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Performance of Coloured Broilers fed with Organic Source of Zinc (Zn) and Manganese (Mn)

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ABSTRACT

An experiment was conducted to evaluate the effect of feeding organic source of Zn and Mn on growth performance of coloured broilers. Three hundred and twenty coloured broilers were assigned to four dietary treatments with four replicates of twenty broilers each. The experimental birds were fed one of the following four diets. T1-Basal diet (Control) with 100% supplementation of Zn and Mn from inorganic source, T2- Basal diet with 100% supplementation of Zn and Mn from organic source, T3- Basal diet with 80% supplementation of Zn and Mn from organic source and T4 Basal diet with 70% supplementation of Zn and Mn from organic source. The inorganic supplementation was $ZnSO_4$ and $MnSO_4$. The experimental diets were fed to birds for 42 days of age. Data was collected for weekly cumulative body weight, weekly cumulative feed consumption and FCR. Among the organic source fed groups 100 per cent replacement of organic source of Zn and Mn (T_2) showed higher body weight (1375 g) followed by T_4 (1329 g), T_3 (1326 g) and Control T1(1252 g).Among the organic source fed groups 100 per cent replacement of organic source of Zn and Mn (T_2) showed better FCR (2.09) followed by T_1(2.15), T_3 (2.26) and T_4 (2.30).Thus organic minerals can be included at much lower levels in the diet than the current recommendations for inorganic minerals, without any negative affect on broiler performance.

Keywords: Broilers, Organic, Zinc, Manganese and methionine

The total poultry population in India is 729.2 million, which is 12.39 percent higher than numbers in the previous census (Livestock Census, 2012). Poultry is one of the fastest growing sectors of Indian agriculture today, with annual growth rates of 4.55 percent in broiler production. The total broiler pproduction is 4.6 million tons (Index Mundi, 2018). India is the fourth largest producer of poultry meat in the world after China, Brazil and USA, valued at US$ 6.6 billion. Poultry production accounts for about 0.66 percent of India's GDP and 7.72 percent GDP from the livestock sector (Prabakaran, 2014; Rajendran *et al.,* 2014). India's per capita consumption of broiler meat is just 3.35 Kg per person per year against recommended level of 10.8 kg by Indian Council Medical Research. (DAHD, 2017). Broiler production in India has continuously faced challenges of providing optimum environment for maximum growth, production, disease control and finally the cost benefit ratio involved for a successful poultry husbandry practices.

Zinc is required in the diet of broilers at 60 mg of the diet (BIS, 2007). Zinc plays a key role in enzyme activity, cell replication, and development of bone and cartilage, and Zn deficiency could cause delayed sexual development (Naz *et al.,* 2016). Often either ZnO or $ZnSO_4$ is added to the diet. Not only there is a need for cheap sources of the mineral, but excess Zn in the feed could lead to excess

Zn excretion and adverse environmental effects. Some research has shown that Zn complexed with amino acids, such as methionine or lysine, makes the Zn more available to poultry (Bao *et al.,* 2009; Saenmahayak *et al.*, 2010; Jahanian and Rasouli, 2015) A Zn amino acid complex could be a more available source than $ZnSO_4$ making it a more economical choice for addition to feeds.

Manganese is essential for normal bone formation, enzyme function and amino acid metabolism in poultry. The utilization of Mn has become an increasing concern because of the extremely rapid growth rate of commercial broiler strains. Supplementation of Mn is generally in the form of $MnSO_4$. The search for a more available source of Mn could lead to a reduced cost in feed ingredients. Research has shown that organic forms of Mn, such as Mn complexed with methionine or Mn proteinate, will be better available source of Mn (Brooks *et al.,* 2012; *Zhu et al.,* 2016).A Mn amino acid complex could be a more economical choice of a source for Mn addition to feeds.

Organic mineral sources exist in the forms of metal amino acid chelate, metal proteinate and metal specific amino acid complexes. Metal amino acid chelates and metal proteinate are the chelating of a soluble salt with amino acids or hydrolysed protein.

In order to reduce the cost of production there is a great need to utilize these alternative source of feed additives through organic minerals that benefits in successful poultry production.

MATERIALS AND METHODS

An experimental study was carried out to evaluate the effects of replacing inorganic source of Zinc (Zn) and Manganese (Mn) by organic source in the diet of coloured broilers on growth performance and Feed Conversion Rate. The experiment was conducted at Department of Poultry Science, Veterinary College, KVAFSU, Hebbal, Bangalore.

A total of 320 day old colored broiler chicks of approximate uniform body weight were selected. The birds were divided among 4 treatments with each treatment having 4 replicates with 20 birds in each replicate. Sixteen compartments were made and the replicates were randomly allotted. The design of the experiment is shown in the Table 1.

The birds were reared under colony cages system with standard managemental conditions including lighting programme, feeding pattern, watering methods and other routine bio security aspects. The experiment lasted for 6 weeks.

Zinc methionine (15 % purity) and Manganese methionine (12 % purity) were procured from Provimi Animal Nutrition India Pvt. Ltd. KHB industrial Area, Yelahanka New Town, Bangalore-560065 and formulated at Pristine Organics Pvt. Ltd. No.44/2A, Kodigehalli Gate, NH-7, Sahakarnagar post, Bangalore-92.

Basal diet was formulated using maize, soybean meal and feed additives. The broiler starter and finisher rations were formulated as per BIS (2007) excluding supplemental Zn and Mn. Starter mash was fed from day one to 21 days and finisher mash from 22 to 42 days. The experimental birds were fed one of the following four diets. T1-Basal diet (Control) with 100% supplementation of Zn and Mn from inorganic source, T2- Basal diet with 100% supplementation of Zn and Mn from organic source, T3- Basal diet with 80% supplementation of Zn and Mn from organic source and T4 Basal diet with 70% supplementation of Zn and Mn from organic source. The inorganic supplementation was $ZnSO_4$ and $MnSO_4$. Ingredient and nutrient composition of experimental diets are given in Table 2.

Growth Performance parameters

The data on the growth performance parameters viz., body weight, feed consumption, feed efficiency and livability during the experimental period were collected and analyzed.

Body weight

Individual day old body weights were recorded at the beginning of the experiment and further body weight were recorded at the end of each week to monitor the pattern of body weight changes. Group wise average body weights under different treatments were analyzed. The weighing of the birds was done in the early hours of the day before feeding.

Feed consumption

The experimental diet was weighed and offered to the

20 birds as per replicate group on daily basis. The feed consumption in each replicate was recorded on weekly basis by subtracting the weight of residual feed on day of weighing from the total quantity of feed supplied during the respective week.

Feed conversion ratio

The feed conversion ratio (FCR) was expressed as the relationship between quantities of feed consumed to the body weight gain under each group of birds was determined. The FCR was calculated by using following formula,

$$\text{Feed Conversion Ratio} = \frac{\text{Average feed consumption per bird during the week (kg)}}{\text{Average weight gain per bird during the week (kg)}}$$

Statistical analysis

Data pertaining to various parameters obtained during the experiment was analyzed as Completely Randomized Block Design according to the methods described by Snedecor and Cochran (1994).

Experimental Design

Table 1: Description of Experimental Treatments

Treatment	Inorganic source	Organic source	Percentage (%) of inclusion
T1 (Control)	$ZnSO_4$ + $MnSO_4$ (60 mg) + Mn (90 mg)	—	100
T2 (Organic Zinc and Manganese 100%)	—	Zn ORGANIC (60 mg) + MnAA (90 mg)	100
T3 (Organic Zinc and Manganese 80 %)	—	ZnAA (48 mg) + MnAA (72 mg)	80
T4 (Organic Zinc and Manganese 70 %)	—	ZnAA (42 mg) + -MnAA (63 mg)	70

Table 2: Per cent ingredient composition of control diet

Ingredients	Broiler starter (0-21 days) Quantity	Broiler finisher (22-42 days) Quantity
Yellow maize (%)	55	62
Soyabean meal (%)	42	33
Vegetable oil (%)	-	2
*Mineral mixture (%)	2	2
DCP (%)	1	1
Salt (%)	0.4	0.4
Dl Methionine (%)	0.2	0.2
**Vit AB_2D_3K (g)	25	25
***Vit B complex (g)	25	25
Vit D_3 (g)	4	4
Hepatocare (g)	100	100
Colidox (Antibiotic) (g)	50	50
Coccidiostat (g)	50	50
Biocare (g)	50	50
Ecare Se (g)	25	25
Calculated Nutrient composition		
Metabolizable energy/ Kg	2860	2904
Crude protein (%)	23	20.9
Lysine (%)	1.35	1.09
Methionine (%)	0.56	0.51
Calcium (%)	1.2	1.2
Phosphorus (%)	0.45	0.45
Manganese (mg)	90	90
Zinc (mg)	60	60

*Mineral Mixture: Contains calcium–32%, phosphorus-6%, copper-100 ppm, cobalt-60 ppm, manganese-2700 ppm, iodine-100 ppm, zinc-2600 ppm, iron-0.1%.

** Vit.AB_2D_3K: Per gram contains Vit. A-82, 500 IU, D_3-12,000 IU, B_2-50 mg and K-10 mg.

*** B-complex: Per gram contains Vit B_1-4 mg, B_6-8 mg, B_{12}-40 mg, E-20 mg, Niacin-60 mg and calcium panthothenate-12.5

RESULTS AND DISCUSSION

The average weekly cumulative body weight (g)changes, weekly body weight gained(g), feed consumption(g), feed conversion ratio (FCR) of broilers fed with organic source of Zn and Mn by replacing inorganic source from first to six weeks of ages are presented in the Tables 3, 4,5 and 6 respectively.

Table 3: Effect of organic Zinc and Manganese on cumulative body weight(g) changes (mean± SE) in colored broilers

Treatment		Week (g)					
		I	II	III	IV	V	VI
T_1	Control	113 ± 1.74^b	234 ± 4.21^b	422 ± 9.46^c	619 ± 12.60^b	880 ± 14.93^b	1252 ± 18.91^b
T_2	Organic	120 ± 1.67^a	272 ± 3.47^a	523 ± 7.12^a	744 ± 11.02^a	1027 ± 14.67^a	1375 ± 18.29^a
T_3	80 %	121 ± 1.42^a	269 ± 3.21^a	528 ± 6.22^a	726 ± 11.29^a	993 ± 13.95^a	1326 ± 17.32^a
T_4	70 %	120 ± 1.36^a	262 ± 3.25^a	491 ± 7.12^b	733 ± 12.24^a	1013 ± 15.86^a	1329 ± 18.78^a

Table 4: Effect of organic Zinc and Manganese on weekly body weight gain (mean± SE) in colored Broilers

Treatment		Week (g)					
		I	II	III	IV	V	VI
T_1	Control	70 ± 1.83^a	121 ± 3.12^c	190 ± 5.95^c	121 ± 5.48^c	261 ± 7.80^a	371 ± 8.78^a
T_2	Organic	76 ± 1.67^b	152 ± 2.27^a	250 ± 5.47^a	174 ± 5.28^a	281 ± 9.64^a	348 ± 8.70^{ab}
T_3	80 %	79 ± 1.46^b	148 ± 2.26^{ab}	258 ± 3.85^a	180 ± 3.61^a	266 ± 9.76^a	333 ± 11.48^{bc}
T_4	70 %	79 ± 1.50^b	142 ± 2.68^b	228 ± 5.17^b	151 ± 4.47^b	280 ± 7.88^a	316 ± 9.78^c

Table 5: Effect of organic Zinc and Manganese on feed consumption grams\bird\week (mean± SE) in colored Broilers

Treatment		Week (g)					
		I	II	III	IV	V	VI
T_1	Control	116 ± 2.76^a	185 ± 2.56^b	315 ± 9.44^b	428 ± 6.55^b	749 ± 17.89^a	907 ± 13.96^a
T_2	Organic	121 ± 2.80^a	208 ± 1.67^a	455 ± 6.51^a	549 ± 15.54^a	781 ± 5.90^a	882 ± 9.89^a
T_3	80 %	123 ± 2.86^a	207 ± 3.56^a	467 ± 6.14^a	547 ± 15.81^a	764 ± 37.09^a	895 ± 19.33^a
T_4	70 %	122 ± 1.19^a	209 ± 4.55^a	478 ± 6.21^a	577 ± 8.87^a	791 ± 20.44^a	879 ± 8.90^a

Table 6: Effect of organic Zinc and Manganese on FCR (mean± SE) in colored Broilers

Treatment		Week (g)					
		I	II	III	IV	V	VI
T_1	Control	1.02 ± 0.03^a	1.29 ± 0.04^a	1.50 ± 0.05^b	1.69 ± 0.06^b	2.03 ± 0.08^b	2.15 ± 0.07^b
T_2	Organic	1.00 ± 0.04^a	1.22 ± 0.03^b	1.49 ± 0.01^b	1.66 ± 0.01^b	1.91 ± 0.02^c	2.09 ± 0.00^b
T_3	80 %	1.01 ± 0.02^a	1.24 ± 0.01^{ab}	1.51 ± 0.01^b	1.83 ± 0.02^a	2.11 ± 0.04^{ab}	2.26 ± 0.04^a
T_4	70 %	1.02 ± 0.01^a	1.28 ± 0.03^{ab}	1.65 ± 0.04^a	1.86 ± 0.03^a	2.15 ± 0.05^a	2.30 ± 0.04^a

Weekly body weight changes

In the present study, coloured broilers chick's response to different dietary Zn and Mn source and levels were studied. The mean day-old body weights at the beginning of the experiment were 42.88, 42.56, 42.71 and 42.03 g in group (T_1), group (T_2), group (T_3) and group (T_4), respectively. At the end of experiment the cumulative body weight was significantly ($P \leq 0.05$) higher in the organic source fed group (T_2, T_3 and T_4) compared to control diet group (T_1) (1252 g). Among the organic source fed groups 100 per cent replacement of organic source of Zn and Mn (T_2) showed higher body weight (1375 g) followed by T_4 (1329 g), T_3 (1326 g). The trend was similar throughout the experimental period. There was no significant difference in body weight among the group fed organic source of Zn and Mn (T_2, T_3 and T_4).

Similar trend of increasing average weekly body weight gains were seen in all the treatment groups (T_2, T_3 and T_4)

compared with the control group (T_1) except during last week where there was increase in weekly weight gain in Control group (T_1). The results obtained in this experiment are in accordance with the findings of Osman *et al.* (2007) who reported the beneficial effects of zinc amino acid complexes on broiler growth performance and observed higher body weight (1793 g) in Hubbard broilers fed with Zn-meth at 0.3 g/kg of diet for 21-42 days of age. The results of the present study are also in agreement with the findings of Bao *et al*. (2007) who reported higher body weight (1499 g) in Cobb broilers by feeding organic (40 mg of Zn and 40 mg of Mn) for 29 days of age.

The results of the present study showed an increase in body weight with 100 per cent replacement of inorganic source of Zn (60 mg / kg diet) and Mn (90 mg/kg diet) by organic source. The similar result was recorded with the findings of Abdallah *et al*. (2009) who reported higher body weight (1712 g) in Ross broiler provided with the diet containing 100 per cent replacement of inorganic source of Zn and Mn by organic source for 35 days of age. The results of the present study are also in agreement with the findings of Zhao *et al*. (2010) who reported higher body weight (2887 g) in Cobb broilers by feeding 50 per cent of organic plus 50 per cent of inorganic (40 ppm of Zn and 60 ppm of Mn) for 45 days of age.

The results of the present study are not in agreement with the results of Abbas *et al.* (2010) who reported non-significant effect of feeding organic Zn (60 mg/kg) and Mn (60 mg/kg) concentration on body weight (1894 g) of Ross broilers for 42 days of age. The similar response of non-significant effect of body weight was reported by feeding diet containing Zn (80 mg from inorganic and 40 mg from organic source) and Mn (80 mg from inorganic and 40 mg from organic source) in commercial broilers (Senanayake *et al.*, 2010). The present study revealed that replacement of inorganic source of Zn and Mn by organic source even at lower level of 80 and 70 per cent showed non significantly comparable body weight with the higher level of inclusion of inorganic source. The reason for better body weight at lower level of inclusion of organic source of Zn and Mn may be due to higher level of bioavailability of organic Zn and Mn.

Weekly cumulative feed consumption

The study revealed significant influence of different dietary treatment on cumulative feed consumption. Among various, dietary treatment groups, cumulative feed consumption was significantly ($P \leq 0.05$) lower in second, third, fourth and fifth weeks of age in control diet (T_1) but in fifth and sixth weeks of age lowest feed consumption was recorded in 100 per cent replacement of organic source of Zn and Mn (T_2). However, on sixth week, weekly cumulative feed consumption was recoded highest in 70 per cent replacement of inorganic source of Zn and Mn (T_4- 42 mg of Zn and 63 mg of Mn) by organic source as compared to other dietary treatment groups. Among the organic source fed groups 70 per cent replacement of inorganic source of Zn and Mn (T_4) by organic source showed less feed consumption compared to 80 per cent and 100 per cent replacement of inorganic source of Zn and Mn (T_3 and T_2 respectively) by organic source.

The results obtained in this experiment are in accordance with the findings of Osman *et al.* (2007) who reported the beneficial effects of zinc amino acid complexes on broiler growth performance and observed less weekly feed consumption (742 g/bird in sixth week of age) in Hubbard broilers fed with Zn-meth at 0.3 g/kg of diet for 42 days of age. The results obtained in present study are also in accordance with the findings of Jahanian *et al*. (2008) in Ross broilers fed 40 mg of Zn-meth upto fourth week of age. The results of the Abbas *et al*. (2010) revealed that birds fed with the diet containing higher level of inorganic and organic minerals (Zn 140 mg/kg, Mn 140 mg/kg and Cu 17 mg/kg) consumed higher feed consumption compared to control diet containing inorganic source of mineral (Zn 100 mg/kg, Mn 100 mg/kg and Cu 10 mg/kg) in Ross 308 broilers from 0 to 21 days of age.

The results of the present study for the higher feed consumption for lower organic fed group (80 and 70 per cent of replacement) were comparable with the study of Abdallah *et al*. (2010), who revealed the highest feed consumption for the group fed lower level of organic sources (Zn 40 mg/kg, Mn 40 mg/kg and Cu 7 mg/kg) compared to control from 21 to 49 days of age group of birds.

In the results of the present study, there was an increase in feed consumption with 100 per cent replacement of inorganic source of Zn (60 mg / kg diet) and Mn (90 mg/kg diet) by organic source during first, second and third week but in fifth and sixth week least feed consumption.

The results of the present study are also not in agreement with the results of Rossi *et al*. (2007) who reported non-significant effect of increasing organic Zn (0 to 60 ppm) on feed consumption of Ross broilers for 42 days of age.

Feed efficiency (Feed Conversion Ratio)

Significant variation had been observed in efficiency of feed utilization among various dietary treatment groups. During first and second week of age there was no difference in feed conversion efficiency among all groups. Among the organic source fed group, from fifth to sixth week of experimental period the 100 per cent replacement of inorganic source of Zn and Mn (T_2) by organic source significantly ($P \leq 0.05$) showed better FCR compared to 80 and 70 per cent replacement of inorganic source of Zn and Mn by organic source (T_3 and T_4). The lower level of organic source fed group (T_3 and T_4) were non-significantly comparable with control (T_1).

In the results of the present study, there was significantly ($P \leq 0.05$) better feed conversion efficiency with replacement of inorganic source of Zn (60 mg / kg diet) and Mn (90 mg/kg diet) by organic source during third to sixth week of age.

The results of the present study agree with the findings of Osman *et al*. (2007) who reported the significant improvement in FCR (1.85) in Hubbard broilers fed with Zn-meth at 0.3 g/kg of diet for 21-42 days of age. The results of the present study are also in agreement with the findings of Bao *et al*. (2007) who reported the better FCR (1.40) of Cobb broilers by feeding mid organic (40 mg of Zn and 40 mg of Mn) for 29 days of age.

The results obtained for the FCR in the present study agree with the findings of Nollet *et al.* (2008) who found that during the starter period (0-21 days) the Bio-Plex fed commercial broilers had better FCR compared to control.

The results obtained for the FCR in the present study are also in agreement with the findings of Hamidi and Pourreza (2009) who found that during the starter period (7-42 days) the Zinc-methionine at 40 and 60 mg/ kg fed to commercial broilers had better FCR. The results of the present study are also in agreement with the findings of Abdalla *et al*. (2009) who revealed better FCR (1.63) for the birds 100 per cent replacement of inorganic Zn and Mn by organic source in Ross broilers for 42 days of age.

The results of the present study are in agreement with the findings of Saenmahayak *et al*. (2010) and Zhao *et al*. (2010) who reported significant improvement in FCR in commercial broilers of 49 days of age by inclusion of dietary Zn- methionine at 50 per cent of organic and 50 per cent of inorganic source.

The present study results are not in agreement with the results of Rossi *et al.* (2007) who found non significant effect of zinc (60 ppm) on FCR in commercial broilers and Jahanian *et al.* (2008) in commercial broilers at the rate 40, 80 and 120 mg/kg of diet.

CONCLUSION

The results of the experiment on replacing inorganic source of zinc and manganese at 60 mg/kg diet and 90 mg/kg diet respectively with 70% (T_4), 80% (T_3) and 100% (T_2) improved the productive performance and increased the relative economic efficiency values of coloured broilers. Thus, organic minerals can be included at much lower levels in the diet than the current recommendations for inorganic minerals, without any negative affect on broiler performance.

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