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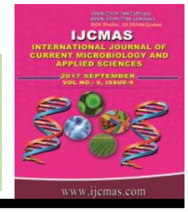

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Carcass Characteristics and Bone Measurements of Commercial Broilers Fed with Inorganic, Organic and Nano Zn Containing Diets

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A B S T R A C T

The present study was conducted to investigate the effect of dietary supplementations of inorganic, organic and nano Zn on carcass characteristics and bone morphometric study in broiler chickens. A total of 300 day-old straight run broiler chicken were randomly assigned to 10 dietary treatments each consisting of 3 replicates and each replicate having 10 chicks for a period of 6 weeks. The dietary treatments includes corn-soybean meal based basal diet as control (T_1) or the basal diet supplemented either with 40 or 80 mg of Zn/kg of feed from each sources, such as Zn oxide (T_2 and T_3), Zn sulphate (T_4 and T_5), Zn-methionine (T_6 and T_7) and Zn-protienate (T_8 and T_9) except that the nano-Zn which was supplemented only at 20 mg/kg (T_{10}). At the day 42, two birds from each replicate were taken randomly for the slaughter study. The highest eviscerated weight (%) observed in the group fed with 40 mg Zn-protienate (T_8) which was non-significant (p>0.05). Ready-to-cook yield, cut-up parts and giblet (%) did not show any significant (p>0.05) difference between experimental groups. Regarding bone morphometric parameters such as bone weight, length and width, a non-significant (p>0.05) difference exist among the treatment groups. It was concluded that the dietary inclusion of inorganic, organic and nano Zn did not show any significant difference on the carcass yields and bone morphometric parameters.

Introduction

Indian Poultry Industry is one of the fastest growing segments of the agricultural sector today in India. India's poultry sector is likely to see huge growth potential because of stable feed prices and encouraging rural demand, resistance to local and global challenges including a recent outbreak of bird flu and threat of chicken-leg imports from the US. India is the third largest broiler-chicken producer in the world with production of 3.8 million tonne of poultry meat a year (Raji Reddi Kesireddy, 2014). Minerals occur naturally in most feed ingredients with varying bioavailability.

Trace minerals like zinc is essential for broiler growth and are involved in many digestive, physiological and biosynthetic processes. They are constituents of many proteins involved in intermediary metabolism, hormone secretion pathways and immune defense systems. The trace mineral supplementation of poultry diets is usually accomplished with inorganic sources (Bao *et al.*, 2007). Excessive use of inorganic salts leads to reduced nutrients absorption and mineral bioavailability. In addition, excessive mineral intake causes environmental pollution by higher mineral excretion.

These excess minerals can leach through soils, potentially contaminating surface and underground water supplies (Jackson *et al.*, 2003). Due to increasing concerns about potential mineral pollution, nutritionists have been focused on how to reduce mineral excretion without any negative effect on production performance (Devrim *et al.*, 2010). Organically complexed trace minerals may provide alternative pathways for absorption, by decreasing mineral excretion (Leeson, 2003).

These types of minerals are more easily absorbed compared to inorganic forms. Due to chelation of metal ions with organic substances this makes these metal ions electrically neutral and chemically stable, thereby allowing easy passage through the small intestinal wall. Nano zinc oxide (nZnO) is a new form of mineral presentation that has been produced and marketed using concepts of nano science and technologies (Song *et al.*, 2010).

Hence, with this background the present study was conducted to investigate and compare the effect of different available forms of zinc (inorganic, organic and nano) on the carcass traits and bone morphometric parameters in the commercial broiler chicken.

Materials and Methods

Ethical approval

The experiment was carried out as per the guidelines of the National Regulations on Animal Welfare and Institutional Animal Ethics Committee. The experiment was carried out in the Department of Poultry Science, Madras Veterinary College, TANUVAS, Chennai, Tamil Nadu, India. A total of 300 day-old straight run vencobb 400 broiler chicks were procured from a franchise (Swami feeds pvt. ltd, Hosur branch) of Venkateshwara Hatcheries Private Limited, Pune. Chicks were individually weighed, wing banded and randomly allotted into 10 different treatment groups, with three replicates. Each replicate had 10 chicks and thus, 30 birds constituted a treatment group.

The birds were reared in brooder cum grower cages up to six weeks of age. Incandescent bulbs of 60watt capacity (electrical brooding) were utilized for maintaining the temperature during the brooding period. The lighting regimen practiced was 24 h light: 0 h dark during the brooding period. An adequate care was taken to provide optimum and uniform managemental conditions to all the treatments groups. Linear feeders and circular drinkers were kept inside the cages to provide sufficient feeding and watering space for the birds.

All the chicks were vaccinated against Ranikhet disease, RDVF on 7^{th} and LaSota on 28^{th} day of age and Infectious Bursal Disease (Intermediate Strain) on 14^{th} day of age. The prestarter, starter and finisher rations prepared in Central Feed Technology Unit (TANUVAS), Kattupakkam (Kancheepuram Dt. Tamil Nadu, India) were fed to chicks during the experimental period. The experimental diets were prepared with or without different source of Zn as feed supplement as per the inclusion levels mentioned in the following Table-1.

The broiler pre-starter (PBS) mash was fed to the birds during first two weeks followed by starter (BS) mash up to four weeks of age and broiler finisher (BF) mash thereafter (5-6 weeks) as per BIS 2007 recommendations. During the period of study period (0-6 weeks), all the birds were provided with *ad libitum* feed and water.

Carcass characteristics

At the end of 6th week of age, two birds from each replicate were taken randomly for the recording of carcass characteristics. Birds were dressed, eviscerated and the per cent eviscerated carcass yield, ready-to-cook yield and cut up yields were estimated.

The following parameters were recorded at the time of slaughter.

Pre-slaughter live weight (g)

$$\text{Evisceration yield (\%)} = \frac{\text{Eviscerated weight without giblet}}{\text{Pre-slaughter live weight}} \times 100$$

$$\text{Ready-to-cook yield (\%)} = \frac{\text{Eviscerated weight with giblet}}{\text{Pre-slaughter live weight}} \times 100$$

$$\text{Cut-up parts yield (\%)} = \frac{\text{Weight of the individual cut-up part}}{\text{Eviscerated carcass weight}} \times 100$$

Measurement of bone osteomorphometry

During the slaughter study, the left tibia bone was dissected out from the birds and their adhering muscles together with connective tissue were removed manually to study the bone morphometric parameters. The bones were processed by dipping in 10% sodium hydroxide (NaOH) solution for five minutes to remove the adhering fine and soft tissue. These bones were dried in hot air oven overnight and the bone measurements were taken with the vernier calliper as shown in Figure 1. De-fattening of dried bones was done with diethyl ether and petroleum sprit following the procedure of AOAC (2000). The weight of each tibia was determined as such using an electronic digital balance of 0.01 g accuracy and fat free dried basis.

Statistical analysis

The data collected on various parameters were grouped and subjected for statistical analysis of variance (ANOVA) as per the procedure of statistical package for social sciences (SPSS) software package for windows as per Snedecor and Cochran (1989). All the percent values in the experiment were transformed to their arcsine roots before subjecting to statistical analysis. Results were expressed as mean ± SE and the difference were considered statistically significant at $P<0.05$ and highly significant at $P<0.01$.

Results and Discussion

The carcass characteristic (per cent eviscerated yield, ready-to-cook yield and giblet per cent) of broiler chicken under different treatments was presented in Table-2. Pre-slaughter live weight was ranged from 1945.33 gm to 2063 gm. There was no significant ($p>0.05$) difference observed between different sources of Zn supplemented (treatment groups) and unsupplement (control) groups. The eviscerated carcass weights (%) were ranged from 64.50% to 66.85%. In the present study there was no significant difference ($p>0.05$) observed in the per cent carcass yield in Cobb broilers. It was observed that the supplementation of Zn either through $ZnSO_4$ or through Zn-protienate at a level of 40 ppm showed numerically higher mean per cent eviscerated and ready-to-cook yield of 66.80 and 66.85; 71.97 and 71.56, respectively. Our results are in agreement with findings of Liu *et al.*, (2011) and Yogesh *et al.*, (2013) in broiler chickens. The present findings were in agreement with the findings of Vladimir *et al.*, (2010) who found that groups fed with trace elements in proteinated form restricted to 50 per cent (on regular levels) Cu, 20 per cent Fe, Zn and Mn and of Se had same effect on carcass yield.

The results of the present experiment was in agreement with Sunder *et al.*,(2008) who also found that supplemental Zn did not influence ready to cook yield in broilers. However, the present findings were in contrary with those of Ellen *et al.*, (2012) who found that dressing percentage was significantly higher in group fed with 2.50g/ton, 11.25g/ton, 15.00g/ton, and 18.75g/ton of amino acid chelates of Cu, Zn, Mn and Fe, respectively. The present findings were also in disagreement with the findings of Jahanian and Rasouli (2008) who indicated that dietary Zn-methionine inclusion in replacement of inorganic sources showed increased carcass meat yield. The present finding with respect to giblet were also in disagreement with that of Iqbal *et al.*, (2011) who observed that broiler chickens fed with lower levels (40 mg) zinc from organic source when combined with different sources and concentrations of copper had significant effect on liver and heart weight. Similarly, Kumar *et al.*, (2009) also reported that the carcass quality traits (dressing and eviscerated yield) of broiler chicken did not show any significant change due to supplementation of different Zn sources and levels.

Table.1 Inclusion levels of different Zn supplements in experimental diets

S. No.	Treatment	Supplemental Zn source	Zn (ppm) level in the feed
1.	T1	Control (un-supplemented with zinc)	-
2.	T2	Zinc oxide	40
3.	T3	Zinc oxide	80
4.	T4	Zinc sulphate	40
5.	T5	Zinc sulphate	80
6.	T6	Zinc-methionine	40
7.	T7	Zinc-methionine	80
8.	T8	Zinc-proteinate	40
9.	T9	Zinc-proteinate	80
10.	T10	Nano-zinc	20

Table.2 Effect of different dietary zinc sources as a feed supplements on carcass characteristics and Giblet (%) in commercial broiler Chicken (Mean ± SE) (n = 60)

Treatments (in ppm)	Carcass characteristics			Giblet (%)		
	Live weight (g)	Eviscerated weight (%)	Ready-to-cook yield (%)	Heart	Liver	Gizzard
T1Control	2063.00 ± 95.89	66.63 ± 0.79	71.91 ± 0.72	0.61±0.06	1.88±0.09	2.79±0.19
T2ZnO - 40	2056.67 ± 72.11	64.50 ± 1.44	69.29 ± 1.40	0.54±0.03	1.81±0.07	2.44±0.11
T3ZnO - 80	2009.67 ±124.89	66.29 ± 0.98	71.37 ± 0.98	0.52±0.03	1.94±0.10	2.61±0.10
T4ZnSO$_4$ - 40	2024.67 ± 64.29	66.80 ± 0.77	71.97 ± 0.64	0.54±0.05	1.88±0.13	2.76±0.31
T5ZnSO$_4$ - 80	2002.67 ±101.97	65.70 ± 0.63	70.77 ± 0.61	0.50±0.02	1.78±0.12	2.80±0.16
T6ZnMet - 40	1996.67 ± 83.75	65.57 ± 0.68	70.77 ± 0.68	0.55±0.05	1.76±0.14	2.90±0.12
T7ZnMet - 80	1955.67 ± 43.91	65.12 ± 0.42	70.32 ± 0.54	0.53±0.05	1.72±0.06	2.96±0.18
T8ZnP - 40	1971.33 ± 80.09	66.85 ± 0.80	71.56 ± 0.85	0.49±0.02	1.70±0.07	2.52±0.18
T9ZnP - 80	1991.67 ± 35.88	66.28 ± 1.15	71.17 ± 0.98	0.54±0.04	1.72±0.07	2.62±0.12
T10Nano Zn	1945.33 ± 67.61	65.68 ± 0.96	71.06 ± 0.86	0.52±0.03	1.83±0.06	3.03±0.17
F value	**0.232**	**0.719**	**0.837**	**0.646**	**0.761**	**1.234**
Significance	NS – Not significant (P> 0.05)					

Table.3 Effect of different dietary zinc sources as a feed supplement on cut-up-parts (%) at sixth week of age in commercial broiler Chicken (Mean ± SE) (n = 60)

Treatments (in ppm)	Cut-up-parts (%)					
	Brest	Drumstick	Wing	Neck	Back	Thigh
T1 Control	34.54±0.95	16.02±0.52	10.09±0.34	3.83±0.17	21.73±0.63	14.01±0.30
T2 ZnO - 40	35.56±0.59	16.01±0.25	9.20±0.21	3.76±0.20	21.27±0.40	13.74±0.34
T3 ZnO - 80	35.36±0.24	16.68±0.29	9.12±0.29	3.61±0.19	21.89±0.33	13.00±0.36
T4 $ZnSO_4$ - 40	34.79±0.53	15.80±0.70	10.06±0.32	4.12±0.30	21.66±0.31	13.48±0.30
T5 $ZnSO_4$ - 80	33.15±0.94	17.30±0.43	9.40±0.34	3.81±0.14	21.43±0.51	14.94±0.35
T6 ZnMet - 40	34.04±0.58	17.47±0.20	9.17±0.27	3.81±0.11	21.15±0.77	14.37±0.45
T7 ZnMet - 80	34.66±0.54	16.99±0.31	8.80±0.18	3.81±0.12	22.12±0.23	13.69±0.17
T8 ZnP - 40	34.97±0.60	16.49±0.46	8.78±0.29	3.77±0.14	21.22±0.45	14.04±0.35
T9 ZnP - 80	34.75±0.79	16.68±0.21	9.218±0.24	3.93±0.18	20.65±0.58	14.00±0.34
T10 Nano Zn	36.16±0.58	17.24±0.37	9.09±0.21	4.14±0.20	20.21±0.61	13.47±0.20
F value	**1.562**	**1.132**	**1.619**	**0.788**	**1.305**	**1.690**
Significance	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table.4 Effect of different dietary zinc sources as a feed supplement on dry bone weight (g), bone length (cm) and diameter (cm) at Sixth week of age in commercial broiler chicken (Mean ± SE) (n = 60)

Treatments (in ppm)	Dry bone weight (g)	Bone length (cm)	Bone diameter (cm)	Total ash (%)
T1Control	6.94±0.36	9.48±0.01	1.12±0.23	49.05±0.91
T2ZnO - 40	6.87±0.39	9.60±0.13	1.08±0.24	47.26±1.06
T3ZnO - 80	6.93±0.60	9.72±0.17	1.10±0.03	47.36±0.73
T4$ZnSO_4$ - 40	6.51±0.18	9.71±0.14	1.04±0.13	49.01±0.75
T5$ZnSO_4$ - 80	6.75±0.35	9.87±0.27	1.09±0.02	48.29±1.46
T6ZnMet - 40	6.95±0.59	9.53±0.16	1.10±0.03	47.97±0.93
T7ZnMet - 80	7.35±0.50	9.51±0.12	1.08±0.12	49.20±1.24
T8ZnP - 40	7.31±0.81	9.76±0.19	1.11±0.04	48.25±1.39
T9ZnP - 80	6.90±0.30	9.73±0.13	1.10±0.03	48.77±1.48
T10Nano Zn	6.40±0.30	9.66±0.12	1.08±0.02	48.39±0.90
F value	**0.397**	**0.619**	**0.576**	**0.619**
Significance	NS – Not significant (P> 0.05)			

Fig.1 Preparation of bones for osteomorphometry study

The per cent cut-up parts of broiler chicken under different treatments were presented in Table-3. Saenmahayak *et al.*, (2010) reported that feeding of organic or chelated trace minerals resulted in a better breast meat yield which was in disagreement with the present findings, showed that no significant (p>0.05) difference in breast meat yield upon organic and inorganic Zn supplementation.

There was no significant (p>0.05) difference observed in the bone morphometric studies with respect to bone weight (g), bone length (cm), bone diameter (cm) and total ash (%) in Cobb broilers under study as shown in Table-4. The present findings were in agreement with the findings of Bao *et al.,* (2010) who reported that addition of all 4 trace minerals (Cu, Fe, Mn and Zn) to the control diet did not improve (P>005) total tibia trace mineral content and tibia bone quality (tibia length and width). The present findings were in agreement with the result of Oliveira *et al.*, (2015) who reported that there was no significant effect noted for dry tibia weights, tibia length and width, tibia length to weight ratio (L/W), when the birds fed with organic sources of Zn, Mn and Cu. The present findings were also in disagreement with the findings of Osama *et al.,* (2012) who reported that birds fed with 50% Zn+50% Mn+50% Cu (organic) diet showed improved tibia weight, length, diaphysis diameter, weight/length index. This might be due to that the birds were sacrificed at 32 days of age whereas, the current study the birds were slaughtered at 42nd day. Soni *et al.,* (2014) observed that physical parameters of tibia bone such as weight, length and cortex thickness in different dietary treatments of zinc did not show any significant change. There was a lack of literature on effect of supplementation of nano zinc on bone physical parameters, however in the present study nano Zn supplementation did not showed any significant change in the bone physical parameters.

It was concluded that the dietary supplementation of inorganic, organic and nano Zn did not show any significant change in the percentage of carcass yield and bone morphometric parameters in the commercial broiler chicken.

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