Antimicrobial Properties of Green synthesized ZnO Nanoparticles Synthesized Using *Parkia biglobosa* Seed Extract

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Abstract

There is increasing interest in improving nanomaterial properties for enhanced efficiency in various applications including usage as antimicrobial agents. Green synthesis approach offers a less toxic, cheaper alternative with reducing and capping agents which are readily available in plants and microorganisms (1). Reported phytochemical studies of *Parkia biglobosa* seeds showed that it is rich in phytochemicals which could serve as potential capping and reducing agents for nanomaterial synthesis (2). Hence, in this work, we studied the optical, morphological, crystallographic and antimicrobial properties of zinc oxide nanoparticles (ZnONPs) synthesized using fermented *Parkia biglobosa* seed extract (PBSE) via precipitation method. This green synthesis approach yielded spherical nanoparticles with significantly reduced particle agglomeration due to the capping properties of the PBSE. Elemental composition was confirmed to be Zn and O at 1:1 ratio. Highly crystalline nanoparticles obtained was a good match to the standard reference-hexagonal wurtzite zincite ZnO (JCPDS: 36-1451). Green synthesis decreased the peak broadening and crystal defects resulting in increased crystallite size from 12.45 nm (without PBSE) to 12.99 nm (with PBSE). The results of the Raman analysis confirmed the successful synthesis of the crystalline hexagonal wurtzite ZnO nanoparticles with $E_2^{(high)}$ peak at 447 cm^{-1} and $E_2^{(Low)}$ peak at 83 cm^{-1} attributed to the vibrations of the lighter oxygen atoms and the heavy Zn sub-lattice, respectively (3). The nanomaterials showed typical ZnO optical properties with strong absorption in the visible region, absorption maxima at 356 nm and energy band gap estimated from the taut plot which was found to increase from 2.97 eV to 3.05 eV for PBSE. The photoluminescence studies confirmed the presence of surface defects. For antimicrobial studies, ZnONPs were tested against bacteria *(S. Aureus, E. Coli, B. Subtillis, P. Aeruginosa, S. Typhi* and *K. Pneumonia)* and fungi *(C. Albicans, A. Niger, P. Roqueforti* and *R. Stonlonifer)* strains. ZnONPs synthesized with and without PBSE significantly inhibited microbial growth even at low concentrations. Lower antimicrobial activity was observed with PBSE-synthesized ZnONPs due to its higher crystallite size and smaller lattice defects compared to the smaller particle size and larger crystal defect ZnONPs synthesized without PBSE (4). Hence, *P. biglobosa* seed extract was effective for synthesis of highly crystalline nano-sized ZnONPs with significant antibacteria and antifungal properties.

Keywords

Antimicrobial, Bandgap, Crystal defect, Nanomaterials, Precipitation, Zinc oxide.