Kemin Industries South Asia Pvt. Ltd., Chennai, India. Ingredients composition of these starter and finisher rations are presented in Table 1.

All the experimental birds were reared in well ventilated shed in deep litter pens and reared under uniform management conditions. They fed with organic chromium powder supplementation as per treatments and clean drinking water was supplied to the birds *ad-libitum* throughout the study period to meet the nutrient as per BIS [10]. All the birds were weighed weekly in the morning, before feeding and watering. Feed intake was calculated by measuring the amount of feed offered and residue left after 24 hours. Feed conversion ratio was calculated by dividing the feed intake with weight gain. Vaccination and other routine poultry management practices were carried out neatly. While calculating the economics, the cost of chicks, brooding, labour, etc. were identical for all the groups hence ignored. Total feed cost was calculated by considering feed cost as variable and comparative economics was calculated for all the experimental groups. Average final body weights of the birds were recorded at the end of the experiment. Selling price per kg live weight was 66 rupees. Return over feed cost for the particular group was calculated by the income from the sale of birds subtracted by the cost incurred on total feed consumed by the group. From each experimental diet, representative samples of feeds were analyzed for proximate composition using standard methods of AOAC [11]. The data generated during this experiment were subjected to statistical analysis using one way ANOVA as described by Snedecor and Cochran [12]. The significance of the mean difference was tested by Tukey [13] post hoc test.

3. Results and Discussion

3.1 Nutrient composition of experimental rations:

Nutrient composition of starter and finisher feed is given in Table 2. All the feeds were found to be iso-nitrogenous and comparable with respect to their proximate composition.

3.2 Feed intake (g/bird/week)

Statistical analysis revealed non-significant effect of organic chromium supplementation on total feed intake (Table 3). However, numerically highest total feed intake was found in T_1 group followed by T_4, T_3 and T_2 groups. It has shown that there is no effect of smell and/or taste of organic chromium powder on the palatability of feed in the diets of broilers. In agreement with the present findings many workers [8, 9, 14, 15, 16, 17, 18] reported non-significant (P>0.05) effect of chromium supplementation on feed intake in broilers. While, some researchers [19, 20, 21] reported significantly (P<0.05) higher feed intake of chromium supplemented groups as compared to control.

3.3 Body weight

Results revealed that birds of all organic chromium supplemented groups attained numerically but non-significant (P>0.05) higher body weight as compared to control (Table 3). The highest total body weight was observed in T_4 group supplemented with 1200 µg organic chromium/kg diet. The body weight (g/bird) of experimental birds during different weeks showed non-significant difference among different treatment groups up to the entire experimental period. These findings are in accordance with the workers [8, 16, 22, 23] who reported non-significant (P>0.05) effect of chromium supplementation on body weight in broilers. On the contrary, other workers [14, 20, 21, 24] reported significant (P<0.05) effect of chromium supplementation on body weight in broiler chickens.

3.4 Average weekly body weight gain

The total body weight gain (g/bird) in T_4 group was significantly (P<0.05) higher as compared to control (T_1) and T_1, T_2 and T_3 groups are non-significantly different from each other (Table 3). It indicates the beneficial effect of organic chromium supplementation, chromium supplementation improves the protein retention, uptake of amino acids by tissues and muscle cells and also enhance the body weight [25]. The results are corroborated with the findings of [14, 20, 21, 26] who reported significant (P<0.05) effect of chromium supplementation on body weight gain in broilers. However, some researchers [15, 22, 27] reported non-significant (P>0.05) effect of chromium supplementation on body weight gain in broilers.

3.5 Feed conversion ratio (FCR)

Result revealed that birds of T_2, T_3 and T_4 groups showed numerically improved FCR as compared to control group (T_1). Improved FCR in T_4 might be due to the improved metabolic rate in birds supplemented with chromium as it is an essential nutrient that increases glucose transport into cells by promoting insulin activity. So, the birds fed chromium were able to more effectively metabolize energy reflected in better FCR [28]. In support of present findings the non-significant (P>0.05) effect of chromium supplementation on feed conversion ratio in broiler chickens is previously reported by several authors [8, 9, 15, 16]. On the contrary, [14, 21, 29] reported significant (P<0.05) effect of chromium supplementation on feed conversion ratio in broilers.

3.6 Return over feed cost

Average in terms of (Rs./bird), income from selling of birds and feed cost of broilers under different treatment groups has been shown in Table 4 and 5. The total income through the sale of chicken was (Rs) 7128, 7161, 7260 and 7359 in T_1, T_2, T_3 and T_4 groups, respectively. The total return over feed cost was (Rs) 1997.44, 2129.88, 2204.64 and 2257.48 in T_1, T_2, T_3 and T_4 groups, respectively. When profit over control in terms of rupees per bird was calculated, it was found to be 5.20, 4.14 and 2.65 more profit in T_4, T_3 and T_2, respectively. By observing the data of profit/bird over control, it is clear that maximum benefit was observed in T_4 group supplemented with 1200 µg organic chromium/kg diet supplemented group. Similarly, Kulkarni [8] reported that the cost/kg live weight was reduced significantly (P<0.05) due to supplementation of chromium.

Table 1: Ingredients composition of feed

Ingredients	Broiler Starter (Kg)	Broiler Finisher (Kg)
Maize	61.00	64.00
Soya bean DOC	33.27	28.40
Calcite powder	1.25	1.25
DCP	1.00	1.00
Vitamins	0.05	0.05
Vitamin B_{12}	0.01	0.01
Trace minerals	0.10	0.10
Choline Chloride 60%	0.10	0.10
Lysine	0.25	0.16
Methionine	0.18	0.15
Phytase	0.01	0.01
Enzyme	0.05	0.05
Salt	0.10	0.10
Sodium Bicarbonate	0.36	0.35
Liver Tonic	0.10	0.10
Immuno-modulator	0.05	0.05
Toxin Binder	0.10	0.10
Growth promoter	0.02	0.02
Anti-coccidial	0.05	0.05
Emulsifier	0.05	0.05
Oil	1.90	3.90
Total (Kg)	100.00	100.00
Cal. ME (Kcal/Kg)	2936	3083

Table 2: Proximate composition of experimental feeds (on %DM Basis)

Nutrient	Treatments							
	Starter Feed				Finisher Feed			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
DM	89.90	90.26	89.46	90.00	90.86	89.73	89.93	90.03
OM	93.00	92.60	92.60	92.50	92.80	93.10	92.70	92.40
CP	22.44	22.31	22.44	22.30	20.21	20.42	20.21	20.47
EE	4.33	5.33	4.49	4.49	4.50	4.99	4.16	4.99
CF	4.25	3.75	3.75	4.25	3.00	3.00	3.25	2.75
NFE	61.98	61.21	61.92	61.46	65.09	64.69	65.08	64.19
TA	7.00	7.40	7.40	7.50	7.20	6.90	7.30	7.60
Ca	0.92	0.95	0.94	0.93	0.98	0.93	0.97	0.95
P	0.46	0.51	0.53	0.52	0.53	0.51	0.52	0.54

EE=Ether extract, DM=Dry matter, OM=Organic matter, CP=Crude protein, CF=Crude fiber, NFE=Nitrogen free extract, TA= Total ash, Ca= Calcium, P=Phosphorus

Table 3: Performance of experimental birds

Particulars	Treatments				p value
	T_1	T_2	T_3	T_4	
Initial body weight (g)	45.00	44.98	44.60	44.40	NS
Av. total feed intake (g)	4055.62	3972.94	3989.28	4022.60	NS
Final body weight (g)	2160.90	2167.84	2199.30	2235.68	NS
Total weight body gain (g)	2115.70^{b}	2122.86^{ab}	2154.70^{ab}	2191.28^{a}	*
Feed conversion ratio	1.92	1.87	1.85	1.84	NS

Means with different superscripts within the treatment groups differs significantly (*P<0.05, NS: Not significant)

Table 4: Cost of feeds under different feed supplement groups

Particulars	T_1	T_2	T_3	T_4
Type of feed				
Broiler starter (Rs./kg)	24.79	24.81	24.83	24.85
Broiler finisher (Rs./kg)	25.53	25.55	25.57	25.59

Table 5: Return over feed cost realized under different feed supplement groups

Particulars	T_1	T_2	T_3	T_4
Total income through sale of birds (Rs.)	7128	7161	7260	7359
Total return over feed cost (Rs.)	1997.4	2129.9	2204.6	2257.5
Profit/ chick (Rs.)	39.94	42.60	44.09	45.15
Profit over control/chick (Rs.)	-	2.65	4.14	5.20

4. Conclusion

It may be concluded that dietary supplementation of organic chromium @ 1200 µg/kg diet significantly increased body weight gain. It also numerically improved feed intake, feed conversion ratio and growth performance. It can be inferred that use of organic chromium @ 1200 µg/kg supplementation improves overall performance, return over feed cost and profit per bird in commercial broiler chickens without any adverse effect.

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