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Effect of dietary supplementation of organic minerals on carcass traits of broilers

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Abstract
A study was conducted to assess the effects of replacing inorganic 'zinc' and 'manganese' with different levels of their organic complexes on carcass characteristics in broilers. Experiment I was conducted with 300 broiler chicks in two different phases, 0-4 weeks, 4-6 weeks for a period of 16 week. Experimental birds were divided into six groups, each consisting of 50 broiler chicks and all groups were also subdivided into five replications each containing 10 broiler chicks. The basal ration was formulated as per BIS (2007) specifications to meet energy and protein requirements of birds. In both the experiments, first group was kept as negative control (T1) containing mineral mixture without 'zinc' and 'manganese' and T2 (positive control containing mineral mixture with inorganic salts of 'zinc' and 'manganese') while experimental groups T3, T4, T5 and T6 were supplemented with mineral mixture incorporated with organic 'zinc' and organic 'manganese' @ 50 and 100% in substitution of their inorganic sources. The highest body weight gain and improved FCR in broilers was observed in T6 group which resulted into higher carcass traits showing highest dressing % (76.07), eviscerated % (63.36) and drawn % (67.45) in T6 group. Total weight of lymphoid organs was also significantly (P<0.05) inflated in T6 group.

Keywords: broilers, carcass characteristics, manganese, zinc

Introduction

In India, the per capita consumption of chicken has gone up from 400 grams per annum, to 2.5 kg per annum in the last five years. The growth rate of broiler market is 8-10% per annum. India is the fourth-largest chicken producer in the world after China, Brazil and the USA (Statista, 2017) [11]. India has exported 544,985.06 MT of poultry products to the world for the worth of Rs.687.31 crores during the year 2018-19 (APEDA).

In poultry diet, micro minerals deserve attention as they exert essential functions in the organism, but in modern poultry nutrition effective use of micro minerals are overlooked. Micro minerals, especially, 'zinc' and 'manganese' are important component of many enzymes or catalysts which play essential role in all biochemical reactions in the body. They are constituent of hundreds of protein, of vital relevance to the animal metabolism, hormone secretion pathways. Furthermore, trace mineral supplements can augment immune system function which eventually may lead to an improvement in bird's growth and be economically beneficial.

Zinc' has been found in every tissue of the bird but the element tends to accumulate in the bones rather than the liver, which is the main storage organ of the other trace elements. Most of the 'zinc' in blood is present in the erythrocytes. 'Zinc' is present as a co-factor in over 300 metalloenzymes, representing all six classes of enzymes and plays an essential role in many metabolic processes, including protein synthesis (O'Dell, 1992; Salim *et al.*, 2008) [8]. 'Zinc' is also a component of lactic dehydrogenase and, therefore, is important for the conversions of pyruvic acid and lactic acid. Also, 'zinc' is a component part of some peptidases and therefore is important for digestion of proteins in the gastrointestinal tract. So deficiency of 'zinc' would exert a negative influence on protein and carbohydrate metabolism and leads to reduced feed intake, decreased tissue growth, poor FCR, abnormalities in immunological, reproductive processes, skeletal and skin tissues (Underwood and Suttle, 1999) [13]. In chicks, 'zinc' deficiency symptoms include, slow growth, reduced weight, shortened and thickened long bones and poor feathering, with keratosis resulting when the deficiency is severe.

Manganese ('Mn') is also a necessary trace mineral in the activation of metalloenzymes that contribute to the metabolism of carbohydrates, lipids and amino acids (Suttle, 2010) [12]. 'Manganese' is required for oxidative phosphorylation in mitochondria, fatty acid synthesis and acetate incorporation into cholesterol, mucoploysaccharide synthesis and bone matrix cell maturation in chicks. It is also an important component of the 'Mn' superoxide dismutase ('Mn'-SOD) that protects cells from oxidative stress (Li *et al.*, 2011) [7].

'Manganese' also participate in various structural and physiological functions, which include oxidant defense system, also plays a significant role in the chicken's body in the formation of chondroitin sulfate which is required for the formation of skeletal and cartilage tissue. Deficiency of 'manganese' in poultry will result in perosis, bone shortening, bowing.

In commercial poultry diets, the majority of these trace minerals are supplemented as inorganic forms (sulphate or oxide salts) which suffer from high rates of loss due to dietary antagonism. Use of organically complexed trace minerals can help to prevent these losses, due to increased stability in the upper gastrointestinal tract. Also competition for the same or similar carriers is a major interference when metals are transferred from the lumen into the enterocyte (Hill & Matrone, 1970) [5]. Use of organically complexed or chelated minerals in premixes has been suggested as a solution to this problem.

Material and Methods

Three hundred, day old broiler chicks were randomly divided into six treatment groups with 5 replicates of 10 birds in each replication following completely randomized design (CRD). Feed ingredients used in the diet formulations were analyzed for the proximate nutrients (AOAC, 2013) [1]. The ingredient and chemical composition of diet given during pre-starter, starter and finisher phases is presented in Table 1.Basal ration formulated as per BIS (2007) [3] to fulfill the metabolizable energy (ME), crude protein and limiting amino acids (methionine and lysine) requirement of birds. Level of crude protein in pre-starter and starter ration was 22 percent and in finisher phase 20 percent. The respective ME content was 3001.7 and 3154.2 KCal/kg. Chemical composition of feed ingredients used to formulate the basal ration is given in Table 2.

Table 1: Ingredients and Chemical Composition (%DM Basis) of Experimental Diets in Different Growth Phases of Broiler Chicks

Ingredients (Kg/100kg)	**Pre-starter**	**Starter**	**Finisher**
Maize	58	58	60
Soybean Meal	30	30	25
Fish Meal	7	7	7
Vegetable Oil	3	3	6
Mineral Mixture	2	2	2
Feed additives (g/100kg feed)			
Spectromax	10	10	10
Spectromax BE	20	20	20
Chlortetracycline	33.5	33.5	33.5
Veldot	50	50	50
Choline chloride	50	50	50
Lysine	50	50	50
DL-methionine	150	150	150
Chemical Composition (%DMB)			
Moisture	11.54	11.54	11.48
Dry Matter	88.46	88.46	88.52
Crude Protein	22.01	22.01	20.10
Ether Extract	3.32	3.32	3.61
Crude Fibre	4.89	4.89	4.85
Ash	9.11	9.11	9.22
Nitrogen Free Extract	49.13	49.13	50.74
Metabolizable Energy(Kcal/Kg)	3001.7	3001.7	3154.2
'Zinc' (mg/Kg)	23.63	23.63	22.67
'Manganese'(mg/Kg)	6.24	6.24	5.53

Moisture, dry matter, crude protein, crude fibre, ash, NFE, ME, 'zinc' and 'manganese' are analysed data.

For the experimental diets, mineral mixture was prepared using inorganic forms of all components except 'Zn' and 'Mn'. Organically complexed 'Zn' and 'Mn' were separately added in mineral mixture at proportion of their inorganic form in positive control group. In dietary treatments, first group was kept as negative control (T_1) containing mineral mixture without zinc and manganese and T_2 (positive control containing mineral mixture with inorganic salts of zinc and manganese) while experimental groups T_3, T_4, T_5 and T_6 were supplemented with organic zinc and organic manganese @ 50 and 100% in substitution of inorganic sources. Birds were reared in deep litter system at poultry farm and were offered feed and water *ad libitum* through linear feeder and watered. Proper ventilation was also provided.

Table 2: Chemical Composition of Feed Ingredients

Ingredient	**CP (%)**	**EE (%)**	**CF (%)**	**TA (%)**	**Lysine* (%)**	**Methionine* (%)**	**ME* (kcal/kg)**	**Cost (Rs.)**
Maize	9.10	3.44	2.44	2.25	0.18	0.15	3300	1545
Soyabean meal	45.2	3.16	3.93	8.47	2.57	0.76	2230	2722
Fish meal	47.4	1.76	5.15	26.6	1.42	1.42	2210	3847

*calculated values Singh and Panda (1998)

A metabolism trial was conducted during 6th week of growth period and one bird from each replicate was randomly selected and transferred to metabolic cages. A preliminary period of two days was given for adaptation to the birds to new system of housing and management, followed by a collection period of three days.

For carcass evaluation, one bird from each replicate was selected randomly, at the end of 6th week. The birds were kept off feed and water was withdrawn three hours prior to their sacrifice. Immediately after recording their live weights, the birds were sacrificed by severing the jugular vein and allowed to bleed completely following 'Halal' method. Their heads were removed at the atlanto-occipital joint and shank at hock joint. The dressed weight thus obtained was recorded as follows.

Dressed weight = Live weight – (blood + feathers + head + shank + skin losses). Dressing percentage was calculated as follows.

$$\text{Dressing percentage} = \frac{\text{Dressed weight}}{\text{Live weight}} \text{ x } 100$$

Dressed birds were then eviscerated by removing the crop, trachea and viscera as a whole. A horizontal cut was given rear to the keel bone, thereby the breast was a little upturned and pushed forward, exposing the viscera along with the visceral organs, which were then removed completely by pulling. The lungs were scrapped off and the heart, liver and gizzard constituting giblets, were removed carefully from the viscera. The gall bladder was removed with care from liver to avoid its puncture. The gizzard was opened and its contents washed out and inner epithelial lining discarded. The heart was made free from blood and adhering vessels. The eviscerated and drawn weights were recorded and their percentage was calculated.

Eviscerated weight = Dressed weight – weight of viscera

$$\text{Eviscerated percentage} = \frac{\text{Eviscerated weight}}{\text{Live weight}} \times 100$$

Drawn weight = Eviscerated weight + weight of giblets

$$\text{Drawn percentage} = \frac{\text{Drawn weight}}{\text{Live weight}} \times 100$$

Separate weight of heart, liver, spleen and gizzard were also recorded after washing and bloating and their relative weights (percentage of live weight were then calculated).

Statistical Analysis

The resultant data were statistically analysed according to the procedure laid down by Snedecor and Chochran, (1994) [10]. Analysis of variance was used to study the differences among treatment means and they were compared by using Duncan's Multiple Range Test (DMRT) as modified by Kramer (1956) [10].

Result and Discussion

Table 3: Weight of carcass traits and lymphoid organs during different growth periods under different dietary treatments

Treatment	T1	T2	T3	T4	T5	T6
Dressing%	73.37^{c}±0.23	74.06^{bc}±0.45	75.32^{ab}±0.64	74.88^{ab}±0.46	75.09^{ab}±0.49	76.07^{a}±0.43
Eviscerated%	61.27^{b}±0.23	62.16^{ab}±0.45	62.88^{a}±0.64	62.65^{ab}±0.46	62.97^{a}±0.49	63.36^{a}±0.43
Drawn%	65.24^{c}±0.22	66.13^{c}±0.46	66.87^{b}±0.64	66.64^{b}±0.46	66.94^{b}±0.50	67.45^{a}±0.44
Giblet%	3.96^{b}±0.01	3.98^{b}±0.01	3.99^{b}±0.01	3.99^{b}±0.01	3.99^{b}±0.01	4.09^{a}±0.03
Total weight of lymphoid(g)	16.40^{b}±0.75	16.30^{b}±0.74	17.10^{b}±0.75	16.60^{b}±1.08	17.20^{b}±0.58	20.00^{a}±0.63
Spleen(g)	3.40^{b}±0.25	3.50^{b}±0.22	3.70^{b}±0.20	3.40^{b}±0.24	3.40^{b}±0.25	4.40^{a}±0.25
Bursa(g)	3.80 ±0.20	3.60 ±0.25	4.20±0.37	4.00±0.45	3.80±0.37	4.80±0.66
Thymus(g)	9.20±0.58	9.21±0.58	9.21±0.58	9.20±0.58	10.0±0.54	10.80±0.37

Means bearing different superscripts in a row differ significantly ($P<0.05$)

Dressed weight of different dietary treatments ranged from 77.37% (T1) to 81.07% (T6). It was observed that addition of organic minerals in the diet of the broilers had significantly increased dressing % in comparison to negative control group (T1) and inorganic minerals supplemented group (T2). The highest eviscerated weight % was observed in birds receiving 100% organic minerals group T6 (63.36%) in feed followed by T5 (62.97%) and T3 (62.88%) and difference was significant as compared to the negative control (T1) and positive control groups (T2). Among different dietary treatments, drawn weight % in T6 (67.45%) and T5 (66.94%) was significantly higher as compared to the negative T1 (65.24) and positive control group T2 (66.13). Significantly ($P<0.05$) higher weight of giblet was observed in T6 (4.09) as compared to the negative control group and other dietary treatments.

The lymphoid organs weight was observed significantly ($p<0.05$) high in birds receiving dietary treatment T6 (20.00g) as compared to other dietary treatments. The effect of supplementing organic minerals in broiler diet did not impart any significant divergence on bursal and thymus weight. However, spleen weight was significantly improved in 100% organic minerals supplemented group (T6) as compared to other dietary treatments. Results of the present study indicated that dietary supplementation of organic 'Zn' and 'Mn' significantly increased carcass weight, dressing (%) and breast muscles (%) which are in coincident with findings of El-Husseiny *et al.* (2012) [4].

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