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Effect of various levels of trace mineral sources on economics & livability of commercial broiler chicken

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Abstract
An investigation was conducted to assess the impact of varying ratios of inorganic and organic trace minerals on the livability and economic efficiency of commercial broiler production. A total of 120 day-old Cobb-400 broiler chicks were randomly assigned to five dietary treatments, each consisting of four replicates with 24 birds. The control diet included trace minerals exclusively from inorganic sources (100% ITM), while the remaining treatments replaced ITM with organic trace minerals (OTM) at inclusion levels of 25%, 50%, 75%, and 100%. Livability and economic parameters were evaluated throughout the six-week trial. The results demonstrated that broilers offered a diet containing 100% organic trace minerals achieved superior survival rates and generated the highest economic benefits compared with birds fed the diet containing only inorganic trace minerals. diet.

Keywords: Broiler, inorganic trace minerals, organic trace minerals, livability, return over feed cost

Introduction
The poultry industry remains one of the most rapidly expanding segments of Indian agriculture, with broiler production being particularly dependent on feed inputs, which generally account for 70-80% of overall production expenses [1]. To prevent nutrient deficiencies that could lead to clinical disorders or pathological issues, mineral supplementation is routinely incorporated into poultry diets [2]. Chickens require a minimum of fourteen essential inorganic nutrients, classified based on the quantities in which they are needed. The first group consists of macro-elements, required in comparatively large amounts and expressed as a percentage of the diet; these minerals are vital for skeletal development and numerous metabolic functions. The second group comprises trace minerals, or microminerals, which are present in minute quantities within body tissues and primarily function as enzyme cofactors and regulators of physiological mechanisms [3].
Broiler rations commonly include trace elements such as zinc (Zn), copper (Cu), iron (Fe), iodine (I), manganese (Mn), cobalt (Co), selenium (Se), chromium (Cr), and molybdenum (Mo). These microminerals are integral to digestive function, metabolic activities, and various biosynthetic processes, all of which contribute to improved growth and physiological performance [4]. To enhance the efficiency of mineral absorption, organic mineral formats-including amino acid chelates, proteinates, and recently developed organic acid chelates-have been introduced [5]. Compared with traditional inorganic sources, organic trace minerals exhibit higher bioavailability and result in lower mineral excretion, helping to minimize environmental contamination. Their supplementation has been associated with a range of benefits such as lower mortality rates, improved skin strength, enhanced feathering, reduced blemishes, and superior carcass quality [6].

Materials and Methods
The experiment was carried out at the Poultry Research Station, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Anand, Gujarat. A total of 120 unsexed, day-old commercial broiler chicks originating from the same hatch were obtained from a private hatchery. The study extended over a six-week period, from 26 February 2021 to 8 April 2021. On arrival, each chick was individually weighed and tagged with wing bands for identification. The chicks were then randomly distributed into five dietary treatments, with each treatment containing 24 birds. Every treatment was further divided into four replicates, and each replicate housed six chicks.

Vaccination schedules adhered to standard protocols: Marek's disease vaccination was administered at the hatchery, while Newcastle disease vaccinations (Lasota strain) were given on days 7 and 21, and infectious bursal disease vaccination was performed on day 14. Phase-specific diets-pre-starter (0-7 days), starter (8-21 days), and finisher (22-42 days)-were formulated for the experiment. The inorganic trace minerals and the glycinated organic trace mineral supplements were purchased from commercial suppliers.

- The treatments consisted of the following mineral combinations:
  - **T_1:** basal diet containing only inorganic trace minerals (100% ITM)
  - **T_2:** basal diet with 75% ITM and 25% organic trace minerals (OTM)
  - **T_3:** basal diet with an equal blend of 50% ITM and 50% OTM
  - **T_4:** basal diet containing 25% ITM and 75% OTM
  - **T_5:** basal diet fortified exclusively with organic trace minerals (100% OTM)

All diets were formulated to be nutritionally comparable, ensuring uniform levels of protein and metabolizable energy across all treatment groups.

Table 1: Proportion of feed ingredients (%) used for preparation of broiler diets (control diet)

Sr. No.	Ingredients	Broiler Pre-starter (0-1 week)	Broiler Starter (2-3 weeks)	Broiler Finisher (4-6 weeks)
1	Yellow maize	55.200	57.300	59.400
2	Soybean Deoiled Cake	38.000	36.000	30.500
3	De-oiled Rice Bran	2.000	1.000	2.800
4	Limestone Powder	1.400	1.380	1.350
5	Dicalcium Phosphate	0.980	1.050	1.150
6	Vitamin Premix	0.050	0.050	0.050
7	Vitamin B12	0.010	0.010	0.010
8	Choline Chloride (60%)	0.100	0.100	0.100
9	Lysine	0.060	0.050	0.055
10	Methionine	0.160	0.130	0.150
11	Phytase	0.010	0.010	0.010
12	Enzymes	0.050	0.050	0.050
13	Salt	0.250	0.250	0.250
14	Sodium Bicarbonate	0.100	0.100	0.100
15	Liver Tonic	0.050	0.050	0.050
16	Immunomodulators	0.100	0.080	0.080
17	Toxin Binder	0.100	0.100	0.100
18	Anticoccidial	0.050	0.050	0.050
19	Emulsifier	0.100	0.100	0.100
20	Vegetable Oil	1.330	2.600	4.200
21	Inorganic Trace Minerals	0.100	0.100	0.100
22	Organic Trace Minerals	-	-	-
Total		100.00	100.00	100.00
CP (%)		23.00	22.00	20.00
ME (kcal/kg)		3005	3105	3195

Results and Discussion

Livability

The livability outcomes for broilers subjected to the various dietary treatments are presented in Table 2. The percentages of birds that survived to the end of the experiment were 91.67% for T_1, 95.83% for T_2, and a full 100% for the T_3, T_4, and T_5 groups. No mortality occurred in the latter three treatments during the entire study period, whereas the T_1 and T_2 groups experienced mortality levels of 8.33% and 4.17%, respectively.

These observations are consistent with earlier findings by Nollet *et al*. (2008) [7], M'sadeq *et al*. (2018) [8], Abdullah *et al*. (2009) [9], and Baloch *et al*. (2017) [10], all of whom reported that supplementing broiler diets with organic trace minerals tends to lower mortality compared with diets relying exclusively on inorganic mineral sources. However, the present results contrast with those reported by Bao *et al*. (2009) [3], who documented a slightly higher mortality rate in birds receiving organic trace minerals (8.0%) compared with those fed inorganic minerals (7.5%).

Economics: Feed constitutes the largest portion of expenditure in broiler production, typically exceeding 75% of the total operational cost. The profitability of broiler rearing is often evaluated through the return over feed cost (ROFC), calculated by deducting the feed cost from the income generated from bird sales. In this study, the ROFC (Rs./bird) values recorded for the T_1, T_2, T_3, T_4, and T_5 dietary treatments were 58.48, 72.19, 79.09, 76.83, and 85.20, respectively. Among all treatments, birds offered the T_5 diet delivered the greatest economic benefit, followed by those in the T_3, T_4, T_2, and T_1 groups in descending order.

These outcomes suggest that the T_5 ration-comprising 100% organic trace minerals-provided the most favorable economic return. Comparable findings were reported by Lu *et al*. (2020) [11], Khatun *et al*. (2019) [12], Ahamed *et al*. (2019) [13], Trivedi *et al*. (2019) [14], and Das *et al*. (2011) [15], who similarly documented enhanced ROFC in broilers supplemented with organic rather than inorganic mineral sources. Conversely, the present results differ from those of Ma *et al*. (2015) [16], who observed greater profitability with diets containing only 25% organic trace minerals. Ciurescu *et al*. (2007) [17] likewise reported that replacing inorganic trace minerals entirely with organic forms did not yield a cost-effective advantage.

Table 2: Livability (%) of broilers fed with different treatment diets

Particulars	T_1	T_2	T_3	T_4	T_5
No. of birds at day-old age	24	24	24	24	24
No. of birds died up to 6th week	3	1	0	0	0
No. of birds at the end of 6th week	21	23	24	24	24
Livability (%)	87.50	95.83	100.00	100.00	100.00

Table 3: Return Over Feed Cost (Rs./ bird) of different treatment diets

Particulars	T_1	T_2	T_3	T_4	T_5
Feed consumption (g)					
Pre-starter	162.10	160.45	163.90	164.22	167.35
Starter	880.12	898.70	889.55	892.10	930.88
Finisher	2025.48	2130.55	2335.40	2125.10	2405.26
Total	3067.70	3189.70	3388.85	3181.42	3503.49
Cost of feed (Rs./kg)					
Pre-starter	29.30	29.33	29.38	29.41	29.45
Starter	30.80	30.85	30.90	30.94	30.98
Finisher	32.30	32.34	32.38	32.42	32.47
Feed cost (Rs./bird)					
Pre-starter	4.76	4.70	4.81	4.83	4.92
Starter	27.13	27.72	27.50	27.58	28.87
Finisher	65.35	68.85	75.60	68.90	78.10
Total feed cost (Rs./bird)	97.24	101.27	107.91	101.31	111.89
Average live body weight (kg)	1.73	1.93	2.09	1.98	2.20
Cost of feed (Rs./kg live bird)	56.20	52.45	51.60	51.15	50.85
Income from sale @ Rs. 90/kg (Rs./bird)	155.70	173.70	188.10	178.20	198.00
ROFC (Rs./bird)	58.46	72.43	80.19	76.89	86.11
ROFC (Rs./kg live bird)	34.00	37.55	38.35	38.80	39.12

Conclusion

The findings of the current investigation indicate that increasing the proportion of organic trace minerals in broiler diets positively influenced both survivability and economic performance, as evidenced by higher return over feed cost (ROFC). Birds fed diets in which inorganic trace minerals were completely replaced with organic sources achieved the highest livability and yielded the greatest economic benefit per bird.

In summary, the results support the recommendation that incorporating 100% organic trace minerals into commercial broiler rations can enhance overall flock health, improve survival outcomes, and increase production profitability under typical farming conditions.

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