

Biogenic Nano Zinc Oxide Particle Production and Their Antimicrobial Potentials: A Review

Abstract

Nano zinc oxide particles (ZnO-NPs) have captured significant interest from researchers worldwide due to their exceptional biological activity. These nanoparticles are known for their low toxicity and biodegradability, which enhance the bioactivity of pharmacophores. In the realms of electronics and optoelectronics, ZnO-NPs are the most widely utilized nano metal oxides, thanks to their distinctive optical properties and chemical behaviors. These properties can be easily modified through changes in morphology and a high bandgap. The synthesis of biomimetic nanoparticles from therapeutic plants, fungi, bacteria, and algae enhances their durability and biocompatibility in various biological environments. Biofabrication also affects their physicochemical behavior, which contributes to increased biological potency. This article reviews various ZnO-NP synthesis methods, including physical, chemical, and biogenic techniques, with a particular emphasis on green synthesis method. The review highlights the unique properties and mechanisms that give ZnO-NPs their powerful antimicrobial activities against a wide range of pathogens, including bacteria, fungi, and viruses. The nanoparticles' small size, large surface area, and biocompatibility enable effective interaction with microbial cells, leading to cell death through direct interaction, the generation of reactive oxygen species (ROS), and modulation of the host immune response. Also delves advantages and disadvantages of zinc oxide nanoparticles compared to other metal oxides, as well as their limitations. The diverse properties of ZnO-NPs make them a versatile and promising option for various applications, particularly in nanomedicine. The integration of biogenic synthesis methods not only improves their ecological profile but also enhances their efficacy and safety in different biological contexts.

Keywords

Anti-microbial; Biogenic fabrication; Nanomaterial; Zinc oxide particles