Dye removing ability of metal oxide nanoparticles synthesized with plant extracts

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Release of untreated effluents from various industries into water bodies is one of the main concerns of environmental pollution. Among many pollutants released into waterways, dyes are one of the major contributors of water contamination. Hence, it is necessary to find more environmentally convenient methods to remove these dyes from waste effluents. In this research, the potential of metal oxide nanoparticles synthesized with plant extracts to remove dyes in water media was investigated. Copper oxide nanoparticles were synthesized from dried Kahata (*Careya arborea)* leaf extract using the co-precipitation method and characterized using UV-vis spectroscopy, Fourier-transform infrared spectroscopy, scanning electron microscopy, and X-ray powder diffraction. The synthesized nanoparticles were tested for removing Rhodamine B (RB), a basic dye and Acid Orange 7 (AO7), an acidic azo dye under different conditions including pH, light source, irradiation time, temperature and the amount of nanoparticles. Highest dye removal was observed with both dyes at acidic pH (≤ 4), under sunlight when treated for 1 h. Further, an increase in dye removal was observed at elevated temperatures (~80 °C). Dye removal capacities were found to be 68% for RB (10 mg L^{-1} initial dye concentration, 50 mg/mL of nanoparticles) and 70% for AO7 (50 mg L^{-1} initial dye concentration, 20 mg/mL of nanoparticles) when treated for 1 h at pH 4 and ambient temperature under sunlight. Similar removal capacities were observed after simple ethanol wash, up to 2 and 3 cycles for AO7 and RB, respectively. Dye removal capacities for chemical synthesized nanoparticles without plant extracts were ~20% and ~50% for RB and AO7, respectively. Dye removing mechanism was studied using adsorption isotherms and both Langmuir and Freundlich isotherms showed best fits to data indicating possibility of variable adsorption sites due to different functional groups on nanoparticle surface. This study showed an improved dye removal ability of green synthesized CuO nanoparticles compared to chemically synthesized CuO nanoparticles. This could be attributed to the incorporation of various functional groups from plant extract onto the surface of the nanoparticles in green method.

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