



Role of Nano Minerals in Poultry Nutrition

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Food is the basic requirement for all living organisms including humans (Cushen *et al.*, 2012). The name "Nano" is derived from the Greek word "nanos," which means "dwarf." Originally, it was only a prefix that replaced SI units with the factor of 10^{-9} (Grunwald, 2017). A recent scientific method that examines the manipulation of matter at the atomic and molecular level is called nanotechnology. Creating materials or devices at the nanometer size is known as nanotechnology, and it facilitates the use of tools and materials at the molecular level that may represent a substance's chemical and physical characteristics (Elegbede *et al.*, 2019). This scale covers important features of agriculture, food processing, packaging, safety, quality, and information technology (Lugani *et al.*, 2021). Nanotechnology is used in animal feed in the form of nano minerals, nano enzymes, as well as additional additives. Nanoparticles promote nutrient absorption by lowering the antagonistic influence of bivalent cations, particularly in small minerals, making them advantageous for cattle and poultry nutrition, as well as enhanced feed and supplement usage (Marappan *et al.*, 2017). Nano-molecules are abundant in nature, as biological systems rely on several nano-scale substances such as proteins, DNA, and enzymes. Nanoparticles also exist naturally in the atmosphere. It is one of the most revolutionary methods for creating materials and components with altered structure, texture, and improved quality at the molecular level. Mineral particles of nano-size can be manufactured using either the "bottom-up method," which relies on wet chemical reduction of mineral salts, or the "top-down method," which includes mechanical grinding of bulk metal. Nanoparticles created by various procedures have distinct properties, therefore they are classed as inorganic, organic, emulsions, dispersions, and nano-clays. Silver, zinc oxide, copper, iron, and selenium nanoparticles have all been employed in chicken production (Gopi *et al.*, 2017).

Various applications of nano minerals in poultry nutrition

Nature of nano mineral	Effect on Poultry
Selenium	<ul style="list-style-type: none">• Nano selenium transferred to the egg provides a stronger antioxidant defence to the developing embryo and improves the hatchability and viability of newly hatched chicks• Reducing the oxidative damage under heat stress condition• Improves internal egg quality and egg shell quality in layer birds
Chromium	<ul style="list-style-type: none">• Nano chromium reduces serum levels of glucose, urea nitrogen, triglycerides, cholesterol and non-esterified fatty acids. Serum level protein, high density lipoprotein and lipase activity were significantly increased. Serum insulin increased. The nanoparticles of chromium picolinate significantly improved egg quality.

	<ul style="list-style-type: none"> increased meat oxidative stability in stressed birds by reducing malondialdehyde concentration in the thigh muscle (Yarmohammadi <i>et al.</i>, 2020)
Copper	<ul style="list-style-type: none"> Copper nanoparticles supplemented to poultry feed act as a growth promoter, immune stimulant, and antibacterial and antifungal agent Cu in nano form is highly bioavailable due to its small size and increased surface area In ovo feeding of nano-Cu has shown promising effects in terms of a better immune response, growth performance, feed conversion ratio (FCR), and higher breast meat yield in broiler (Joshua <i>et al.</i>, 2016)
Zinc	<ul style="list-style-type: none"> nano-Zn improved antioxidant function by enhancing the activities of anti-oxidases while reducing the levels of free radicals in broilers. Nano-particles of Zinc have effective antibacterial activity against Salmonella and Campylobacter isolates from poultry Nano-Zn has significantly desirable effects on carcass characteristics by increasing dressing percentage, weights of proventriculus, and pancreas
Iron	<ul style="list-style-type: none"> Nano Fe improves fertility in poultry birds Improves feed efficiency Nano Fe particles has lower antagonism in the intestine, which can reduce excretion into the environment
Silver	<ul style="list-style-type: none"> Increased phagocytosis and leukocyte metabolic activity Improve the innate and adaptive immunity of chickens and embryos (Kulak <i>et al.</i>, 2018)

Future prospects of nano minerals in poultry nutrition

Nano-particles of inorganic metals have recently acquired popularity due to their improved antibacterial properties and increased bioavailability. Their usage in chicken diets is also becoming increasingly widespread due to the restriction on in-feed antibiotics, as they have good antibacterial potential with no residue and undesirable side effects. Nano-Ag, nano-Cu, and nano-Zn have recently demonstrated strong antibacterial activity against major poultry pathogens such as Salmonella and Campylobacter, indicating their outstanding potential for use in chicken production and food safety. These benefits strongly argue for the use of trace mineral nanoparticles in chicken meals to improve overall bird performance and health due to lower needs and excretion levels.

Conclusion

Nano-trace elements not only have increased bioavailability, but they also have lower dietary needs, which leads to less excretion in the environment, making them environmentally safe. Nanoparticles improve the retention of trace elements in chicken meat and eggs, opening up new opportunities for the production of enhanced goods and functional diets for humans. Nano-trace minerals have several applications, but their safety and upper limits must be studied before they are commercially used in the poultry industry. Recent research on the efficiency of nano-trace minerals against important poultry diseases opens up prospects for the poultry industry to use nanoscience to generate healthy, efficient, and safe chicken products.

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