Comparable Studies of Photocatalytic Dye Degradation and Antimicrobial Activities of Co_3O_4/ZnO and Co_3O_4/CuO Nanocomposite Synthesized Using *Litsea Glutinosa* Leaf Extract

Khondaker Afrina Hoque[a,b*], Farjana Akter[a], Khadiza Akter[a], Ommay Honey Jarka[a], Rayhan Sarkar[a], Mehedi Hasan Pritom[c], Fatema T. Zohura[d], Bijoy Chandra Ghos[e], Abu Bin Imran[b*], and Al-Nakib Chowdhury[b*]

[a]*Department of Chemistry, Comilla University, Cumilla-3506, Bangladesh*

[b]*Department of Chemistry, Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh*

[c]*Applied Bioengineering Research Incubator, Department of Chemical Engineering, Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh*

[d]*Chemistry, Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh*

[e]*BCSIR, Rajshahi Laboratories, Bangladesh Council of Scientific and Industrial Research (BCSIR), Rajshahi-6206, Bangladesh*

Corresponding Emails: khafrina@cou.ac.bd, abimran@chem.buet.ac.bd, nakib@chem.buet.ac.bd

Abstract:

The current work focused on the synthesis of Co_3O_4/ZnO and Co_3O_4/CuO nanocomposites (NCs) via *Litsea Glutinosa* leaf extract to evaluate their photocatalytic and antibacterial activities. The NCs were synthesized using 80mL of 50 mM solutions of the respective precursor salts zinc nitrate hexahydrate, cobalt dichloride hexahydrate, and cupric nitrate trihydrate, and 20ml of leaf extract at pH 13. Single Co_3O_4, ZnO, and CuO NFs have been produced to evident the synthesis of NCs. The synthesized nanoparticles were characterized by UV−vis, X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), and Scanning electron microscopy (SEM) analyses to study the energy band gap, average crystallite size, functional groups, and morphology of the samples, respectively. UV-Vis absorption spectra reveal that Co_3O_4/ZnO exhibits a significant redshift in its absorption spectrum, with a peak at 409 nm. Bandgap measurements, derived from Tauc plots, show a clear difference in the optical bandgaps of the materials. Co_3O_4/ZnO has a significantly narrowed bandgap of 1.5 eV, compared to Co_3O_4/CuO, which has a higher bandgap of 3.49 eV. FT-IR characterization confirms the presence of various functional groups in samples including different metal-oxide (M-O) stretching modes below 600 cm^{-1}. Crystallite sizes of the formed particles were obtained at 8.93 nm for Co_3O_4/CuO, and 12.45 nm Co_3O_4/ZnO NCs from the XRD data. SEM analysis revealed distinct hybrid structures of Co_3O_4/ZnO with spherical ZnO and rod-shaped Co_3O_4, and Co_3O_4/CuO with coal-like porous fragments and powder-like agglomeration, suggesting potential functional enhancements. The photocatalytic activity study under sunlight revealed that Co_3O_4/ZnO achieved 84.77% methylene blue degradation ($k = 1.05\times10^{-2}$ min^{-1}) at optimized conditions 7 ppm dye, 0.6 mg catalyst, pH 11, and 180 min, while Co_3O_4/CuO achieved 75.59% ($k = 0.78\times10^{-2}$ min^{-1}) under similar conditions with 13 ppm dye. The green synthesized Co_3O_4/ZnO and Co_3O_4/CuO NCs were employed for antibacterial activity by disc diffusion and well diffusion and were found to exhibit moderate antibacterial activity against *E. coli*. Both NCs were also tested for antibacterial efficacy using resazurin to determine Minimum Inhibitory Concentrations (MIC) and Minimum Bactericidal Concentrations (MBC). Co_3O_4/CuO showed greater efficacy, with MICs of 5.469 mg/ml for *E. coli* and 10.9375 mg/ml for *B. cereus*, outperforming Co_3O_4/ZnO. MBC tests confirmed these results, highlighting Co_3O_4/CuO's superior activity against both Gram-negative and Gram-positive bacteria.

Keywords: *Litsea Glutinosa, Nanocomposites, Photocatalytic activity, Antimicrobial activity, Morphology.*