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Role of Organic Mineral Supplements in Enhancing Poultry Performance

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Abstract | The present study examines the use of organic mineral supplementation to improve poultry performance through its influence on growth rate, feed efficiency, immune response, and egg quality. 180 poultry birds (120 broilers and 60 laying hens) were subjected to various dietary treatments, namely control (no supplement), inorganic mineral supplementation, and organic mineral supplementation. The findings proved that broilers that were supplemented with organic minerals showed significantly increased body weight gain (2800 g compared to 2500 g in the control group) and improved feed conversion efficiency (FCR: 1.55 compared to 1.85 in the control group). The levels of immunoglobulin (IgG and IgM) were also significantly higher in the organic mineral group, proving a stronger immune response. In laying hens, egg weight, eggshell strength, and yolk color were enhanced significantly with organic mineral supplementation. Moreover, fecal excretion of minerals was reduced, affirming increased nutrient retention and decreased environmental loss. These results indicate that organic minerals improve poultry productivity, health, and sustainability and are a good substitute for the use of inorganic supplements.

Keywords | Poultry nutrition, Organic minerals, Feed efficiency, Immune response, Egg quality

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INTRODUCTION

The international food security framework greatly benefits from the poultry sector, as this industry supplies a critical source of animal protein through the production of both meat and eggs (Abd El-Hack *et al.*, 2017; Hsu *et al.*, 2024; Govindarajan *et al.*, 2023). The steady upward trend in global demand for poultry products has pushed researchers, farmers, and policymakers to prioritize strategies that optimize performance, animal health, and product quality (Alagawany *et al.*, 2021; Kadham *et al.*, 2023; Karupusamy *et al.*, 2023). Among the key pillars influencing poultry productivity, nutrition stands out as one of the most decisive factors impacting growth rates, immune function, reproductive efficiency, and overall economic return (Atmaja *et al*., 2024; Saadh *et al*., 2024; Al-Saadi and Shwan, 2024).

A central challenge in poultry nutrition revolves around the types of mineral additives used in feed. While standard poultry feed commonly relies on inorganic mineral sources such as sulfates and oxides, these compounds often show poor absorption rates inside the animal's body, reducing nutritional efficiency and contributing to environmental contamination through mineral excretion (Baloch *et al*., 2017; Ahmad *et al*., 2019; Alhaqmuhamad *et al*., 2019). In contrast, organic mineral supplements where minerals are bound to amino acids, peptides, or organic acids offer superior bioavailability and gastrointestinal stability, leading to enhanced mineral uptake, better growth performance, stronger skeletal development, and improved immune competence (Zangana *et al*., 2022; Noman and Ahmad, 2023; Ahmad and Noman, 2023).

Poultry rely heavily on key minerals for essential biological functions, including bone formation, enzymatic catalysis, metabolic regulation, and immune defense (Bhagwat *et al*., 2021; Ahmad *et al*., 2024; Ahmad, 2023). However, the form in which these minerals are supplied plays a decisive role in determining their physiological effectiveness (Dong, 2022; Laylani *et al*., 2024). Inorganic minerals are prone to forming insoluble complexes within the gastrointestinal tract, significantly reducing their absorption and effectiveness (Ebeid and Al-Homidan, 2022; Ahmad, 2025; Mohamad *et al*., 2025). Organic mineral sources, such as organic zinc, selenium, and manganese, have been shown to circumvent these limitations by ensuring higher bioavailability, thus improving skeletal health, egg quality, productivity, and resistance to disease (Echeverry *et al*., 2016; Ramadhan *et al*., 2025; Saadoon *et al*., 2025).

Moreover, the use of organic minerals not only enhances poultry health and performance but also presents environmental advantages. By reducing the mineral excretion into the environment, organic mineral supplementation can help mitigate the soil and water pollution often associated with intensive poultry farming systems (El-Katcha *et al*., 2017; Saed *et al*., 2024; Abdulateef *et al*., 2024). This improves the overall efficiency and sustainability of modern poultry production, aligning with global goals for sustainable agriculture and food security (Ghasemi *et al*., 2022; Abed *et al*., 2024; Thabet and Alsalame, 2024).

Despite these promising benefits, poultry farmers face ongoing challenges related to mineral deficiencies, which can impair bone strength, slow productivity, and increase vulnerability to infectious diseases (Güz *et al*., 2019; Alsalame and Laylani, 2024; Abdulnabi *et al*., 2024). Therefore, there is an urgent need for more research, farmer education, and practical guidelines to integrate organic minerals effectively into poultry nutrition programs across different production systems (Haq *et al*., 2017; Alsalame, 2019, 2020; Al-Aameli *et al*., 2019).

This study aims to evaluate the role and effectiveness of organic mineral supplementation in poultry production, assess its advantages over inorganic alternatives, and provide evidence-based recommendations to enhance poultry health, farm profitability, and environmental sustainability.

MATERIALS AND METHODS

Study design

The purpose of this research was to examine the contribution of organic mineral supplements towards improving poultry performance using a controlled feed test in a commercial broiler farm environment (Min, 2019). The aim was to determine the impact of organic mineral supplementation on growth rate, feed conversion ratio, immune function, and eggshell quality of broilers and laying hens. The experiment was run over the course of six weeks for broilers and twelve weeks for layers (M'Sadeq, 2018), providing a sufficient time of observation to evaluate the effect of feed treatments.

Experimental birds and housing

A study involved 180 poultry birds, including 120 Cobb 500 strain broilers and 60 White Leghorn breed layers. The birds were kept in a ventilated shed under normal conditions, with temperature control, artificial lighting, and biosecurity (Nys *et al*., 2018). Ad libitum feeding and water were provided, and brooding temperature was gradually reduced (Ogbuewu and Mbajiorgu, 2023).

Table 1 presents the distribution of poultry birds into different experimental groups based on the dietary treatments.

Table 1: Experimental groups and dietary treatments.

Group	Dietary treatment	Number of birds
Control (T1)	Basal diet (no supplementation)	40 broilers + 30 layers
T2	Basal diet + Inorganic mineral supplementation	40 broilers
T3	Basal diet + Organic mineral supplementation	40 broilers
L1	Basal diet + Inorganic mineral supplementation	30 layers
L2	Basal diet + Organic mineral supplementation	30 layers

Table 2: Composition of experimental diets (per kg of feed).

Nutrient	Basal diet	Basal + Inorganic minerals	Basal + Organic minerals
Crude Protein (%)	22.0	22.0	22.0
Metabolizable Energy (kcal/kg)	3,200	3,200	3,200
Calcium (%)	1.0	1.0	1.0
Phosphorus (%)	0.45	0.45	0.45
Zinc (mg/kg)	50 (basal)	50 (Zn sulfate)	50 (Zn chelate)
Selenium (mg/kg)	0.3 (basal)	0.3 (sodium selenite)	0.3 (organic selenium)
Manganese (mg/kg)	60 (basal)	60 (Mn oxide)	60 (Mn chelate)
Copper (mg/kg)	10 (basal)	10 (Cu sulfate)	10 (Cu chelate)

Each bird was marked using wing bands to ensure proper identification throughout the study. The ambient temperature, humidity, and ventilation levels were monitored daily to maintain optimum rearing conditions.

Dietary composition and feeding regimen

The basal diet was designed to satisfy the nutritional standards prescribed by the National Research Council (Khatun *et al*., 2025) for broilers and layers. Organic mineral supplements consisted of chelated zinc, selenium, manganese, and copper (Olukosi *et al*., 2019), which were added to the feed at manufacturer-specified rates. The inorganic mineral supplements used for comparison were sulfates and oxides.

The feed was provided twice daily, with uneaten feed weighed to calculate intake. Clean drinking water was available at all times, and the feeders and drinkers were cleaned daily to maintain hygiene.

Performance evaluation parameters

The effects of mineral supplementation were assessed based on the following performance parameters:

- Body weight gain (BWG) and Feed Intake (FI): The birds were weighed upon commencement of the experiment and then on a weekly basis until completion using an electronic balance (Polycarpo *et al*., 2017). Total intake of feed was obtained by taking the difference between total offered and the residual feed.
- Feed Conversion Ratio (FCR): FCR was calculated as:

$$FCR = \frac{\text{Total Feed Intake (g)}}{\text{Total Body Weight Gain (g)}}$$

- Immune response assessment: Blood samples (2 mL/bird) were drawn from the brachial vein of five randomly chosen birds in each group on day 21 and day 42. Serum was separated and kept at -20°C to analyze immunoglobulin (IgG, IgM) (Ramos-Vidales *et al*., 2019). The titers of antibodies were measured by ELISA to test immune competence.
- Egg Quality Parameters (Layers only): Eggs were collected daily, and measurements were taken weekly to evaluate:
  - Egg weight using a precision balance
  - Eggshell thickness using a micrometer screw gauge
  - Yolk color using a Roche yolk color fan

Poultry farmers face nutrition management challenges due to mineral shortages, which harm skeletal health, reduce production, and increase disease risk. Organic mineral supplements, like zinc, selenium, and manganese, are effective in addressing these issues. Organic minerals also reduce environmental impact, making poultry farming greener.

Statistical analysis

All the data were processed with SPSS v.26 software. One-way analysis of variance (ANOVA) was applied to compare the means between various treatment groups. If a significant difference was found, Tukey's post-hoc test was employed for multiple comparisons. Results were presented as mean ± standard error (SE), and the level of statistical significance was kept at $p < 0.05$ (Alani and Kawan, 2024).

RESULTS AND DISCUSSION

Growth performance of poultry

Six weeks were used to evaluate organic mineral supplementation on broiler weight gain. Table 3 indicates broiler mean body weights by treatment group. Organic minerals supplementation increased weight gain compared to inorganic mineral treatment and the control, suggesting a bigger involvement in poultry growth (Rezapour *et al*., 2024). Figure 1 depicts the three groups' development trends during the research.

The organic mineral group (T3) had consistently higher body weight in all six weeks, with a final average of 2800 g, against 2650 g for the inorganic mineral group (T2) and 2500 g for the control group (T1). This indicates that organic minerals promoted growth performance through enhanced nutrient use and efficiency of metabolism in broilers.

Table 3: Weekly body weight (g) of broilers in different treatment groups.

Week	Control (T1)	Inorganic minerals (T2)	Organic minerals (T3)
1	250 ± 12	255 ± 10	260 ± 9
2	540 ± 22	560 ± 18	590 ± 15
3	960 ± 30	1000 ± 28	1080 ± 25
4	1450 ± 40	1510 ± 38	1620 ± 35
5	1980 ± 50	2070 ± 45	2210 ± 40
6	2500 ± 60	2650 ± 55	2800 ± 50

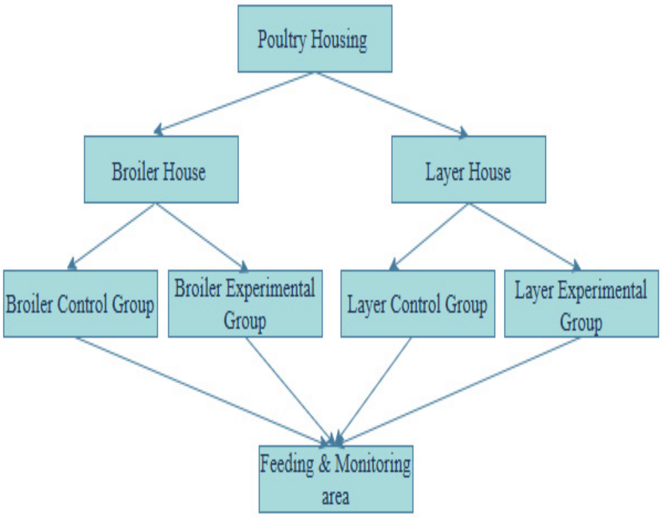

Figure 1: Schematic representation of poultry housing and experimental layout.

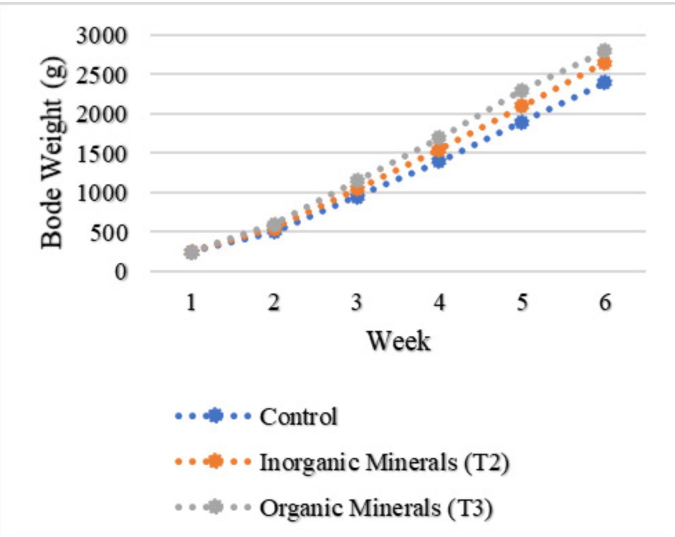

Figure 2: Weekly body weight of broilers in different treatment groups.

Figure 2 shows that the organic mineral group (T3) grew the fastest during the trial, with weight increase increasing quicker after the third week. The control group (T1) had the lowest growth rates, whereas the inorganic mineral group (T2) placed second. Organic minerals increased metabolic activity, which boosted body weight accumulation over time, as T3's growth curve sloped upward.

Feed conversion ratio (FCR) and feed intake

Feed efficiency is an important parameter in poultry production, and the Feed Conversion Ratio (FCR) is a direct measure of how effectively the birds convert their feed into weight gain (Saleh *et al.*, 2020). The lower the value of FCR, the better the feed efficiency. Figure 2 shows the FCR trends in the treatment groups over six weeks.

Broilers in the organic mineral group (T3) had the best FCR (1.55), which represented higher feed efficiency than the inorganic mineral group (T2) with 1.70 and the control group (T1) with 1.85. The lower FCR in the organic mineral group implies that poultry made better use of nutrients consumed from the diet because of increased mineral absorption and retention, leading to improved weight gain using less feed.

Immune response assessment

To determine the effects of mineral supplementation on the immune system, serum immunoglobulins (IgG, IgM) were recorded at week 3 and week 6. Chicken fed with organic minerals showed significantly greater antibody titers, indicating a better immune response. The result is shown in Table 4.

The organic mineral group (T3) registered the most elevated IgG levels (570 mg/dL at week 6) among 480 mg/dL in the inorganic group (T2) and 420 mg/dL in the control group (T1). IgM levels followed a similar trend, being most elevated in T3 (145 mg/dL at week 6), then 120 mg/dL in T2 and 100 mg/dL in T1. These results show that organic minerals greatly improved immune responses, potentially because they play a part in antioxidant defense and immune cell activation.

Table 4: Immunoglobulin (IgG, IgM) levels in poultry (mg/dL).

Parameter	Control (T1)	Inorganic minerals (T2)	Organic minerals (T3)
IgG (Week 3)	350 ± 15	410 ± 18	490 ± 20
IgG (Week 6)	420 ± 17	480 ± 20	570 ± 22
IgM (Week 3)	80 ± 5	95 ± 6	115 ± 7
IgM (Week 6)	100 ± 6	120 ± 7	145 ± 8

Egg quality parameters in layers

The effect of organic minerals on egg weight, eggshell thickness, and yolk color was evaluated in laying hens. Table 5 provides the average values recorded during the experimental period.

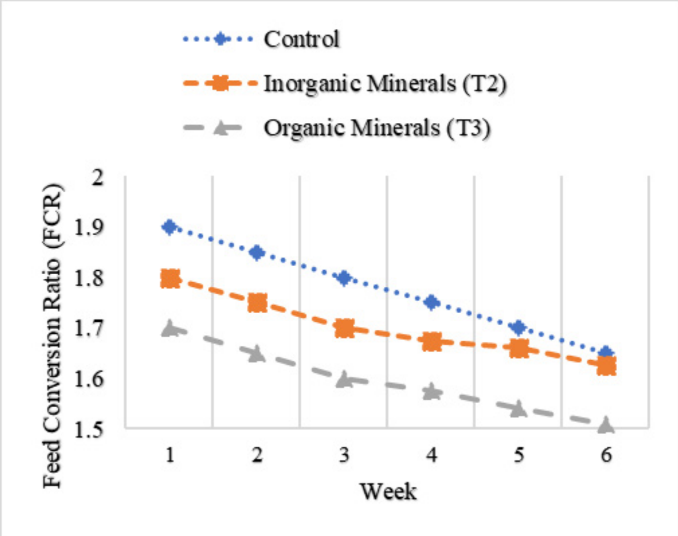

Figure 3: Feed conversion ratio (FCR) of broilers over six weeks.

Table 5: Egg quality parameters in laying hens.

Parameter	Control (L1)	Inorganic minerals (L2)	Organic minerals (L3)
Egg weight (g)	58.5 ± 1.2	61.2 ± 1.5	64.8 ± 1.7
Eggshell thickness (mm)	0.31 ± 0.02	0.34 ± 0.02	0.38 ± 0.02
Yolk color score	7.2 ± 0.4	8.1 ± 0.5	9.5 ± 0.6

The organic mineral group (L3) laid eggs that weighed 64.8 g, compared to 61.2 g for L2 and 58.5 g for L1. Organic minerals had thicker eggshells (0.38 mm), perhaps due to higher calcium and trace mineral retention. The organic group had better yolk color scores, indicating better carotenoids absorption and pigmentation. The results show that organic mineral supplementation enhances egg quality and shell resistance, making it an effective layer hen diet.

Mineral retention and excretion

To determine the efficiency of mineral utilization, fecal mineral excretion levels were analyzed for different groups. Figure 3 illustrates the excretion levels of Zinc, Selenium, Manganese, and Copper in broilers under different treatments.

Poultry fed organic minerals (T3) eliminated less unabsorbed minerals, which suggested greater retention and bioavailability. Excretion of zinc, for example, decreased from 50% in the control group to 30% in the organic group. Excretion of selenium fell from 40% to 25%, implying that organic minerals were more readily absorbed and utilized by the birds. These results support the economic and environmental benefits of organic mineral supplementation since less mineral waste results in lower feed costs and less environmental pollution.

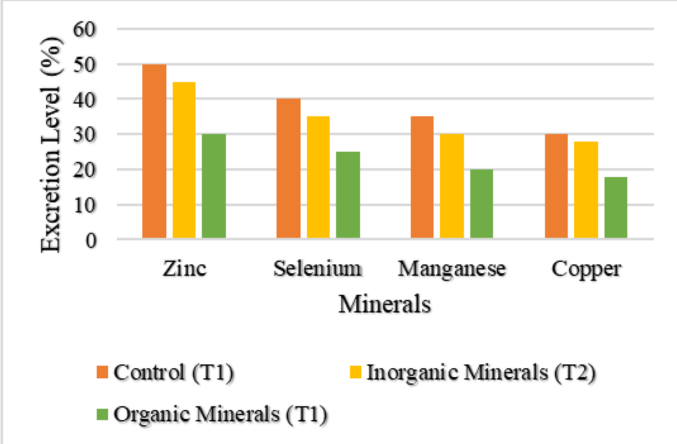

Figure 4: Fecal mineral excretion in different treatment groups.

Implications of organic mineral supplementation in poultry production

The results of this research prove that organic mineral supplementation has a major positive impact on poultry performance by increasing growth rates, improving feed efficiency, immune response (Su *et al*., 2018), and egg quality. The increased absorption and retention of organic minerals result in increased utilization of nutrients, lower excretion, and less environmental pollution (Świątkiewicz, 2014).

Organic minerals improve protein synthesis and energy metabolism, leading to increased weight gain and feed efficiency in broilers (Wang *et al*., 2019). This results in reduced feed costs for commercial poultry production. Organic minerals also enhance immune function, with enhanced IgG and IgM levels, reducing infection vulnerability (Zafar and Fatima, 2018). Additionally, organic minerals improve egg quality traits, leading to thicker eggshells and better yolk color, enhancing productivity and marketability (Zapata, 2016).

Organic mineral supplementation in commercial poultry production improves bioavailability and retention of nutrients, reducing fecal mineral excretion levels and soil and water pollution (Zhu *et al*., 2019). This greener option offers improved health outcomes and sustainable agriculture, but further studies are needed for optimal dosage and long-term consequences.

CONCLUSION AND RECOMMENDATIONS

Organic mineral supplementation improves significantly growth performance, feed efficiency, immune response, and egg quality in poultry and lowers environmental impact. Organic mineral-supplemented broilers exhibited superior weight gain, improved feed conversion, and greater immunity, whereas laying hens laid heavier eggs with enhanced shell strength and yolk color. Lower fecal mineral excretion attests to superior nutrient retention and sustainability. Broiler poultry farmers should incorporate organic minerals to boost productivity and economic efficiency, with future studies addressing optimal dosage and long-term benefits for commercial application.

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NOVELTY STATEMENT

This research emphasizes the higher bioavailability and efficacy of organic minerals in poultry feeding, showing higher growth, immunity, feed conversion, and egg quality while conserving mineral wastage and reducing environmental pollution. The results justify organic minerals as a green and efficient option compared to traditional additives for enhanced poultry productivity.

AUTHOR'S CONTRIBUTION

All of the trials were designed by Bushra Hameed Lafta, Ghadir Kamil Ghadir and Harith Ahmed Mustafa. Zeyad Tareq Hussein Aljuboori, Ghufran Nazam Abdul-Hur and Mohammed Abed Jawad conducted all of the tests, gathered the data, and composed the manuscript draft. Sadiq Naama Henedy and Hasan Abdullah helped with the data analysis that was done to prepare the work for submission to the journal. The final draft of the work was reviewed and approved by all authors for publication in the Journal of Animal and Health Production.

Ethical consideration
Not applicable.

Generative AI or AI-assisted Technology Statement
The author(s) declare that no Genrative AI was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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