Production of cellulose from sugarcane bagasse for adsorption of copper ions

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Abstract

The presence of metal ions in drinking water as well as high concentrations of heavy metals in wastewater are serious issues that warrant greater scrutiny. As such, utilizing natural materials to adsorb metals from aqueous solutions is an attractive solution as it is inexpensive. Therefore, the present study evaluated the efficacy of utilizing cellulose derived from sugarcane bagasse (SB) as a bio-adsorbent precursor to remove copper ions (Cu²⁺). This study aimed to determine the optimum acid to SB ratio by combining varying acid concentrations at different temperatures during acid hydrolysis for cellulose isolation. A microscope as well as Fourier-transform infrared (FTIR) spectroscopy were used to observe the morphology and structure of these bio-adsorbent precursors, respectively. Atomic absorption spectrometry (AAS) was then used to determine the efficacy of the bio-adsorbent precursors by measuring the Cu²⁺ concentrations, and percentage of Cu²⁺ removed. Microscope image analysis showed that SB had rigid fibre bundles prior to acid hydrolysis. This changed to a smoother surface post-hydrolysis as the binding materials ruptured. FTIR spectroscopy showed an average peak of 3,400 cm⁻¹ within the 3,500 to 3,000 cm⁻¹ spectral bands with varying peak intensities, which alluded to the presence of different concentrations of O-H bonds depending on the nature of the treatment. More significant peaks between the 1,500 to 1,000 cm⁻¹ range were observed in the hydrolysed SB than in the raw SB, indicating the successful removal of hemicellulose and lignin. In the adsorption experiment, SB that had been hydrolysed with 3 M H₂SO₄ sulphuric acid provided the highest adsorption efficiency (86.6%) after 24 h. Hence, it can be concluded that cellulose derived sugarcane bagasse is a promising ‘green’ adsorbent for the removal of copper ions from an aqueous solution.

Keywords: Adsorbent; Cellulose; Heavy metal; Hydrolysis; Sugarcane bagasse