

Green Synthesis and Characterization of Zinc Oxide Nanoparticles Using Neem (*Azadirachta Indica*) Leaf Extract and Investigation of Its Antibacterial Activities

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Abstract : Zinc oxide nanoparticles (ZnO NPs) have garnered significant attention due to their diverse applications encompassing catalytic, optical, photonic, and antibacterial properties. In this study, we successfully synthesized zinc oxide nanoparticles using a rapid, environmentally benign, and cost-effective method. Neem (*Azadirachta indica*) leaf extract served as the reducing agent for Zn (NO₃)₂·6H₂O solution under optimized conditions (pH = 9). Qualitative screening techniques and FT-IR Spectroscopy confirmed the presence of active biomolecules such as flavonoids, phenolic groups, alkaloids, terpenoids, and tannins within the Neem leaf extract, both before and after reduction. The formation of ZnO NPs was visually evident through a distinct color change from colorless to light yellow. The biosynthesized nanoparticles underwent comprehensive characterization through UV-visible, FT-IR, and XRD spectroscopies. The reduction process proved to be straightforward and user-friendly, with UV-visible spectroscopy demonstrating a surface plasmon resonance (SPR) at 321 nm, unequivocally confirming the ZnO NP formation. X-ray diffraction analysis elucidated the crystal structure, revealing an average particle size of approximately 20 nm using Scherrer's equation based on the line width of the plane. Furthermore, the synthesized zinc oxide nanoparticles were evaluated for their antimicrobial properties against both Gram-positive and Gram-negative bacteria. The results showcased significant inhibitory activity, with the highest zone of inhibition observed against *Escherichia coli* (15 mm) and comparatively lower activity against *Staphylococcus aureus*. This research underscores the potential of Neem leaf extract-mediated synthesis of ZnO NPs as an eco-friendly and effective approach for various applications, including antibacterial agents.

Keywords : zinc oxide nanoparticles (ZnO NPs), bioreducing agent, green synthesis, antibacterial activity

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