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Eco-Friendly Innovation: Photocatalytic Degradation of IC-50 Orange Dye with Banana Flower ZnO Nano Particles

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Integrating green nanotechnology contributes to a circular economy by converting waste into functional materials, thereby reducing pollution and promoting the sustainable use of resources. This study focused on synthesising zinc oxide nanoparticles (ZnO NPs) derived from Banana Flower (*Musa acuminate*) (BF), emphasizing their photocatalytic efficiency against IC 50 orange pigment dye (PD), a widely used industrial dye. The optimal conditions for synthesizing ZnO NPs with improved yields were determined by varying parameters such as pH, ion precursor concentration, plant extract-to-ion solution ratio, irradiation methods, and incubation time. The NPs were characterized using UV-Vis spectroscopy, FTIR, SEM, TEM, EDS, and XRD analysis. Surface plasmon resonance peaks between 350 and 370 nm preliminarily confirmed the formation of ZnO NPs. FTIR analysis indicated the stretching mode of the Zn-O bond around 625 cm-1. SEM analysis revealed the spherical morphology of the NPs, while TEM analysis showed an average particle size of 84.3 nm. XRD analysis confirmed the presence of the hexagonal crystalline structure typical of ZnO NPs, and EDS analysis validated the elemental composition, with Zn and O being the predominant constituents. Under optimized conditions, including catalytic load, pH, and dye concentration, the ZnO NPs synthesized from BF demonstrated exceptional photodegradation efficiency, achieving a 93.80% dye degradation within 7 hours. These findings highlight the potential of ZnO NPs synthesized with BF as a sustainable solution for textile and wastewater treatment applications due to their high photodegradation efficiency, environmentally friendly synthesis process, and effective removal of industrial dyes.

Keywords: *banana flower, photocatalytic activity, photodegradation, Pigment dye, ZnO NPs*