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Influence of zinc sulphate and zinc-methionine dietary supplementation on carcass characteristics and feed efficiency of broilers

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ABSTRACT

An experimental trial has been conducted on 288 broiler male chicks fed with maize-soybean-fishmeal based diet supplemented with Zinc-sulphate at 0(T_1), 20 (T_2), 40 (T_3), 60 (T_4) and 80 (T_5) mg/Kg diet and Zinc-methionine (BIOPLEX) at 20 (T_6), 40 (T_7), 60 (T_8), 80 (T_9) mg/Kg diet. Each treatment consisted of 4 replicates with 8 birds per replicate. All the birds during the first week were fed with a basal diet without any zinc supplementation to deplete the body zinc reserves. From 1st to 4th week the birds were fed with starter diet containing 23.0% CP, 2877 Kcal of ME/Kg diet and 5th and 6th week the birds were fed with finisher diets containing 20.4% CP, 2943 Kcal of ME/Kg diet. There was no significant difference among different treatments in relation to the body weight gain but there was slight increase in body weight gain in treatments supplemented with zinc when compared to control. The supplementation of zinc in the form of inorganic and organic zinc at 20, 40, 60, 80 ppm levels did not influence much with regard to the feed intake. The feed efficiency for the overall experimental period from (1-6 weeks) ranged between 1.92±0.03 to 1.99±0.06 which is also statis tically not significant (P > 0.05). Similarly there was no significant difference in the ready to cook yields and the liver weights among the various treatment levels.

Key words: zinc, zinc methionine, carcass characteristics, feed efficiency

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INTRODUCTION

The mineral elements exist in the cells and tissues of animal body in a variety of functional combinations and in characteristic concentrations which vary with the element and the tissue. The concentrations of these trace elements must be maintained within quite narrow range if the functional and structural integrity of the tissues is to be safeguarded and the growth, health, and reproductivity of the animals are to remain unimpaired. [1, 2] Different organic and inorganic zinc supplementations have been tried in poultry to overcome the deficiency and to sustain good production performance. [3, 4, 5, 6] had evaluated the bioavailability of zinc among different inorganic sources and reported that, zinc sulphate ($ZnSo_4$), zinc carbonate ($ZnCo_3$) and zinc oxide (ZnO) had 100%, 93%, and 67% respectively in broilers. [7] suggested that the bioavailability of zinc in zinc-lysine is 109% and [8] suggested that, zinc in zinc-methionine had 117% bioavailability.

Organic sources of trace minerals have been reported to have greater bioavailability due to the ability of organic compounds such as amino acids to bind strongly to zinc and other divalent minerals under physiological pH conditions [9, 10, 11] this strong bond between the mineral and its organic carrier prevents phytate from binding to the metals in the gastro intestinal tract while still being water soluble thus facilitating mineral uptake into the mucosa of the small intestine.

[12, 13] expressed that increasing the level of zinc up to 120mg/kg significantly ($P<0.01$) improved body weight gain, feed conversion efficiency and antibody titers to SRBC in broiler chicks. An attempt has been made to present the critical information concerning the present investigation which intended to know the effect of dietary supplementation of zinc sulphate and zinc-methionine on Carcass characteristics and feed efficiency of broilers.

MATERIALS AND METHODS

The experiment was performed with 288 day old broiler male chicks which were procured from the local hatchery and were distributed randomly into nine treatments with 32 birds per treatment (8 birds per replicate with four replicates per treatment). Nine treatments (T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9), with four replicate groups of 8 chicks in each were allowed *ad libitum* access to the experimental diets and fresh potable water. Chicks were maintained in heated thermostatically controlled stainless steel batteries with raised wire floors. To minimize zinc contamination from the environment, stainless steel feeders and waterers were also used. Chicks were exposed to constant fluorescent light 24 hour per day. Nine treatments were prepared using corn-soybean meal based diets using BIS specifications with inorganic zinc sulphate at 0, 20, 40, 60, 80mg/kg diet (T_1, T_2 , T_3, T_4 , and T_5) and organic zinc-methionine at 20, 40, 60 and 80mg/kg diet supplementation (T_6,T_7,T_8, and T_9). The first control treatment (T_1) with 4 replicates was fed on basal diet without zinc supplementation. The T_2, T_3, T_4, T_5 were fed on basal diet with 20, 40, 60, 80mg/kg diet zinc sulphate and T_6, T_7, T_8, and T_9 were fed on basal diet with zinc-methionine supplementation. The basal diet was prepared using corn-soybean meal, fish meal based diet and it was mixed with the inorganic zinc sulphate and organic zinc-methionine as per the concentrations described above. The mineral mixture was prepared using the feed grade mineral supplements as per the BIS (1992) specifications and was mixed in the basal diet along with vitamins and feed additives.

For the first 7 days all the birds were fed with basal corn soy based diet so that the body zinc levels are depleted. On the day 8, the chicks were weighed individually and the birds averaging from 128 to 135 gm were distributed randomly into 36 cages (4 replicates per treatment with each cage having 8birds). All the chicks were housed in battery brooders all through the experiment. Feed and water were provided *ad libitum*. Other managemental practices like vaccination of chicks etc. were adapted. The chicks were fed on the respective experimental starter (2-4 weeks) and finisher (5th and 6th weeks) diets *ad libitum* from 1-6 weeks. The feed offered was weighed daily and feed leftover was weighed weekly once, to quantify feed utilized. B-complex and calcium supplements were offered in water for 3 days during the first week.

Table I: Ingredient composition of basal broiler starter diets on % DM basis

Ingredient	Parts	CP %	ME Kcal/kg	Ca %	P %	Lysine%	Methionine %
Maize	57	5.42	1886	0.14	0.23	0.103	0.086
Soybean meal	30	12.9	808	0.11	0.27	0.771	0.228
Fishmeal	10	4.7	183	0.72	0.17	0.417	0.142
Minerals + Vitamins + Feed Additives + salt	3	0	0	0.28	0.25	0	0
TOTAL	**100**	**23.02**	**2877**	**1.25**	**0.5**	**1.291**	**0.456**

** Feed additives*

Rovibee (Roche): 25g/ 100 kg; containing Vit B_1:4mg; Vit B_6: 8mg; Vit B_{12}: 40 mg; Niacin : 60mg; calcium pantothenate 40mg; Vit E 40mg per gram. Hyblend A, B_2, D_3, K: 20 g/100kg; containing Vit A: 82,500IU; B_2:50mg; D_3: 12000IU, Vit K: 10mg per gram. Neftin- 200:30g/100kg (Furazolidine: 20percent W/W); Veldot (ventrichemicals Ltd): 40/ 100kg; Each kg contains 250g of DOT (3-5 Dinitro-o-Tolumide)

Growth performance:

All the birds were individually weighed and the feed intake per cage was recorded (8 chicks per replicate) at the end of each week. The feed consumption and body weights were calculated for both the starter diet and the finisher diet. The feed conversion ratio was calculated basing on this data.

Carcass characteristics:
At the end of the study period (6th week) 2 birds per replicate and thus a total of 8 birds per treatment were randomly selected, weighed and slaughtered. The data on percent ready- to- cook yield and percent live weights of liver were recorded.

Table II: Ingredient composition of broiler finisher diets on % DM basis

Ingredient	Parts	CP %	ME Kcal/kg	Ca %	P %	Lysine%	Methionine%
Maize	65	6.22	2167	0.16	0.26	0.12	0.09
Soybean meal	22	9.46	593	0.08	0.19	0.56	0.16
Fishmeal	10	4.7	183.4	0.71	0.17	0.42	0.14
Minerals + Vitamins + Feed Additives + salt	3	0	0	0.34	0.3	0	0
TOTAL	**100**	**20.38**	**2943**	**1.29**	**0.92**	**1.1**	**0.39**

** Feed additives*

Rovibee (Roche): 25g/ 100kg; containing Vit B_1:4mg; Vit B_6:8mg; Vit B_{12}: 40mg; Niacin: 60mg; calcium pantothenate: 40mg/gram. Hyblend A, B_2, D_3, K: 20g/100kg; containing Vit A: 82,500IU; B_2:50mg; D_3: 1200IU, Vit K: 10mg/gram. Neftin-200:30g/100kg (Furazolidine: 20 percent W/W). Veldot (Ventrichemicals Ltd): 40g/100kg; each kg contains 250g of DOT (3-5Dinitro-o-Tolumide)

RESULTS

GROWTH PERFORMANCE OF BROILERS:

Body weight gain:
Body weight gains during the experiment are given in Table III. During starter period (1-4) weeks, the body weight gain ranged from 792.50±24.52 to 871.44±29.03 grams in different treatments. There was no significant difference among treatments from T_1 to T_9. During finisher period (5-6 weeks) the body weight gains (Table III) ranged from 810.69±13.26 to 917.25±47.39 grams in different treatments and the differences among treatments were not significant (P > 0.05). During overall growth period (0-6 wks) the body weight gain ranged between 1620 to 1731 grams among different treatments which were not significant (P > 0.05). Even though there was no significant difference among different treatments there was slight increase in body weight gain in treatments supplemented with zinc when compared to control.

Table III: Average body weight gain per bird (gms) of broilers fed on different levels of zinc supplementation.

Zinc source	Treatment		STARTER	FINISHER	TOTAL PERIOD	Mortality %
Zinc sulphate	mg/kg		1-4 week	5-6 week	1-6 week	1-6 weeks
	T_1	0	792.50±24.52	868.31±12.82	1660.8±22.02	0
Zinc sulphate	T_2	20	814.37±19.47	917.25±47.39	1731.62±54.39	0
	T_3	40	818.12±15.06	869.94±58.51	1688.06±67.28	0
	T_4	60	830.94±11.73	791.00±53.15	1621.94±62.09	0
	T_5	80	850.47±17.71	821.97±30.48	1672.44±25.14	0
Zinc-Methionine	T_6	20	826.09±16.27	820.72±06.90	1676.81±18.48	0
	T_7	40	840.94±8.12	876.69±32.58	1717.62±37.25	0
	T_8	60	831.88±17.00	823.12±44.90	1655.00±43.99	0
	T_9	80	871.44±29.03	810.69±13.26	1682.12±36.97	0
SEM			6.53	12.82	14.02	
SIGNIFICANCE			NS	NS	NS	

Feed intake
Feed intake during starter period (1-4 weeks) ranged from 1263 to 1322gms among different treatments (Table IV). The feed intake showed no significant differences (P<0.05) between the treatments. Among different levels of inclusion of zinc with inorganic and organic forms in the treatments no significant difference was observed.

During finisher period (5-6 weeks) feed intake (Table IV) ranged from 1940.94±15.57 to 1993.91±0.78gms.The differences among different treatments were not significant. During overall growth phase (1-6 weeks) the feed intake ranged from 3231.25±22.87 to 3281.72±11.57gms. The differences among different treatments were not significant. The supplementation of zinc in the form of inorganic and organic zinc at 20, 40, 60, 80 ppm levels did not influence much with regard to the feed intake.

Table IV: Average feed intake per bird (g) of broilers fed on different levels of zinc supplementation

Treatment	1-4week	5-6week	0-6week
T1	1295.63±11.69	1977.34±16.46	3272.97±24.86
T2	1288.75±10.77	1992.97±0.82	3281.72±11.57
T3	1322.50±20.20	1993.91±0.78	3316.41±20.01
T4	1290.31±38.14	1940.94±15.57	3231.25±22.87
T5	1353.44±35.06	1942.97±37.77	3296.41±22.55
T6	1304.06±35.21	1976.25±15.65	3280.31±38.94
T7	1322.19±27.39	1971.09±16.57	3303.28±18.37
T8	1283.75±26.71	1975.0±15.25	3261.25±35.92
T9	1263.75±48.36	1991.56±1.21	3255.31±48.55
SEM	9.96	5.97	9.52
Significance	NS	NS	NS

Feed efficiency

The feed efficiency (Table V) during starter period (1-4 weeks) was found non significant among the treatments. There was no significant difference in feed efficiency among the diets containing different levels of inorganic and organic zinc. The feed efficiency was ranged from 1.45±0.02 to 1.64±0.06 during the starter phase (1-4 weeks). In finisher diets the feed efficiency between treatments ranged from 2.19±0.11 to 2.49±0.18 and the feed/kg body weight gain was high in treatments 2 and 7 respectively but it is not significant. The feed efficiency for the overall experimental period from (1-6 weeks) ranged between 1.92±0.03 to 1.99±0.06 which is also statistically not significant (P > 0.05).

Table V: Feed efficiency (Feed/gain) of broilers fed on different levels of zinc supplementation

zinc source	Treatment		Starter	Finisher	Final
	PPM		0-4 WEEK	5-6 WEEK	1-6 WEEK
	T_1	0	1.64±0.06	2.28±0.02	1.97±0.03
zinc sulphate	T_2	20	1.58±0.02	2.19±0.11	1.90±0.05
	T_3	40	1.62±0.01	2.32±0.14	1.97±0.06
	T_4	60	1.55±0.03	2.49±0.18	2.00±0.06
	T_5	80	1.59±0.06	2.38±0.12	1.97±0.03
zinc-methionine	T_6	20	1.58±0.05	2.41±0.02	1.99±0.03
	T_7	40	1.58±0.03	2.25±0.09	1.92±0.06
	T_8	60	1.54±0.01	2.42±0.15	1.97±0.11
	T_9	80	1.45±0.02	2.45±0.03	1.93±0.04
SEM			0.01	0.03	0.01
SIGNIFICANCE			NS	NS	NS

CARCASS CHARACTERISTICS

The percent ready to cook yield and liver weight (Table VI) in broilers fed on different levels of inorganic and organic zinc were ranged between 1.25±0.10 to 1.48±0.04 kgs, and 33.5±2.54 to 39.29±1.35 gms. There was no significant difference in the ready to cook yields and the liver weights among the various treatment levels.

Table VI: Effect of zinc supplementation on ready to cook yield and other body organ weights

Treatment	Ready to cook yield (grams)	Ready to cook yield on % live weight basis	Liver weight (grams)	Liver weight on % live weight basis
T1	1.37±0.03	72.06±0.55	33.5±2.54	1.76±0.11
T2	1.48±0.04	71.97±1.02	38±1.28	1.84±0.05
T3	1.40±0.04	72.74±1.26	39.25±2.60	2.03±0.11
T4	1.43±0.03	74.63±3.51	38.13±2.17	1.99±0.13
T5	1.39±0.03	72.85±0.70	35.71±2.10	1.88±0.07
T6	1.35±0.04	71.86±1.19	37.88±2.42	2.01±0.12
T7	1.39±0.01	71.62±0.74	34.38±1.61	1.76±0.07
T8	1.35±0.03	75.33±3.42	34.75±1.71	1.9±0.04
T9	1.25±0.10	65.7±0.81	39.29±1.35	2.02±0.03
SEM	0.016	0.016	0.68	0.69
SIGNIFICANCE	NS	NS	NS	NS

DISCUSSION

Body weight gain:

Weekly body weight gains (Table III) during starter period (1-4 weeks) ranged from 792.50±24.52 (T_1) to 871.44±29.03 (T_9) gms. Even though significant difference ($P > 0.05$) were not observed among the treatments, there was positive increase in body weight gains (Figure 1) with increase in zinc sulphate and zinc-methionine supplementation during starter phase. This showed that supplemental zinc had positive impact on body weight gain. [8] Observed that body weight was improved when total dietary zinc increased from 10-30mg/kg. [12] reported that increasing the level of zinc up to 120mg/kg diet significantly ($P < 0.05$) improved body weight gain**.**

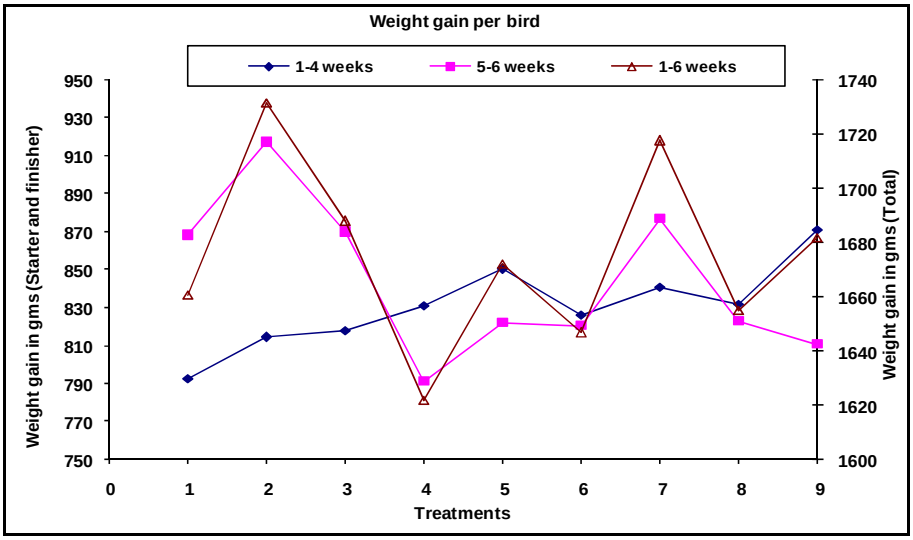

Fig: 1 Effect of zinc supplementation on body weight gain

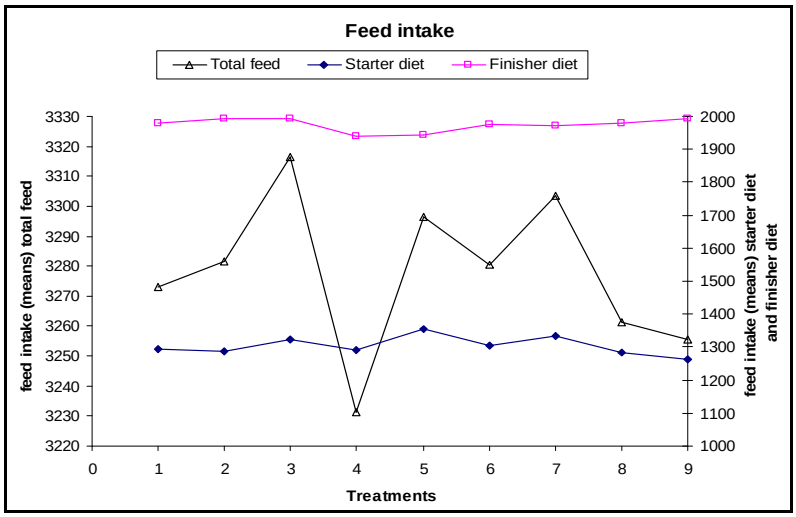

Fig: 2 Effect of zinc supplementation on feed intake

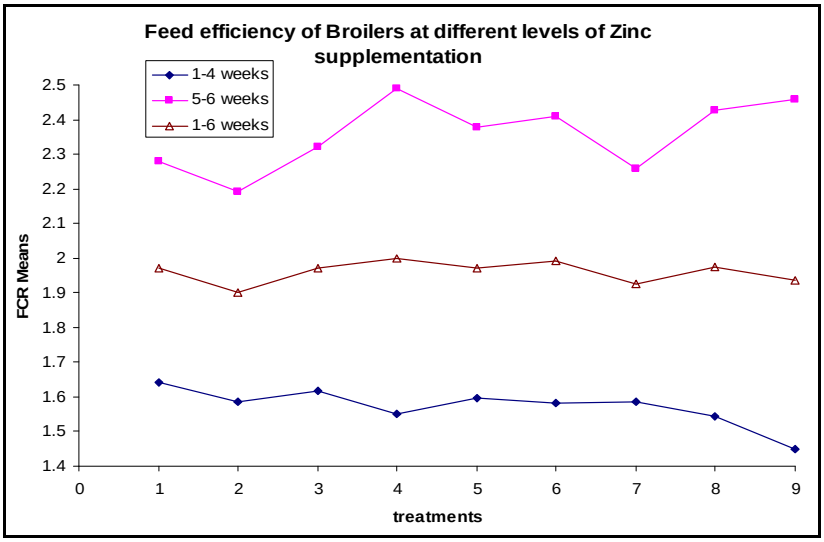

Fig: 3 Effect of zinc supplementation on feed efficiency

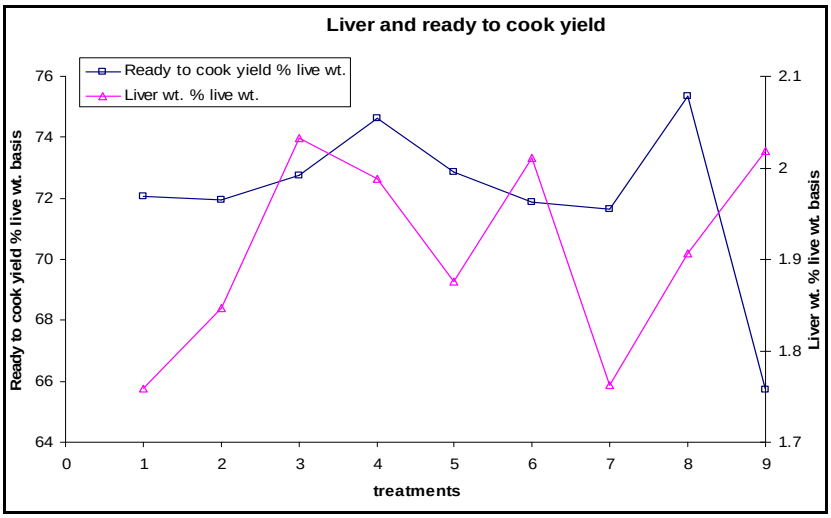

Fig: 4 Effect of zinc supplementation on carcass characteristics

Feed intake:

Feed intake (Table IV) during starter period (1-4 weeks) ranged from 1263.75 to 1322.50 grams among the treatments. There was no significant difference ($P < 0.05$) between the treatments both in starter and finisher phases. As all the treatment groups were fed on same basal diet with varied zinc supplementation (Figure 2), there was no significant difference in feed intake. [14] studied the effect of different dietary levels of zinc (63, 93 and 123 ppm) on the performance of broiler chicks and reported that, supplemental zinc did not improve feed intake. [15] also reported that supplementation of zinc at 20, 40, 60mg/kg diet did not affect feed intake from 0-6 weeks.

Feed efficiency:

The feed efficiency (Table V) ranged from 1.45±0.02 (T_9) to 1.64±0.06 (T_1) in starter phase and 2.19±0.11to 2.49±0.18 in finisher phase without any significant difference ($P > 0.05$). Improved FCR was noticed with increase in zinc supplementation (Figure 3) showing that zinc improved the feed utilization. Similar findings were reported by [8, 16, 17] who observed increased feed efficiency with increase in zinc supplementation. However [14] did not observe any improvement in FCR with zinc supplementation. Better FCR was observed during starter phase when compared with finisher phase. Zinc sulphate and zinc-methionine supplementation, did not show much difference between them with regard to feed conversion ratio.

Carcass characteristics:
The ready to cook yields and liver weights (Table VI) in broilers (Figure 4) fed with different levels of inorganic and organic zinc ranged between 1.25±0.10(T_9) to 1.48±0.04 kg (T_2) and 33.5±2.54(T_1) to 39.29±1.35gms(T_9), respectively, without any significant difference ($P < 0.05$). Similar findings were reported by [18] who observed that meat yields remained unaffected when dietary zinc concentrations were provided in excess of the NRC recommendations of 40 mg/kg supplemental zinc. The findings of the present study are similar to [19] who concluded that zinc concentration in diets up to 40mg/kg had not shown any affect on meat yields.

CONCLUSION

Based on the findings of the present investigation it can be concluded that, there was no significant response ($P<0.05$) to zinc supplementation both in the form of inorganic zinc sulphate and organic zinc methionine with regard to FCR and carcass characteristics. How ever, the birds fed with 60mg/ kg diet with zinc sulphate and 40mg/kg diet zinc methionine supplementation can produce better growth.

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