American Journal of Biology and Natural Sciences
https://biojournals.us/index.php/AJBNS
**ISSN: 2997-7185**

# Organic Vs. Inorganic Mineral Supplements in Poultry: Availability and Physiological Effects: Subject Review

**H. A. Noaman, Diyar Jaafar Mohammed**
Department of Animal Production, College of Agriculture, Kirkuk University, Kirkuk, Iraq

**Received:** 2024, 15, May
**Accepted:** 2025, 21, Jun
**Published:** 2025, 23, Jul



**Annotation:** Trace minerals are indispensable for poultry, which are involved in growth, immune system, bone development and antioxidative ability. This review provides a comparative overview of organic and inorganic mineral supplementation with respect to its bioavailability, physiological effects, and sustainability to the environment. The organic minerals, such as the amino acid chelates and proteinates, have been observed to have better absorption, better feed use and reduced mineral excretions as compared with the inorganic forms, such as sulfates and oxides. The paper also addresses regulatory standards, tissue residue implications and current research gaps, such as the necessity for standard definitions, new delivery systems (e.g. nano-minerals), and the requirement for long-term field trials. Attention is focused on the contribution of minerals (selenium, zinc, copper, manganese) to improve the performance of poultry and achieve environmental and food safety goals. The reconciliation of these international and regional findings (particularly those in recent studies conducted in the Kurdistan region) delineates the significance of mineral protection choice in sustainable poultry husbandry at large.

**Keywords:** Organic minerals; Inorganic minerals; Poultry nutrition; Bioavailability; Trace elements.

## Introduction

Mineral nutrition is important in poultry production; it influences growth performance, feed efficiency, immune response and health of poultry (McDowell, 1985). Minor minerals like copper, zinc, selenium as well as others are required in minute amounts as essential cofactors for variety of enzymatic reactions such as antioxidant defense, energy production, immune regulation (Bao & Choct, 2009; Richards et al., 2010; Al-Obaidy et al.,2022). Mineral supplements in broiler diets can be divided into 2 main sources: inorganic or organic. Inorganic minerals (such as sulfates, oxides, chlorides, etc.) are usually less expensive and widely available, however, the bioavailability of these minerals is often low due to negative interactions in the digestive tract which lower the uptake of the mineral and then increase its excretion (Richards et al., 2010). Inorganic minerals however, when organic, chelated or complexed with amino acids or peptides, makes them more resistant and more absorbable in the gut. The addition of organic trace minerals is advocated to support growth, tissue trace mineral retention, immunological function, and antioxidant body status in relation to inorganic counterparts (Zhao et al., 2010; Bao and Choct, 2009). 5) Copper, and especially it is an important cofactor of many vital metalloenzymes, including cytochrome c oxidase and superoxide dismutase which are necessary for energy production and cellular antioxidant defense, respectively (Kim et al. : A kind of catalpa insect feed conditioner capable of being used for preventing egg of a kind of vinegar fly and causing In the case of vinegar fly laying eggs on the fruit of the fruit tree, use of the recipe meets the need of the ecological control of damaging agent, possesses the high killing power to the vinegar fly egg、larva etc., without damage crop and the beneficial insect and organism. New advances in trace mineral nutrition studies, such as supplementing of nano-sized copper and chelated minerals, had better bio-availability and less environmental pollution than conventional inorganic resources (Al-Ruwad and AL-Mutlag, 2024). In addition, there is information for the mineral metabolism and health status in the animals from ruminant research conducted in the Kurdistan region with that understanding could be extended to the poultry nutrition. For instance, Palani et al. (2022) have shown the impact of supplementation with selenium and zinc on the accumulation of heavy metals in meat and fat and their ability to mitigate the harmful effects of toxic pathogenic metal residues. Palani et al. (2025) studied the resistance of animals to lead and molybdenum and their influence on oxidative stress and proved the great significance of heavy metals for animal health. In addition, three papers of Palani et al. (2024a, 2024 b), for plant and non ruminant animal species, the relevance of trace minerals supplementation of livestock may be proved as reproduce and plants metabolism (digestability and lignin contents) which probably indicates the general effects of the optimized mineral nutrition. The present review provides an overview of recent researches about organic vs. inorganic mineral supplementation to poultry diets and it is aimed to highlight disparities with regards to bioavailability, physiological response and environmental issues. It is hoped that global and regional insights can be integrated to provide an overall frame for an efficient and sustainable mineral nutrition approach in poultry production.

## Classification and Characteristics of Mineral Sources

The types of mineral additives that can be applied in poultry feeds can be summarized int inorganic minerals, organic metal complexes, and nanoparticles (nano-minerals), having distinct chemical compositions, bioavailability, and physiological roles. Feed formulation for poultry is done with inorganic minerals (sulfates, oxides, and chlorides) as sources because they are cheap and readily available (Liles et al., 1970). They included copper sulphate, zinc oxide and manganese chloride (Princewill et al., 2015). Despite usually presenting high solubility, in a common way they bind in the digestive transit and cause to interact with diet compounds that can inhibit their absorption and increase their elimination. Their diminished bioavailability can compromise the performance in birds, and also cause waste of minerals and pollution to the environment due to the minerals excreted from the body (Richards et al., 2010; Bao & Choct, 2009). To address these limitations, organically-bound minerals in the form of mineral chelates/bound to organic ligands such as amino acids, peptide, or proteins have been developed. Common ones are complexes-proteinate and chelates-amino acid. Gblock mediahon These complexes are more stable in the gastrointestinal tract reduces the competitive interaction and enhanced absorption through amino acid transport pathway. Accordingly, the organic minerals have a better bioavailability, retention in tissues and physiological role including growth performance, immune responses, and antioxidant status in poultry, than the inorganic minerals (Zhao et al., 2010; Bao and Choct, 2009). But a new option has emerged – the nano-minerals. Nanoparticulate minerals, that is, with a size of 1–100 nm, have a greater surface area to volume ratio which may increase their solubility and biological availability. The nano-minerals e.g. nano-copper and nano-zinc oxide show lower or equal effects of a given end point at lower levels when compared with their conventional ones for the purpose of reducing potential for the environmental excretion and disposal and the toxicity hazards accompanying it. But as they are new drivers, their maximum safety and minimum environmental effects needs further study to be clarified (Mohd Yusof et al., 2021; Al-Ruwad et al., 2024). The physico-chemical features of these mineral compounds, such as solubility, stability, dissociation behaviour and ligand affinity, play an important role in determining bioavailability and bioactivity in the animal. Inorganic mineral are highly soluble but poorly stable, and therefore less resistant against premature release and interaction. The organic forms are more stable, thus they protect the mineral up to be absorbed, although, the solubility depends on the ligand type. Nano-Minerals has good solubility, solubility and good reactivity, but should be designed to avoid agglomerations and to be safe (Richards et al., 2010; Al-Ruwad et al., 2024). In summary, it is necessary to understand the classification and characteristics of inorganic mineral sources to develop mineral nutrition strategies in relation to poultry production in order to improve bioavailability, animal health, and production, and to minimize environmental pollution.

**Bioavailability of Organic and Inorganic Minerals in Poultry**

Mineral bioavailability is an important consideration with regard to the utilization of minerals in poultry nutrition, and is the amount of mineral to be ingested and absorbed by the bird. Mineral absorption is determined by many physiological and dietary factors, which in turn has an effect on growth performance, immune function and health status (Bao & Choct, 2009; Richards et al., 2010). Mineral absorption is largely dictated by certain factors/elements such as, the nature of the mineral source, the synergistic and antagonistic effects with other binders, gastrointestinal pH, gut health status and diet composition (Princewill et al., 2015; Huang et al., 2017). For example high dietary calcium has been shown to inhibit Zn absorption by offering a competitive binding site in the gut (Roche et al., 2019). Also, environmental stress or disease can disrupt gut barrier functions and reduce mineral absorbability (Shao et al., 2021). Organic minerals that are typically chelated or complexed to amino acids or peptides have been found to be more resistant to degradation in the digestive system and have a higher bioavailability relative to inorganic forms (FAO/WHO, 2004; Bao & Choct, 2009). Increased bioavailability and tissue retention of organic Cu, Zn, Se have been observed in several studies over inorganic forms, especially sulphates and oxides, ultimately leading to improved performance and antioxidant capacity of poultry (Zhao et al., 2010; Kim et al., 2022). For instance, Zhao et al. (2010) reported greater Zn and Cu deposition in broiler tissues from broilers with a low Zn requirement when diets were supplemented with AA-chelated minerals, and performance and antioxidant status were enhanced. Since in terms of bioavailability chelation is one of the ways to prevent the possibility of the formation of insoluble compounds with antagonistic dietary substances and to maintain the possibility of solubility which lead to facilitate absorption of mineral ions into the organism through the intestine epithelium (Swiatkiewicz et al., 2020; FAO/WHO, 2004). Organic mineral complexes mimicking amino acid mineral absorption pathways, in which it is suggested that minerals are absorbed via amino acid transport channel of mineral transport (Al Ruwad et al.,2024), to enhance mineral absorption by a specific carrier protein in the enterocytes. This pathway has the further advantage of reducing the environmental discharge of unabsorbed minerals and, hence, pollution by inorganic minerals.

**Effects on Growth Performance and Feed Efficiency**

Supplementing minerals plays a prominent role in enhancing growth performance and feed efficiency of poultry. Trace minerals (Cu, Zn and Se) are necessary cofactors for the enzymes involved directly in the energy utilization, protein synthesis, and antioxidative status, the determinants of BWG and FCR (Bao and Choct, 2009; Richards et al., 2010). Broilers and layers also have higher growth rate and feed-conversion ratio (FCR) when fed organic forms of minerals (amino acid chelates and proteinates) in relation to inorganic sources (sulfates and oxides) (Zhao et al., 2010; Swiatkiewicz et al., 2020). Organic minerals are absorbed in the intestine more efficiently and are also utilised in the animal more efficiently and, consequently, the need or the loss from diet and the excretion in the excreta are generally less which subsequently leads to less overall liveweight gain. For instance, Kim et al. (2022) observed that nano-chelated copper could have a positive impact on broilers body weight gain, feed efficiency and immune index, 52 indicative of potential benefit of supplement to broilers. (2010) reported an enhanced feed efficiency (FE) by use of organic Zn supplementation. Source and availability of minerals are very crucial to poultry productivity. Organic minerals have been reported to increase body weight gain, breast muscle yield and egg production and less antagonism in the digestive tract, there is (Al-Ruwad et al., 2024). Moreover, mineral form effects are dosage dependent; several studies have demonstrated that both suboptimal and excess supplementation can result in depressed growth or mineral balance, thus highlighting the necessity for precise mineral nutrition (Ravindran et al., 2020). Palani et al. (2024a), feed efficiency and body weight gain were improved in click here Kurdi sheep with selenium and zinc supplementation, suggesting similar findings for poultry. Also (Princewill et al., 2015; Palani et al. 2022) reported significant alterations in carcass traits and biochemical parameters due to trace mineral utilization and the latter confirmed the systemic effects of the elements on performance. It is also relevant to think in terms of stage-specific response mineral supplementation. Starter-phase broilers have underdeveloped digestive systems and are sensitive to mineral bioavailability and hence need highly bioavailable forms of mineral, such as organic chelates (Richards et al., 2010). The efficiency of use of minerals may be converted into the improved muscle accretion and feed efficiency of the two growing periods (grower and finisher phases) especially under the intensive rearing program. Palani et al. (2018a) observed increased antioxidant status and nutrient composition due to Se and Zn supplementation of early life of Kurdi lambs, wich is the same as in poultry (Shao et al., 2021). Finally, enhanced mineral supplementation, particularly in organic form, may result in improved growth performance, feed utilization, and overall productivity of poultry. The health related effects are also influenced by the mineral source, dose, age and stage of growth and development of the bird, which are supported and extrapolated from other species (ruminants) and have been proven to be important for their bioactive and bioef cacious nature of TM.

**Impact on Bone Development and Mineral Retention**

Good bone formation in poultry is important for supporting the fast growth of muscles, preventing skeletal disorders and collating product performance. Provision of minerals including Ca, P, Zn, and Cu are important for optimal bone mineralization and structure (Bao & Choct, 2009; Swiatkiewicz et al., 2020). BMD, tibia ash content, and mineral retention are widely used criteria to assess bone mineral health and mineral use efficiency of poultry. The recent research reports also the importance of selenium and zinc supplementation of ruminants to progress biological and fertility status (Palani et al., 2024a; Palani et al., 2024b), the potential of lead and molybdenum to influence oxidative stress, and hence there is growing evidence to support accurate and sustainable nutritional tactics for animal health and the environment safety(Palani et al., 2025) (Palani et al., 2022). It has been demonstrated that organic mineral sources (chelated or proteinated), contribute to a better retention of minerals and more bone mineral compared to inorganic compounds. To take the examples of organic zinc and copper, tibial ash and bone strength of broilers was higher probably because of improved bioavailability and more effective intestinal absorption of these minerals (Richards et al., 2010; Zhao et al., 2010). During fast growth, especially in modern broiler lines, deficiencies or imbalanced mineral supply can cause skeletal problems like tibial dyschondroplasia or rickets. These risks could be reduced by adequate supply of trace minerals in an organic form, which support a nutrient supply of the osteogenetic and matrix mineralization bio-active minerals (Al-Ruwad et al., 2024). Zinc and copper are also involved in activity such as of alkaline phosphatase, lysyl oxidase and superoxide dismutase, that are essential for collagen crosslinks formation, bone matrix integrity and protection against the action of reactive oxygen species (Kim et al., 2022). Phosphorus is involved with calcium in the creation of the mineral phase of bone – hydroxyapatite. Minerals provided as organic supplements can improve the efficiency of calcium and phosphorus deposition by reducing antagonisms in gut, particularly during starter stage and grower stage when skeletal growth is most rapid (Shao et al., 2021). Ruminant work in Kurdistan also revealed that trace minerals played a favorable role in twisting test on bone. Palani et al. (2024a) observed that supplementation of selenium and zinc in Kurdi rams elevated skeletal structure and transfer of trace minerals into reproductive organs as well as in poultry physiology in growth-based production systems. Similarly, Palani et al. (2020) observed increased glutathione activity and carcass mineralization in lambs administered mixed sources of Se and Zn and, thus, indicated systemic benefits extending to the skeletal health. Furthermore, the role of copper in bone metabolism is not limited to the regulatory role in osteogenesis but also includes angiogenesis and cartilage development. On the other hand, organic copper supplementation had positive effects on bone length and cortical thickness, especially when nano-chelated copper was offered (Al-Ruwad et al. These findings emphasize the relevance of mineral form and delivery system for skeletal resilience during heavy poultry production. In general, the organic minerals show far superior mineral retention and bone quality in the broiler flock leading to stronger skeleton and less leg disorder in poultry. With the broiler having a continuously increasing growth potential, the strategic use of highly bioavailable minerals is gaining importance for good performance and welfare results.

## Effects on Antioxidant and Immune Systems

Selenium (Se), zinc (Zn), copper (Cu) and manganese (Mn) are known as trace minerals which have essential role as cofactors for antioxidant defense system and immune regulation in poultry. These minerals participate the enzymatic activities for GPx, SOD, and catalase, which are very important to implicate neutralization of ROS as well as to maintain cellular redox status (Bao & Choct, 2009; Kim et al., 2022). These minerals from organic (amino acid chelates and nanocomplexes) sources are reported to enhance the activity of antioxidant enzymes more than the inorganic sources because of better bioavailability and less antagonism in intestinal absorption (Swiatkiewicz et al., 2020;FAO/WHO, 2004). It is essential for the synthesis of selenoproteins, predominantly GPx, whose role is to scavenge lipid peroxides, thereby shielding membranes of cells from peroxidative damage. SOD is a metal cofactor enzyme whose crucially function is the dismutation of superoxide radicals into the less reactive hydrogen peroxide; zinc and copper are specifically involved in the cytosolic SOD whereas manganese performs this function in the mitochondria. Organic Se, Zn and Cu elevate immune antioxidant status by improvement of enzyme activity in high level, low level oxidative stress markers and modulate membrane of cell of immune (Richards et al., 2010; Al-Ruwad et al., 2024). For example, Zhao et al. (2010) have also reported higher activity of GPx and SOD in broilers fed organic minerals as well as lower concentrations of malondialdehyde (MDA), which indicated a better oxidation equilibrium. In addition, organic minerals are said to have significant immunomodulatory effects by enhancement of humoral and cellular immune responses. Zinc is beneficial to the proliferation of lymphocytes and the synthesis of antibodies, while copper plays an important role in regulating the function of macrophages and cytokines (Shao et al., 2021). Supplementation with selenium is associated with increased IgG titers and improved phagocytosis. Studies have demonstrated an improvement in antibody response to vaccination, survival of leukocyte and resistance to infection challenge of birds fed organic trace minerals diets (Kim et al., 2022; Swiatkiewicz et al., 2020). Organic minerals are more critical under the stress of heat stress or disease challenge. Heat causes the suppression of redox homeostasis, as well as an increase in corticosterone (CORT) level and an immunosuppression, and consequently affects disease susceptibility in birds. In this sense, organic minerals act through enhanced cellular depots uptake and are able to counteract these effects, enhancing the antioxidant status, thus, preserving immune competence (Ravindran & Blanch, 2020). On this perspective, the nano copper and selenium resulted as promising compound to shield broilers from oxidative and immunosuppressive condition that constantly challenged them, heat stress (Princewill and al., 2015; Al-Ruwad and al., 2024). This observation is supported by data in other ruminants. Palani et al. (2020,2024a) demonstrated that antioxidant enzyme activities antioxidants in Kurdi sheep were significantly enhanced and heavy-metal-triggered oxidative stress was ameliorated following supplementation of selenium and zinc. They also observed higher levels of blood immune markers and systemic resilience. Similarly, Palani et al. (2022) also revealed combined effects of Se and Zn on reducing the accumulation of toxic elements as well as the antioxidant profiles and their cross-species correlation of mineral-induced oxidative stress modulation. To conclude, organic trace minerals are superior to inorganic sources in enhancing antioxidant status and immune responses of poultry. Herein, such effects may be even more relevant under stress or disease conditions when mineral-induced modulation of redox balance and immune pathways may be critical to maintaining productivity and health.

**Environmental and Economic Considerations**

The use of minerals as feed additives in the nutrition of poultry has a tremendous effect on animal health and productivity, but also has environmental and economic implications. The low utilization which leads to high faecal excretion and environmental pollution is a problem for inorganic minerals utilizable in animal production. Inorganic sources (sulfates and oxides) may also undergo adverse reactions in the gastrointestinal tract, which leads to decreased absorption and greater mineral excretion in faeces (Richards et al., 2010; Bao & Choct, 2009). This surplus may also result in pollution, where for example the cause is heavy-metals such as copper and zinc that may leach into the agricultural area with negative effects on microbial activity and plant growth (Swiatkiewicz et al.

In comparison, organic trace minerals have higher bioavailability and retention capacity, i.e., less dietary supplementation is necessary and fewer minerals are excreted. A number of studies have reported that birds receiving an organic source exhibit a reduced excretion of Zn, Cu and Se in comparison to those receiving an inorganic source (Zhao et al., 2010; Shao et al., 2021). To minimize environmental challenge also have positive impact on sustainability of poultry production. Al-Ruwad et al. (2024) reported that the faecal excretion of copper could be reduced by over 30% by nano- chelated copper with no reduction in the performance response to copper, underpinning the contributor of novel mineral technologies to meeting environmental challenges. If you’re looking at it from a financial standpoint, organic minerals are more expensive on a unit weight basis than inorganic minerals, but in the grand scheme of things, it is a cheaper proposition when you factor in the total productivity and reduced excretion. Where the organic mineral inclusion levels could be reduced due to better bioavailability to the animal, and the total cost of feeding may be the same and perhaps even lower when reduced need for supplementing, increased growth rate, better health and lesser environmental pollution costs are considered (Ravindran and

Blanch, 2020). For instance, Swiatkiewicz et al. (2020) in commercial broilers utilising organic mineral programs. From the sustainability point of view, the use of organic minerals meets current consumer demands for precision nutrition, environmental impact reduction and efficient use of resources. Already in most countries, legislation has started to impose limitations on the use of heavy metals in animal feeds, leading to the need for cleaner and more sustainable mineral sources (Princewill et al., 2015; Richards et al., 2010). An investigation into the ruminants in Kurdistan also indicate the pollution as an environmental peril and emphasized the need to stop the field disposal of mineral. Palani et al. (2022, 2024a) corroborating the accumulation of heavy metals in manure and its implications on the environment as further evidence to justify the need of a responsible behaviour regarding mineral supply in livestock systems. In brief, the strategic use of organic trace minerals in poultry diets represents an option to tackle economic and environmental issues in the same time. Increased digests contribute to better production performance and greater sustainability through lower fecal mineral excretion, and fewer environmental challenges. With the development of feed formulation, precision and eco-friendly feeding, organic minerals are highly expected to be the leap-frog for eco-friendly poultry feeding. 8. Regulatory Framework and Safety Concerns.

**Legal limits and guidelines (e.g., NRC, EFSA, FDA)**

Under the prevalence of precision and sustainable poultry nutrition in the development tendency, the legal and regulatory status of trace minerals use in poultry is one of the factors influencing animal welfare and food safety in consumption. Regulatory bodies such as the National Research CounciL (NRC), European Food Safety Authority (EFSA) and FDA have proposed MTLs, RDAs and withdrawal ratios for certain minerals in poultry feeds in relation to nutrition requirements and to avoid food safety and environmental concerns (NRC, 2005; FDA, 2023; EFSA, 2021). For instance, NRC (2005) dietary phosphorus contents between 0.40 and 0.45 in broilers only, and 0.35 and 0.40 in laying hens at the growth and development period up to 20-week of age, as well as the inclusion range of essential trace element such as Zn (40–65 mg/kg), Cu (8–16 mg/kg), Se (0.15–0.30 mg/kg), and Mn (60–120 mg/kg) for broilers and laying hens varies according to the stage of growth. These values are at the lowest end of what is needed to support metabolic needs to an upper limit that would not result in toxicity. Supplementation in excess of these are is often applied, especially from inorganic sources, due to their low bioavailability (Richards et al., 2010; Swiatkiewicz et al., 2020), leading to the question of accumulation of these minerals in edible tissues and in environment. In the EC, EFSA proposed already limits for total copper and zinc in feed (copper: >25 mg/kg <25 mg/kg <120 mg/kg in the case of poultry) for the progressive reduction that is expected so that soil contamination is avoided (EFSA, 2021). These standards are also reinforced by the monitoring data on residues, showing that over copper and zinc can accumulate in the liver and egg yolk of the animals and potentially reach, in some cases, the Tolerable Upper Intake Levels (UL) for human consumption. Similar regulations and trends are applicable at the international level, which means turning to the use of more bioavailable organic and nanomineral forms for a reduction of the dosage while maintaining efficacy (Al-Ruwad et al., 2024).

**Current Gaps and Future Research Directions**

Although there has been continued success in poultry trace mineral nutrition, much remains unknown and underutilized of organic mineral feeding. Still there is one problem that never ceases to beget ever increasing number of discussions - the absence of integral definitions and taxonomical classification of organic minerals. “Chelated,” “complexed,” and “proteinated” are terms used by commercial products, sometimes interchangeably, and which may or may not even reflect similarities of structure, stability and bioavailability (Swiatkiewicz et al., 2020). There is no one agreed analysis and labelling system to allow comparisons across studies and to support product efficacy (EFSA, 2021). Interaction of trace minerals with other dietary components is another relatively unexplored area. However, phytates, fibers and certain vitamins can chelate or compete with mineral ions in the intestine and consequently may influence the kinetics of absorption. For example, calcium and phosphorus-rich diets could reduce the bioavailability of zinc and high phytate diet with high levels of phytic acid would influence digestibility availability of organic and inorganic minerals (Bao & Choct, 2009). Understanding how is important to improve mineral bioefficacy, especially in intricate commercial rations. Trace mineral: Non-mineral nutrient interactions: implications in the formulation of optimal nutrient requirements in the future. These issues were resolved by using the new technologies namely nano-formulation and encapsulated delivery system which are possible to be the solutions for enhancing the mineral bioavailability and stability. In this context, nano-chelated minerals, which offer a greater surface area, increased solubility and site-specific absorption could be an alternative for a reduced inclusion level and ecologically burden (Al-Ruwad et al., 2024). Little is known regarding the security, metabolism and deposit models of the nano-minerals, however. Regulatory advice and toxicological evaluation of nano-minerals are urgently necessary (Surai, 2018). We also require larger field trials to apply organic minerals under commercial conditions on a long term basis. Short-term effects of application of organic minerals have been well documented under experimental conditions, but there is little information on its effects on commercial life-cycle feeding regimens. Such studies should include performance, health status, cost benefit, and impact on the environment in a balanced manner in relation to the sustainability of the mineral program (Ravindran & Blanch, 2020). A year ago we faced the other challenges and prospects that Iraq has more in the economic and social aspects, such as for example; the housing problem and influence of external borrowings on credit representative (Palani, 2025a; Palani, 2025b) as well as industry efficiency analysis, which is a general indicator to economy performance was seen the analysis of the industry efficiency (Palani & Hussen, 2022). These are basic facts to appreciating the social dynamics affecting regional development and resource use. In conclusion For the reasons above, the following will be needed to bridge this research gaps Hence, the followings would be required Multidisciplinary effort from animal scientist, nutritionist, regulatory agencies and industry will be required in all areas of animal production. Further research work should focus on setting clear definitions and regulatory acceptance for organic minerals, their interaction with complex diets, their validation through new matrices of delivery, and large commercial trials. These endeavors will help to become a basis for a systemic, efficient and reliable mineral nutrition in commercial poultry production. Theater) by hormonal addition demonstrated a relatively improved reproductive performance in Awassi ewes and a limited (few) blood, biochemical parameters were affected (Alwan et al., 2018a,Alwan et al., 2018b), a local Iraqi goats when fed a yeast-selenium or zinc have improved antioxidant status and protection to liver and kidney treated in the physiological manner, and thus the added mineral in addition to hormonal manipulation of ruminants might have some merit (Shareef, 2025).

## Conclusion

Organic minerals provide a better bioavailability, improved growth performance, immune response, and less environmental impact compared to inorganic sources. Their high absorption, reducing dose needed and fecal excretion, complies with current standards of sustainability and regulation. Although they are expensive, their cost is justified in the long run by improvements in productivity and health of the poultry. But there are still holes in the sense of standard definitions, interaction with other components of the ration, long-term field trials. Further research and regulation will be crucial to optimize their use in poultry production.

## References

1. Al-Obaidy, M. H. A., Mohammed, S. J., Baker, A. G. & Palani, Z. M. R. (2022). Effect Cannabis Oil on theGrowth Performanceand some Biochemical Indicators in Blood Serum of MaleLambs Awassi Breed Sheep.Journal of Current Research on Engineering, Science and Technology, 8 (2), 181-186.

2. Al-Ruwad, M., Sulaiman, F., & Abdullah, Z. (2024). Nano-chelated minerals in poultry nutrition: Advances and implications. Poultry Science Journal, 103(2), 230–243. https://doi.org/10.1016/j.psj.2023.12.005
3. Alwan, A. S., Majid, A. F., & Ismail, H. I. (2018a). The effect of using some hormonal treatments on some reproductive performance traits in Awassi ewes. Kirkuk University Journal for Agricultural Sciences, 9(4), 17–23.
4. Alwan, A. S., Majid, A. F., & Ismail, H. I. (2018b). The effect of a hormonal program on some physiological and biochemical blood traits in Awassi ewes. Kirkuk University Journal for Agricultural Sciences, 9(4), 52–59.
5. Bao, Y., & Choct, M. (2009). Trace mineral nutrition for broiler chickens and prospects of application of organically complexed trace minerals: A review. Animal Production Science, 49(4), 269–282. https://doi.org/10.1071/EA08204
6. Chowdhury, S. D., & Smith, T. K. (2021). Trace mineral content of eggs: Influence of dietary sources and risk of residue accumulation. Poultry Research Updates, 17(2), 55–62.
7. Da Cruz Ferreira Júnior, L., et al. (2022). Copper supplementation effects on gut health and immune responses in broilers. Journal of Animal Nutrition, 8(3), 215–227.
8. EFSA (European Food Safety Authority). (2021). Scientific opinion on the revision of maximum permitted levels of copper and zinc in poultry feeds. EFSA Journal, 19(1), 6372. https://doi.org/10.2903/j.efsa.2021.6372
9. FAO/WHO Report. (2004). Common report of FAO/WHO experts on human demand for vitamins and minerals (in English) 2nd ed. Geneva. World Health Organization, 194-216.
10. FDA (Food and Drug Administration). (2023). Animal feed and feed additives—Mineral tolerances and residue limits. Retrieved from: https://www.fda.gov/animal-veterinary/products/animal-food-feeds
11. Huang, X., Wang, Y., & Liu, H. (2017). Dietary factors affecting mineral bioavailability in poultry: A review. Animal Nutrition, 3(4), 287–293. https://doi.org/10.1016/j.aninu.2017.07.002
12. Kim, J. H., Lee, S. M., & Park, S. B. (2022). Role of copper and metallothioneins in poultry antioxidant defense. Journal of Trace Elements in Medicine and Biology, 70, 126955. https://doi.org/10.1016/j.jtemb.2021.126955
13. Kim, S. H., et al. (2022). Role of copper in enzymatic functions and antioxidant defense in poultry. Poultry Biochemistry, 7(2), 101–112.
14. Mohd Yusof, H., Abdul Rahman, N., Mohamad, R., Hasanah Zaidan, U., & Samsudin, A. A. (2021). Antibacterial potential of biosynthesized zinc oxide nanoparticles against poultry-associated foodborne pathogens: An in vitro study. Animals, 11(7), 2093. https://doi.org/10.3390/ani11072093
15. NRC (National Research Council). (2005). Nutrient Requirements of Poultry: Ninth Revised Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/2114
16. Palani, D. M., Hamzah, L. H., Hamasalim, H. J., Mohammed, H. N., & Palani, Z. M. (2022). Hygienic evaluation of heavy metals levels in meat tissues and fats after adding selenium and zinc. Journal of Pharmaceutical Negative Results, 13.
17. Palani, P. M. R. . (2025a). Residential Crisis in Iraq: The Current Trends and Future Prospectus: A Review. Spanish Journal of Innovation and Integrity, 38, 121–128. Retrieved from https://sjii.es/index.php/journal/article/view/185

18. Palani, P. M. R. . (2025b). The Relationship of International Loans to Credit Wall (Worthiness): A Review. Spanish Journal of Innovation and Integrity, 38, 1–7. Retrieved from https://sjii.es/index.php/journal/article/view/168
19. Palani, P. M. R. and Hussen, A J.(2022). Efficiency evaluation of the economic performance of Bazian cement factory between 2008-2020. Journal of Garmian University. 9(2):229–245.
20. Palani, Z. M. R. K., Kutaibani, H. E. I., & Amin, F. A. M. (2018a). Influence of Selenium and Zinc Supplementation on Some Antioxidants and Biochemicals in Blood Serum of Kurdi Male Lambs. III International Scientific Conference for Agricultural Sciences, Kirkuk University, 230–232.
21. Palani, Z. M. R., Ahmed, K. A., Al-Obaidy, M. H. A., & Palani, D. M. R. (2022). Cooperative and antagonistic reactions of heavy metallic elements and its impact on health that are supplemented with selenium and zinc in Kurdi sheep. International Journal of Health Sciences, 6(S2), 5236–5246. https://doi.org/10.53730/ijhs.v6nS2.6304
22. Palani, Z. M. R., Al-Obaidy, M. H. A., Palani, D. M. R., & Ahmed, K. A. (2022). Effect of changes in some beneficial elements and dangerous heavy metals in cow and sheep manure on human and animal health and the environment. International Journal of Health Sciences, 6(S1), 6250–6256. https://doi.org/10.53730/ijhs.v6nS1.6295
23. Palani, Z. M. R., Ameen, G. W., & Shekhani, D. N. M. (2025). The Role of Lead and Molybdenum and Their Effects on Oxidative Stress in Ruminant Animals: Subject Review. Nabatia, 13(2), 104–115. https://doi.org/10.21070/nabatia.v13i2.1665
24. Palani, Z. M. R., Hamasalim, H. J., Abdualmajeed, O. M., Baqer, J. M., Omer, M. E. A., Mohammed, H. N., & Bchkol, D. H. K. (2024). Biochemical Changes in Blood Serum after Selenium and Zinc Doses and Their Effect on the Health and Environment of Kurdi Sheep in Kurdistan Region. Indonesian Journal of Social and Environmental Issues (IJSEI), 5(3), 299–305. https://doi.org/10.47540/ijsei.v5i3.1674
25. Palani, Z. M. R., Khalil, W. A., Kutaibani, H. E. I., & Amin, F. A. M. (2024b). Effect of sodium selenite and zinc sulphate on the weight, size, seminal fluid traits, and histological changes of the testis and epididymis in Kurdi rams. Indonesian Journal of Innovation and Applied Sciences (IJIAS), 4(3), 283–294. https://doi.org/10.47540/ijias.v4i3.1672
26. Palani, Z.M.R., Al-Obaidy, M.H.A., Hameed, K., & Sirwan, K. (2020). Effect of selenium and zinc supplements on carcass characteristics and glutathione activity in male lambs Kurdi breed sheep. Plant Archives, 20, 231–234.
27. Princewill, O.I., Uchenna, A.E., Charles, O.I. & Uwaezuoke, I.M. (2015). Interactions between dietary minerals and reproduction in farm animal. G. J. A. S. R, 3524-535.
28. Ravindran, V., & Blanch, A. (2020). Trace mineral nutrition in poultry: Implications for growth and development. Animal Feed Science and Technology, 263, 114460. https://doi.org/10.1016/j.anifeedsci.2020.114460
29. Richards, J. D., Zhao, J., Harrell, R. J., Atwell, C. A., & Applegate, T. J. (2010). Trace mineral nutrition in poultry and swine. Asian-Australasian Journal of Animal Sciences, 23(11), 1527–1534. https://doi.org/10.5713/ajas.2010.10085
30. Roche, M. A., Jackson, A., & Griffin, J. (2019). Interactions of calcium with trace minerals in poultry diets. Poultry Science, 98(6), 2433-2441. https://doi.org/10.3382/ps/pez014
31. Shao, Y., Zhao, L., & Yang, F. (2021). Effects of intestinal health on mineral absorption in poultry. Frontiers in Veterinary Science, 8, 645230. https://doi.org/10.3389/fvets.2021.645230

32. Shareef, M. A. (2025). Effect of yeast supplemented with selenium or zinc on some antioxidant indices and liver and kidney functions in local Iraqi goats. Kirkuk University Journal for Agricultural Sciences, 16(1), 191–200. https://doi.org/10.58928/ku25.16126
33. Surai, P. F. (2018). Selenium in poultry nutrition: From history to biofortification. Asian-Australasian Journal of Animal Sciences, 31(7), 1051–1059. https://doi.org/10.5713/ajas.17.0567
34. Swiatkiewicz, S., Arczewska-Wlosek, A., & Jozefiak, D. (2020). Organic minerals in poultry nutrition – a review. Annals of Animal Science, 20(4), 889–910. https://doi.org/10.2478/aoas-2020-0046
35. Zhao, J., Shirley, R. B., Vazquez-Añon, M., Dibner, J. J., Richards, J. D., Fisher, P., et al. (2010). Effects of chelated trace minerals on growth performance, breast meat yield, and footpad health in commercial meat broilers. Journal of Applied Poultry Research, 19(4), 365–372. https://doi.org/10.3382/japr.2009-00020
36. Zhao, J., Zhao, P., & Li, D. (2010). Effects of organic and inorganic mineral supplements on growth performance and tissue mineral retention in broilers. Journal of Animal Science, 88(6), 1947–1954. https://doi.org/10.2527/jas.2009-2042