

ABSTRACT

This study is a first-hand report of the immobilization of *Nauclea diderrichii* seed waste biomass (ND) (an agro-waste) with eco-friendly mesoporous silica (MS) and graphene oxide–MS (GO + MS) nanoparticles, producing two new hybrid materials namely: MND adsorbent for agro-waste modified with MS and GND adsorbent for agro-waste modified with GO + MS nanoparticles showed improved surface area, pore size and pore volume over those of the agro-waste. The adsorptive potential of the new hybrid materials was explored for uptake of Cr(III) and Pb(II) ions. Analysis of experimental data from these new hybrid materials showed increased initial sorption rate of Cr(III) and Pb(II) ions uptake. The amounts of Cr(III) and Pb(II) ions adsorbed by MND and GND adsorbents were greater than those of ND. Modification of *N. diderrichii* seed waste significantly improved its rate of adsorption and diffusion coefficient for Cr(III) and Pb(II) more than its adsorption capacity. The rate of adsorption of the heavy metal ions was higher with GO + MS nanoparticles than for other adsorbents.

Kinetic data were found to fit well the pseudo-second-order and the diffusion–chemisorption kinetic models suggesting that the adsorption of Cr(III) and Pb(II) onto these adsorbents is mainly through chemisorption mechanism. Analysis of kinetic data with the homogeneous particle diffusion kinetic model suggests that particle diffusion (diffusion of ions through the adsorbent) is the rate-limiting step for the adsorption process.