INFLUENCE OF DIFFERENT SOURCES OF ZINC ON GROWTH PERFORMANCE OF DUAL PURPOSE CHICKEN

Siddhartha S. Pathak[1], K Venkata Reddy[2] and Prasoon S.[3]

[1] Ph.D. Scholar, Department of Poultry Science, Veterinary College, KVAFSU, Bangalore, Karnataka, 560024.

[2] Professor and Head, Department of Poultry Science, Veterinary College, KVAFSU, Bangalore, Karnataka, 560024

[3]Assistant Professor, College of Avian Sciences and Management, Thruvazhamkunnu, Kerala, 678601

(Received on Date: 13th August 2016 Date of Acceptance: 4th September 2016)

ABSTRACT

A trial was designed to study the effect of supplementation of inorganic, organic and nano zinc on the growth performance in Giriraja; dual purpose chicken. The trial was conducted in seven treatments with 336 birds (48 chicks per treatment). The diets were formulated according to NRC (1994) specifications. The treatment diets were supplemented with $ZnSo_4$ and Zn-Met at the level 30 and 60 mg/kg from both sources in T1, T2, T3 and T4 respectively. Nano zinc was added to contain 15, 30 and 60 mg/kg in T5, T6 and T7 treatment groups. The body weights of chicks were recorded individually at weekly intervals. The weekly feed consumption was recorded from which the feed conversion ratio (FCR) was calculated for every week. During all the weeks of study period, body weight was significantly ($P \leq 0.05$) higher in T_7 group (nanozinc at 60 mg/kg level) and the lowest ($P \leq 0.05$) for T_1 group (Zinc sulfate at 30 mg/kg level). The feed consumption in all the treatment groups were non significant at all weeks. A significantly better feed consumption ratio was recorded in T_7 group (nanozinc at 60 mg/kg level) and the poor for T_1 group (Zinc sulfate at 30 mg/kg level) at all the weeks. Results revealed that the growth performance of the dual purpose chicken can be improved by supplementing nano zinc at the level of 60 mg/kg.

KEY WORDS: inorganic, organic, nano zinc, growth performance, giriraja, dual purpose

No. of Tables: 4 **No. of References: 20**

INTRODUCTION

Growth rate, feed consumption, feed efficiency, and carcass traits are factors that determine the performance of a broiler flock. Several nutritional factors influence those parameters, including trace mineral status. These minerals participate in many metabolic pathways influencing nutrient metabolism, growth, immune response. Among these minerals one important mineral is "zinc". Zinc participates as a cofactor or component of more than 240 enzymes, being important for protein and carbohydrate metabolism, growth and reproduction.The most common forms of zinc used in feeding of poultry are zinc sulphates, zinc carbonates, zinc methionine, zinc proteinate etc. Recently a new form of mineral presentation in marketed using concepts of nano science technology (Song *et al*., 2010). The transformation from particles to nano particles involves an increment of the surface area during nano particles synthesis allowing a higher interaction with other molecules.The aim of this study was to investigate and compare the effect of different available forms of zinc (inorganic, organic and nano) on the growth, feed consumption and feed conversion ratio.

MATERIALS AND METHODS

A total of 336 day old straight run Giriraja chicks, (a dual purpose chicken) were wing banded, weighed and randomly assigned to seven groups with four replicates in each group having 12 chicks in each replicate (48 chicks per treatment). The chicks were reared in deep litter system with all standard management practices including vaccination till eight weeks of age. Basal diet for broiler pre-starter, starter and finisher was prepared as per BIS (2007) specification. Seven dietary treatments *viz*: $ZnSo_4$ (Inorganic) was added to T_1 and T_2 at the level of 30mg/kg and 60 mg/kg; Zn-Met (Organic) at the level of 30mg/kg and 60 mg/kg in T_3 and T_4; Nano ZnO at the level of 15, 30 and 60 mg/kg in T_5, T_6 and T_7 respectively were tested. Experimental feed samples were analyzed for proximate composition according to the AOAC (Association of official Analytical Chemists, 2000). Zinc concentration of the basal diet was estimated to be 30 ppm by atomic absorption spectrophotometer. The ingredient and proximate composition of the experimental basal diet for the birds is presented in Table 1. The body weights of chicks were recorded individually at weekly intervals. The weekly feed consumption was recorded from which the feed conversion ratio (FCR) was calculated for every week. Data pertaining to various parameters obtained during the trial were analyzed statistically by ANOVA using SPSS 20 statistical software. Differences between the means were tested using Duncan's Multiple Range Test (Duncan, 1995) at $P < 0.05$.

RESULTS AND DISCUSSION

Body weight

During all the weeks of study period, body weight was significantly (P≤0.05) higher in T_7 group (nanozinc at 60 mg/kg level) and the lowest (P≤0.05) for T_1 group (Zinc sulfate at 30 mg/kg level). A non significant difference in body weight was recorded for Zinc-Met fed groups and nano zinc at 15 mg/kg group. Among nano zinc fed groups, T_7 was recorded with higher body weight whereas T_5 and T_6 did not differed significantly. During VI, VII and VIII weeks, Zn-Met treated group at the level of 60 mg/kg was non-significant (P≤0.05) to nano zinc groups at 30 and 60 mg/kg (Table 2).The improvement in body weight of nano zinc supplemented groups at the level of 60 mg/kg is supported by Zhao *et al.* (2014), wherein chickens fed 20 or 60 mg/kg nano-ZnO resulted increased in body weight at all the weeks until the end of the experiments of 42 days. The findings in the present study also goes in line with the reports of Huang *et al.* (2007) and Hudson *et al.*(2004) who reported that different sources of zinc significantly affected body weight gain of broilers. This higher body weight in Nano zinc supplemented groups might be due to higher uptake of zinc nano particles in the gastro-intestinal tract. Because of particle size of nano zinc a faster diffusion through GIT membrane has taken place to reach the cells of the intestinal lining. The growth ameliorative effect of Zn-Met group at the level of 60 mg/kg was comparable to that of nano zinc supplemented groups at the level of 15 and 30 mg/kg and can be used for substitution of each other. A similar finding for organic Zn was also reported by Sahoo *et al.* (2016), wherein, supplementation of organic zinc at the level of 7.55 ppm were similar to that of nano zinc (0.06ppm). The body weight of the chickens in treatment T_1 was found to be lowest among all the treatment groups throughout the present study period indicated that Zn was essential for growth. On comparison to the body weight of ZnSo4 and Zn-Met groups, the body weight was insignificant. Similar findings were also reported by Tronina *et al.* (2007) who reported that on 21st day, the body weight of chicken receiving ZnO lowered by 2% compared to the chickens received Zn-glycine and also confirmed with the findings of Rossi *et al.* (2007) reported Zn from an organic source had no influence on body weight gain. These reports are contrast with the reports of Świątkiewicz *et al.* (2001) and Bao *et al.* (2009). The findings of present study are also in contrast to the findings of Abdallah *et al.* (2009) where the body weight of chicks at 35th day fed with 100% organic zinc were significantly (P≤0.05) higher than the group fed with 50 % organic and 50 % inorganic zinc and group fed with 100 % inorganic zinc. Zinc is involved in several biochemical reactions, and the live performance improvements detected in the present study may be explained by the fact that the supplemented Zn levels met the requirements of enzymes that have a main role in the synthesis of DNA, RNA, and body protein (Karamouz *et al.* 2010). The lack of consistent effects of dietary Zn on performance of chickens may be due to the amount of Zn present in the basal diet (Leeson and Summers, 2005) or to the amount and sources added. Furthermore, the presence of other dietary ligands, such as phytate, which forms insoluble complexes with Zn and prevents absorption of mineral (Zn).

Feed consumption: Feed consumption was found to be statistically ($P \leq 0.05$) insignificant in all the treatment groups at different weeks except I and II week. A higher amount of feed intake (g/bird) was recorded in T_7 (Nano zinc, 60 mg/kg) compared to other groups in I and II weeks of study period (Table 3). The finding of present study for nano zinc supplemented groups was contradictory to the findings of (Ahmadi *et al.,* 2014; Sahoo *et al.,* 2016), wherein an increase in feed intake was recorded for chickens fed ZONP when compared to organic and inorganic sources. One possible reason may be the purity of the source used (99.99%), whereas the purity of the present source for nano zinc was 26%. The present non- significant influence of feed consumption was in agreement with the result of (Mohanna and Nyss, 1998; Pimental *et al.,* 1991; Iqbal *et al.,* 2011) who reported that feed intake of broiler chickens were not influenced significantly by supplementation of Zn from inorganic and organic sources. The present findings were also in agreement with the results of Rossi *et al.* (2007) who concluded that basal diet containing 60 ppm Zn from an inorganic source in Ross broilers and by adding graded level of 0, 15, 30, 45 and 60 ppm of dietary organic Zn had no significant effect on feed consumption. The results obtained in the present study is contradictory to the findings of Rahaman *et al.* (2008) who reported that Ross broilers fed with zinc- methionine (40, 80 and 120 mg/kg) showed significantly higher feed intake compared to inorganic source fed groups. The lack of response in the feed intake might be due to increased synthesis of intestinal metallothionein which reduces the zinc absorption.

Feed conversion Ratio: During I, III, IV and V week, the FCR in T_7 (Nano zinc, 60 mg/kg) group were recorded to be statistically ($P \leq 0.05$) significant between the groups. During I week, a poor FCR of 0.70 was recorded for (T_1, 30 mg/kg) between all the treated groups but the difference was statistically ($P \leq 0.05$) insignificant when compared to Zn-Met counterparts at the same level. During III week, a significantly better FCR was recorded for T_7 group; the difference between Zn-Met at the level of 60 mg/kg was comparable to other nano zinc sources (T_6 and T_7). The FCR between $ZnSo_4$, Zn-Met treated groups at different levels were insignificant however a slightly better FCR was recorded for $ZnSo_4$ than Zn-Met treated groups at the same level of respective Zn supplementation. During VIII week, the FCR was insignificant between the $ZnSo_4$ and Zn-Met treatment groups (Table 4). The present results were also in agreement with the findings of Iqbal *et al.* (2011); Mohanna and Nyss (1999) who reported that the FCR of broiler chicken was not influenced by supplementation of Zn inorganic and organic sources. Among the nano zinc fed groups, a better FCR was recorded in T_7 treatment group which was close to the other nano zinc supplemented groups. Since the nano zinc supplemented groups showed comparable better FCR values on par with the other different zinc sources supplementation which implied a better absorption of nano zinc particles by the chickens. The FCR of chicks fed on diets containing $ZnSo_4$ was inferior to that of organic zinc fed groups. This might be due to lower feed consumption as loss in appetite appears to be responsible for decline of feed intake in these groups ($ZnSo_4$) resulting in slower growth rate of the group as compared to others (Sandoval *et al.* 1999; Jahanian *et al.* 2008). Probably lower absorption rate of Zn from inorganic sources caused the need for high levels of supplemental Zn to meet nutritional requirements of chick. The results are contradictory to the reports of Bao *et al*. (2009), wherein increase of FCR was recorded when zinc was chelated with organic sources of Fe and Cu. The reason might be the role of Cu in growth hormone level.

ACKNOWLEDGEMENT

The corresponding author is thankful to Directorate of Science and Technology, Government of India for providing the financial assistance during whole period of study. The authors are also thankful to Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka for providing the facilities to conduct the trials.

Table (1): Per cent ingredient composition of basal experimental diet

Ingredients	Pre-starter (0-3 weeks)	Starter (4-6 weeks)	Finisher (7-8 weeks)
Yellow maize	52.25	58.5	63.56
Soyabean meal (46%)	40.55	33.3	28.1
Vegetable oil	3.5	4.95	5.25
Oyster shell	1.0	1.0	0.90
Dicalcium phosphate	1.6	1.2	1.15
Common salt	0.35	0.35	0.35
Mineral mixture*	0.55	0.55	0.55
Vitamin premix **	0.1	0.1	0.1
DL-Methionine	0.1	0.055	0.04
Total	100.0	100.0	100.0

* Mineral mixture: Each 100 g contains Magnesium oxide- 1.48g, Ferrous sulphate- 6.0 g, copper sulphate- 0.05g, Manganese Sulphate-0.04 g, Potassium Iodide- 0.001g, Potassium Chloride-17.09g and Sodium selenite- 0.001g.

** Vitamin-mineral Premix: Each 100g contains Vitamin AD3 (Vitamin A-10,00,000 IU/g, Vitamin D-200000 IU/g)- 0.165g, Vitamin K3-0.103g, Vitamin E- 2.4g, Thiamine Mononitrate- 0.206 g, Riboflavin- 0.513g, Pyridoxine hydrochloride- 0.309g, Cyanocobalamine- 0.00031g, Folic acid- 0.103g, Niacin-4.124 g, Ca-D-Pantothenate-1.031g, Biotin- 1.5g, Maltodextrine- 89.545g.

[a] calculated values; [b] analyzed values

Table (2): Effect of supplementing $ZnSo_4$, Zn-Met and nano zinc on the mean cumulative body weight of dual purpose chickens

Treatment	Zinc source	Level (mg/kg)	Cumulative body weight (g/bird)							
			I week	II week	III week	IV week	V week	VI week	VII week	VIII week
T1	$ZnSo_4$	30	82.41±1.00[a]	196.23±3.52[a]	366.64±5.60[a]	588.57±11.02[a]	833.39±9.63[a]	1068.90±18.79[a]	1337.65±13.29[a]	1598.67±13.52[a]
T2	$ZnSo_4$	60	86.62±1.06[b]	199.88±4.05[a]	369.55±4.11[a]	596.80±11.53[a]	846.28±10.18[ab]	1085.29±13.89[ab]	1353.93±11.07[a]	1615.47±13.33[ab]
T3	Zn-Met	30	87.24±1.26[b]	204.50±3.41[ab]	375.00±7.48[ab]	605.92±14.31[a]	857.23±7.86[abc]	1100.18±14.21[abc]	1371.26±12.52[ab]	1631.43±17.49[abc]
T4	Zn-Met	60	86.44±1.59[b]	212.12±3.75[bc]	382.18±4.67[abc]	612.41±10.84[ab]	868.09±9.92[bc]	1114.05±14.89[abc]	1391.15±10.95[bc]	1658.27±15.52[bcd]
T5	Nano Zinc	15	87.91±0.96[bc]	215.13±2.45[c]	387.29±5.09[bc]	618.12±11.55[ab]	878.20±10.02[bc]	1121.00±14.62[bcd]	1400.36±11.06[bc]	1671.76±15.58[cd]
T6	Nano Zinc	30	91.04±0.75[c]	219.54±2.53[c]	392.32±4.55[c]	624.75±11.51[ab]	888.54±12.61[cd]	1137.72±17.91[cd]	1422.53±14.56[cd]	1695.92±16.12[d]
T7	Nano Zinc	60	96.80±1.54[d]	230.09±2.30[d]	409.86±4.10[d]	645.830±9.30[b]	910.92±14.42[d]	1164.18±18.10[d]	1455.18±13.89[d]	1741.72±14.85[e]

Means having same superscript column wise do not differ significantly

Siddartha et al.,

Table (3): Effect of supplementing $ZnSo_4$, Zn-Met and nano zinc on the mean cumulative weekly feed consumption (g/bird) of dual purpose chickens

Treatment	Zinc source	Level (mg/kg)	Mean cumulative feed consumption (g/bird)							
			I week	II week	III week	IV week	V week	VI week	VII week	VIII week
T1	$ZnSo_4$	30	58.13±1.21[a]	275.53±5.85[a]	601.23±3.68	1039.96±11.32	1482.19±33.84	2051.36±18.90	2649.05±50.25	3506.49±32.77
T2	$ZnSo_4$	60	61.42±1.31[ab]	279.87±6.80[ab]	602.33±4.05	1050.37±7.50	1490.00±11.88	2066.47±22.23	2666.66±58.12	3520.83±27.89
T3	Zn-Met	30	61.73±1.13[b]	285.91±4.49[abc]	604.26±5.81	1052.28±9.76	1509.01±9.09	2076.79±27.31	2683.52±15.37	3541.36±30.38
T4	Zn-Met	60	61.95±1.03[b]	287.66±5.67[abc]	609.20±7.59	1053.97±12.31	1515.90±15.90	2085.41±34.08	2705.68±30.45	3573.86±35.31
T5	Nano Zinc	15	61.38±0.96[ab]	292.79±5.13[bcd]	611.51±3.94	1052.65±23.15	1525.00±14.55	2093.18±37.18	2717.80±39.13	3583.83±73.57
T6	Nano Zinc	30	61.875±0.92[b]	296.56±3.03[cd]	612.7±3.95	1060.75±19.15	1525.00±25.00	2108.33±36.22	2743.37±28.40	3615.90±50.70
T7	Nano Zinc	60	63.44±1.00[b]	307.70±2.43[d]	612.57±4.16	1061.75±22.65	1529.16±29.16	2145.83±20.83	2764.20±27.46	3636.36±30.30

Means having same superscript column wise do not differ significantly

Siddartha et al.,

Table (4): Effect of supplementing $ZnSo_4$, Zn-Met and nano zinc on the mean cumulative weekly feed conversion ratio of dual purpose chickens

Treatment	Zinc source	Level (mg/kg)	I week	II week	III week	IV week	V week	VI week	VII week	VIII week
T1	**$ZnSo_4$**	**30**	0.70 ± 0.03^{b}	1.40 ± 0.40	1.63 ± 0.01^{e}	1.76 ± 0.01^{b}	1.77 ± 0.04^{b}	1.91 ± 0.01	1.98 ± 0.03	2.19 ± 0.02^{b}
T2	**$ZnSo_4$**	**60**	0.70 ± 0.01^{b}	1.40 ± 0.03	1.62 ± 0.01^{de}	1.76 ± 0.01^{b}	1.76 ± 0.01^{ab}	1.90 ± 0.02	1.96 ± 0.04	2.18 ± 0.01^{b}
T3	**Zn-Met**	**30**	0.70 ± 0.01^{b}	1.39 ± 0.02	1.61 ± 0.01^{cde}	1.73 ± 0.01^{b}	1.76 ± 0.01^{ab}	1.88 ± 0.02	1.95 ± 0.01	2.17 ± 0.01^{ab}
T4	**Zn-Met**	**60**	0.71 ± 0.01^{b}	1.35 ± 0.01	1.59 ± 0.01^{bcd}	1.72 ± 0.02^{ab}	1.74 ± 0.02^{ab}	1.86 ± 0.03	1.94 ± 0.02	2.15 ± 0.02^{ab}
T5	**Nano Zinc**	**15**	0.69 ± 0.01^{b}	1.36 ± 0.02	1.57 ± 0.01^{bc}	1.70 ± 0.03^{ab}	1.73 ± 0.01^{ab}	1.86 ± 0.03	1.94 ± 0.02	2.14 ± 0.04^{ab}
T6	**Nano Zinc**	**30**	0.67 ± 0.01^{a}	1.35 ± 0.01	1.56 ± 0.01^{b}	1.69 ± 0.03^{ab}	1.71 ± 0.02^{ab}	1.85 ± 0.03	1.92 ± 0.01	2.13 ± 0.03^{ab}
T7	**Nano Zinc**	**60**	0.65 ± 0.01^{a}	1.33 ± 0.01	1.49 ± 0.01^{a}	1.64 ± 0.03^{a}	1.67 ± 0.03^{a}	1.84 ± 0.01	1.89 ± 0.01	2.08 ± 0.08^{a}

Means having same superscript column wise do not differ significantly

REFERENCES

Abdallah, A. G.; El-husseiny, O. M. and Abdel-Latif, K O. 2009. Influence of Some Dietary Organic Mineral Supplementations on Broiler Performance. *Int. J. Poult. Sci.,* 8 (**3**): 291-298

Ahmadi, F.; Ebrahimnezjad, Y.; Ghiasi Ghalehkandi, J. and Maheri Sis, N. 2014. The effect of dietary zinc oxide nanoparticles on the antioxidant state and serum enzymes activity in broiler chickens during starter stage. International Conference on Biological, Civil and Environmental Engineering (BCEE-2014) March 17-18, 2014 Dubai (UAE).

Bao Y. M. and Choct, M. 2009. Trace mineral nutrition for broiler chickens and prospects of application of organically complexed trace minerals: a review. *Anim. Prod Sci*, **49**: 269-282

Bureau of Indian Standards, 2007. Nutrient requirement of poultry. Bureau of Indian Standards, I.S. 13574:1992

Huang Y. L.; Liu, L.; Luo, X. G. and Liu, B. 2007. An optimal dietary zinc level of broiler chicks fed a corn-soybean meal diet. *Poult. Sci.,* **86**: 2582-2589

Hudson, B. P.; Dozier, W. A.; Wilson, J. L.; Sander, J. E. and Ward, T. L. 2004. Reproductive performance and immune status of caged broiler breeder hens provided diets supplemented with either inorganic or organic sources of zinc from hatching to 65 week of age. *J. Appl. Poult. Res.* **13**:349-359.

Iqbal, S.; Deo, C.; Mandal, A. B.; Praveen., K. and Wachat, V. B. 2011. Response of feeding different sources and concentrations of zinc and copper on performance of broiler chickens. *Ind. J. Poult. Sci*., 46(**3**): 330-336.

Jahanian, R.; Moghaddam, H. N. and REZAEI, A. 2008. Improved broiler chick performance by dietary supplementation of organic zinc sources. *Asian-Australas. J Anim Sci.* 21, 1348–1354A.O.A.C, 1995. Official Methods of Analysis, 16th ed. Association of Official Analytical Chemists, Arlington, VA

Karamouz, H.; Shahriyar, H. A. and Gorbani, A. 2010. Effect of Zinc Oxide supplementation on some serum biochemical values in Male broilers. *Glob. Vet*., 4(**2**): 108-111

Leeson, S. and Summers, J. D. 2001. Scott's Nutrition of the Chicken. 4th Ed. University Books, Guelph, Ontario.

Mohanna, C. and Nys, Y. 1998. Influence of age, sex and cross on body concentrations of trace elements (zinc, iron, copper and manganese) in chickens. *Br. Poult. Sci.,* 39: 536-543.

Pimentel, J. L.; Cook, M. E. and Greger, J. L. 1991. Research note: Bioavailability of zinc-methionine for chicks. *Poult. Sci.* 70:1637–1639

Rossi, P.; Rutz, F. and Anciuti, M. A. 2007. Influence of graded levels of organic zinc on growth performance and carcass traits of broilers. *J. Appl. Poult. Res.* **12**: 219–225

Rossi, P.; Rutz, F. and Anciuti, M. A. 2007. Influence of graded levels of organic zinc on growth performance and carcass traits of broilers. *J. Appl. Poult. Res.* **12**: 219–225

Sahoo, A.; Swain, R. K.; Mishra, S. K.; Behura, N. C.; Beura, S. S.; Sahoo, C., Das, A.; Mishra, A. and Jena, B. 2016. Growth, feed conversion efficiency, and carcass characteristics of broiler chicks fed on inorganic, organic and nano zinc supplemented diets. *Anim. Sci. Rep.*, 10(**1**): 10-18

Sandoval, M.; Henry, P. R.; Littell R. C.; Miles, R. D.; Butcher, G. D. and Ammerman, C. B. 1999. Effect of dietary zinc source and method of oral administration on performance and tissue trace mineral concentration of broiler chicks. *Journal of Animal Science,* 77:1788-1799.

Song, S.; Qin, Y.; He, Y.; Huang, Q.; Fan, C. **and Chen, H. Y.** 2010. Functional nanoprobes for ultrasensitive detection of biomolecules. *Chemical Society Reviews*, 39 (**11**), 4234-4243.

Świątkiewicz, S.; Koreleski, J. and Zhong, D. Q. 2001. Bioavailability of zinc from inorganic and organic sources in broiler chickens as affected by phytase addition. *J. Anim. Feed Sci.* **10**: 317-328

Tronina, W.; Kinal, S. and Lubojemska, B. 2007. Effect of various forms of zinc applied in concentrate mixtures for broiler chickens on its bioavailability as well as meat composition and quality. *Pol. J. Food Nutr. Sci*., 57(**4C**): 577-581

Zhao, C. Y.; Tan, S. X.; Xiao, X. Y.; Qiu, X. S.; Pan, J. Q. and Tang, Z. X. 2014. Effects of Dietary Zinc Oxide Nanoparticles on Growth Performance and Antioxidative Status in Broilers. *Biol. Trace Elem. Res*. **60**: 361-367