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Advances in Nanotechnology and its Benefits in Livestock and Poultry Feeding

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Abstract

Nanotechnology has the potential to transform the livestock and agriculture industries by creating nanoparticles with reducing agents. It is used in animal nutrition to prepare trace minerals, reduce intestinal mineral antagonists and improve animal health, environmental sustainability and feed efficiency. However, there are concerns about safety, legal frameworks and environmental effects. Addressing these issues is crucial to fully realize the potential of nanotechnology in creating more effective, sustainable, and healthy livestock and poultry production systems.

Key words: Nanoparticles, Animal nutrition, Nanotechnology

Introduction

Nano is a Latin word which means dwarf and this concept was first explained in 1959 by Richard Feynman. It is the study of shrinking bigger molecules to nanoscale sizes. The intrinsic physical and chemical properties of the base material are altered throughout the process of shrinking these bigger molecules into smaller ones. Changes in solubility, absorption, transport method, excretion and most importantly antagonists are among these modifications. Greater penetrability, reactivity, surface area and quantum characteristics are among the unique qualities of the technology's end product, which may be applied in a variety of scientific domains. Its main uses in relation to animals include the delivery of nutrition, vitamins, probiotics and medications; the identification and treatment of illnesses; the maintenance of an animal's identity register and the regulation of reproduction through the use of hormonal immune sensors (Loghman, 2012; Ognik, 2016).

Nanotechnology is mostly used in animal and poultry feed in the form of nano-minerals. This region is significant because it decreases the antagonistic impact between the bi-valent cations, increasing the absorption of trace minerals. This innovative method may be used to feed animals and poultry such that nutrients are efficiently absorbed and feedstock and other supplements are effectively utilized.

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Types of Nanoparticles:

Nanoparticles can be categorized as inorganic, organic, emulsions, dispersions or nano-clays based on their chemical characteristics. The inorganic nano-particles consist of nano-sized inorganic substances that have been approved for use in feed, such as titanium dioxide. Proteins, fats, and sugar molecules are examples of organic nanoparticles. Conversely, the active ingredients can be stabilized and delivered by the nano-emulsions by the encapsulation of the functional feed ingredients in an oil/water interface or in a continuous stage. Polymeric nanoparticles are synthesized into nanoparticle-sized bits that can be grafted onto other materials, potentially increasing biocompatibility and disintegration (Travan *et al*., 2009).

Mode of Action of Nanoparticles:

The gastrointestinal tract (GIT) can absorb nanoparticles through a variety of routes, such as ingestion, inhalation, oral administration. The solubility, charge and size of nanoparticles are among its physicochemical characteristics that determine how they are absorbed, distributed, metabolized and excreted by the body. Particles less than 100 nm can enter different tissues and organs, whereas particles smaller than around 300 nm can enter the bloodstream. Bypassing the difficult barrier known as the blood-brain barrier, inhaled opioid particles can enter the central nervous system through the inhalation pathway.

However, their reactivity with other compounds may have negative effects on the environment and human health. Bio-functionalized nanoparticles (BN) have gained widespread recognition recently as agents for pathogen purging before processing and transportation in the treatment of enteric infections. Furthermore, it has been discovered that D-mannose can prevent bacteria from adhering to intestinal cells. Preliminary research provided evidence that BN was selective for the mannose receptor sites on Campylobacter cells.

The tendency of nanoparticles to expand surface area for improved interaction with biological support:

Effect of Inclusion Nanoparticles on Animal Feed:

1. Nutrient absorption and utilization

Natural or artificial nutrient nanoparticles can help cells absorb bioactive chemicals and stabilize them. By encapsulating nano particles with natural nano nutrients and artificial nanoparticles like casein, it is typically possible for them to bypass the body's normal physiological pathways for nutrient transport via cell membranes and distribution in tissues. Due to their small particle size and large surface area in the intestinal lumen, nanoparticles often have better absorption. Nanotechnology revolutionizes animal production, breeding, disease treatment and identity preservation, transforming medicine delivery methods and disease diagnosis. Ruminants can benefit

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from microminerals for improved digestion, metabolism, microbiota balance and reproductive success (Awuchi et al., 2022).

2. Milk production and quality

Nanotechnology can also assist and ensure that milk is of a quality that is safe for human consumption. Nano-composites using anti *S. aureus* antibodies, gold nanoparticles and magnetic nanoparticles can detect the presence of bacteria in milk in just 40 minutes (Sung et al., 2013). Toxins in milk can be found utilizing polyclonal antibodies and gold nanoparticle immune chromatographic strips within 10 minutes (using the cancer-causing aflatoxin M1) (Rastogi et al., 2022).

3. Meat and egg quality

The incorporation of nanomaterials to animal feed or water can improve both the final product's quality and the process of production, such as the quality of broiler meat, egg yolks and eggshells.

4. Immune responses of the gastrointestinal tract (GIT)

The interpretation of nano particle ingestion studies is influenced by the biological and physicochemical characteristics of the GIT. The performance of animals is significantly influenced by a healthy gut. Thus, the performance of trace mineral dietary supplements and effective management can help achieve this goal.

5. Feed additives

With enhanced bioavailability, essential oils, taste, antioxidants, coenzyme Q10, vitamins, minerals and phytochemicals are all carried by minute micelles, or nano capsules. To avoid oxidative reactions and off-taste, active substances (such as minerals, micronutrients and polyphenols) can be encapsulated in nanoparticle form.

6. Feed processing

Due to their incredibly small size, nanoscale particles have a far higher surface area than macroscale structures and hence perform much more effectively. As a result, micro- and nano-sieves with pore sizes in the micro- and nanometer range may be used. They keep the precious or functional feed components from being lost during feed preparation by encapsulating them.

Conclusion

With enhanced feed ingredients, additives, food safety and quality control, nanotechnology offers new approaches to boost livestock growth and productivity. There have been few studies conducted despite the technology's continuous growth and wide range of applications. One potential substitute for the chemical synthesis approach might be the green synthesis method, which produces nanoparticles. Much more study is required to ensure its effectiveness and biosafety while preventing damage to people, animals and the environment.

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