

Green synthesis of ZnO nanoparticles using the stem of *Murraya koenigii* and investigation of their photocatalytic activity

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About 20% of the global water pollution caused by the apparel and textile industry is linked to textile dyeing. Chemical dyes used in the production of clothing are often discarded into rivers without proper treatment. These contaminants persist in ecosystems, damaging aquatic life and polluting water sources. To address this issue, the development of eco-friendly and cost-effective solutions is essential. Zinc Oxide (ZnO) nanoparticles (NPs) synthesized through green methods using plant extracts. In photocatalysis, these nanoparticles can act as efficient catalysts. *Murraya koenigii*, valued for its leaves and berries in culinary and medicinal applications, has an underutilized stem that could potentially offer additional benefits and is explored further in this study. Green-synthesized ZnO nanoparticles were obtained using zinc acetate as the precursor at an optimal concentration of 0.01 mol dm^{-3} . The plant extract to precursor ratio was optimized to 1:50, at a pH of 12 and room temperature. The synthesized NPs were characterized using UV-Visible spectroscopy, Fourier Transform Infrared (FTIR) spectrometer, and Scanning Electron Microscope (SEM). The UV-Visible spectrum of synthesized nanoparticles exhibited a distinctive peak at around 360-390 nm, while FTIR analysis

showed a peak in the wavenumber range of 500-600 cm^{-1} , corresponding to the stretching vibration of Zn-O bonds, confirming the formation of ZnO NPs. SEM analysis revealed that the ZnO NPs had a flake-like morphology, organized in a nano-flower arrangement. The photocatalytic activity of the green synthesized ZnO NPs was evaluated under varying conditions to optimize parameters for dye degradation. The optimum pH was found to be 10, with an optimal ZnO catalytic load of 25 mg and the dye degradation time was optimized to 120 minutes. Under these conditions, the ZnO NPs demonstrated a maximum dye degradation efficiency of 85% for methylene blue (MB) when exposed to solar light. Future studies should focus on exploring antibacterial, antimicrobial, antioxidant potential of green synthesized ZnO NPs. Further investigations are also warranted to elucidate the precise mechanisms of action and to conduct detailed kinetic studies to optimize their efficiency.

Keywords:

Green synthesis; *Murraya koenigii*; photocatalytic activity; methylene blue; ZnO nanoparticles