RESEARCH ARTICLE
Open Access

Nano zinc oxide – An alternate zinc supplement for livestock

K. Geetha[1], M. Chellapandian[2], N. Arulnathan[2] and A. Ramanathan[3]

1. Nanotechnology Division, Periyar Maniammai Institute of Science and Technology, Thanjavur, Tamil Nadu, India;
2. Department of Animal Nutrition, Veterinary College and Research Institute, Tirunelveli, Tamil Nadu, India;
3. Department of Animal Husbandry, School of Agriculture and Animal Sciences, Gandhigram Rural Institute, Dindigul, Tamil Nadu, India.

Corresponding author: A. Ramanathan, e-mail: ramanathangri@gmail.com
Co-authors: KG: rktgeetha@gmail.com, MC: mcpandian69@gmail.com, NA: drarulnutri@gmail.com
Received: 26-09-2019, **Accepted:** 05-12-2019, **Published online:** 16-01-2020

doi: www.doi.org/10.14202/vetworld.2020.121-126 **How to cite this article:** Geetha K, Chellapandian M, Arulnathan N, Ramanathan A (2020) Nano zinc oxide – An alternate zinc supplement for livestock, *Veterinary World*, 13(1): 121-126.

Abstract

Aim: This study was aimed to investigate antimicrobial and cytotoxicity effect of nano ZnO in *in vitro* for the application of livestock feed supplement.

Materials and Methods: Nano ZnO was synthesized by wet chemical precipitation method using zinc acetate as a precursor and sodium hydroxide was used for reducing the precursor salt. The properties of synthesized powder were characterized using ultraviolet (UV)–visible spectroscopy, Fourier transform infrared (FTIR), scanning electron microscopy (SEM), and X-ray diffraction (XRD), respectively. *In vitro* antimicrobial activities were analyzed against the pathogenic bacteria in poultry *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae,* and *Streptococcus aeruginosa.* 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay was conducted to analyze the cytotoxicity effect of nano ZnO.

Results: SEM showed a spherical ZnO particle in the range of 70-100 nm. The size of the particle and purity of the sample were confirmed by XRD. The nano-sized ZnO particles exhibited the UV absorption peak at 335 nm. In FTIR spectroscopy, pure ZnO nanoparticles showed stretching vibrations at 4000-5000 cm^{-1}. ZnO nanoparticles exhibited remarkable antibacterial activity against *E. coli*, *S. aureus*, *K. pneumoniae,* and *S. aeruginosa* bacterial strains. Cell viability was significantly reduced in a dose-dependent manner in the cytotoxicity study.

Conclusion: From the broad-spectrum antibacterial activity and the lower cytotoxicity observed at the prescribed dose, it is concluded that nano ZnO powder is a potential alternate zinc supplement for livestock.

Keywords: antimicrobial, cytotoxicity, nano zinc oxide, precipitation method, zinc supplementation.

Introduction

Zinc is the second most essential trace element in all living systems from animals to humans, plays an essential role in many metabolic processes of the body [1]. The daily dietary intake of zinc is essential to regulate the cell division by regulating the synthesis of protein and DNA [2]. The two predominant sources of Zn used by the animal feed industry are ZnO and $ZnSO_4.H_2O$ [3]. Deficiency of zinc in cattle leads to improper growth, reduced feed intake, reduced milk yield, and decreases of cycling and conception rate [4,5]. Milk yield increased when Zn is supplemented in the form of zinc methionine or zinc lysine to the cattle [6]. The National Research Council recommended 30 ppm (mg/kg) as the dietary requirement of zinc on a dry matter basis for cattle. Supplementation of nano zinc drastically reduced somatic cell count in milk from cows with subclinical mastitis and improved milk production than cows supplemented with macro zinc oxide [7,8]. Zinc deficiency in lamb results in slipping of wool, decreased growth and improper growth of testes [9], weight loss during lactation, development of skin lesions, and excessive salivation [10]. Elevation of phytate by poor intestinal absorption of zinc from improper zinc supplement ends in prolonged enteritis and dermatosis [11]. Continuous supplementation of zinc in the form of zinc sulfate (10 mg/kg/day) or zinc methionate (1.7 mg/kg/day) is normally required for maintenance [12]. Zinc plays with disease resistance, cellular immunity, spleen development, and alteration in high-density lipoprotein cholesterol in poultry [13,14]. The supplemental zinc used in poultry is zinc sulfate or zinc chloride [15]. Zinc in the form of Zn methionine shows greater biological availability than zinc from inorganic sources [16]. The recommended level of zinc in various poultry diets ranges from 40 to 75 ppm [17].

Zinc oxide is the most commonly used zinc supplement with high antibacterial activity, antifungal, and growth promoter ability [18]. Zinc oxide generates hydrogen peroxide which can pass through the cell wall, disrupt metabolic process, and, in turn, inhibit the microbial growth. The affinity of zinc