Efficient removal of Cu(II) from aqueous systems using enhanced quantum yield nitrogen-doped carbon nanodots

ABSTRACT

The valorization of cellulose-based waste is of prime significance to green chemistry. However, the full exploitation of these lignocellulosic compounds to produce highly luminescent nanoparticles under mild conditions has not yet been achieved. In this context, we convert low-quality waste into value-added nanomaterials for the removal of Cu(II) from wastewater. Carboxymethylcellulose (CMC), which was derived from empty fruit bunches, was selected for its high polymerization index to produce luminescent nitrogen-doped carbon dots (N-CDs) with the assistance of polyethylene glycol (PEG) as a dopant. The optimum N-CD sample with the highest quantum yield (QY) was characterized using various analytical techniques and the results show that the N-CDs have great crystallinity, are enriched with active sites and exhibit a long-shelf life with an enhanced QY of up to 27%. The influence of Cu2+ concentration, adsorbent (N-CDs) dosage, pH and contact time were investigated for the optimal adsorption of Cu2+. The experiments showed the rapid adsorption of Cu2+ within 30 min with a removal efficiency of over 83% under optimal conditions. The equilibrium isotherm investigation revealed that the fitness of the Langmuir isotherm model and kinetic data could be well explained by the pseudo-second order model. Desorption experiments proved that N-CDs can be regenerated successfully over five adsorption–desorption cycles owing to the ability of ascorbic acid (AA) to reduce the adsorbed nanocomplex into Cu+. The rapid adsorption property using low-cost materials identifies N-CDs as a superior candidate for water remedy.