The impact of copper oxide nanoparticles reinforced nanocellulose acetate membrane on antibacterial and dye removal Potency

ABSTRACT

With the rapid growth of the textile, leather, cosmetics, and pharmaceutical industries, concerns about pollutants in these sectors, especially dye pollutants, are increasing. This research characterizes bacterial nanocellulose acetate membranes made from Sargassum extract reinforced with copper oxide nanoparticles and tests their antibacterial properties and dye removal in water. Sargassum sp. extract was fermented using Acetobacter xylinum for 10 days, producing bacterial nanocellulose, which was then esterified to create bacterial nanocellulose acetate. Copper oxide nanoparticles were added to the bacterial nanocellulose acetate solution in varying concentrations, cast, and oven-dried. The membrane was analyzed using Fourier-transform infrared spectroscopy, Xray diffraction, scanning electron microscope, antibacterial activity, and dye removal. Results showed uniform copper oxide nanoparticles distribution on the membrane surface. Structure analysis revealed diffraction peaks at 35.44◦ and 38.57◦, indicating a reduced crystalline index but improved membrane effectiveness. Antibacterial tests showed a zone of inhibition against bacterial growth, increasing with higher copper oxide nanoparticle content. The addition of copper oxide nanoparticles also influenced the dye removal capacity for Metanil Yellow, Congo Red, Eosin Yellow, Methylene Blue, and Malachite Green. The kinetic analysis showed that the adsorption process follows a pseudo-first-order model, with higher correlation coefficients (R2) compared to the pseudosecond-order model.