Kinetic, Equilibrium and thermodynamic studies on the biosorption of Cd(II) from aqueous solutions by the leaf biomass of Calotropis procera – ‘Sodom apple’

Loretta Chukwudumebi Overah (1), Oyebamiji. Babalola (), Adesola Babarinde (), Vincent Oninla (), and Abimbola Olatunde ()

(1) CHEMISTRY DEPARTMENT, FACULTY OF SCIENCE, DELTA STATE UNIVERSITY, ABRAKA, Nigeria (overahrubyisaac@yahoo.com), (2) CHEMISTRY DEPARTMENT, FACULTY OF SCIENCE, UNIVERSITY OF IBADAN, OYO STATE, NIGERIA, (3) CHEMISTRY DEPARTMENT, FACULTY OF SCIENCE, OLABISI OLABANJO UNIVERSITY, AGO-IWOYE, NIGERIA

ABSTRACT: The kinetics, equilibrium and thermodynamics of the biosorption of Cd (II) from aqueous solution by the leaf biomass of Calotropis procera popularly known in western Nigeria as ‘bom bom’ and generally known as Sodom apple were investigated at different experimental conditions. Optimum conditions of pH, contact time, biomass dosage, initial metal ion concentration and temperature were determined to be 5, 60 minutes, 110 mg, 0.3 mM and 27°C respectively. The maximum biosorption capacity was found to be 8.91 mg/g. The kinetic studies indicated that the biosorption process of the metal ion followed the pseudo-second-order and intra-particle diffusion models with an R-square value of 0.998 and 0.985 respectively. Equilibrium studies showed that the biosorption of Cd (II) is well represented by both Freundlich and Langmuir isotherms but the Langmuir model gave a better fit with an R-square value of 0.979. Langmuir constant, \( b_m \) of 0.0080 and monolayer adsorption capacity, \( q_m \) of 123.46. The calculated thermodynamic parameters (\( \Delta G^\circ \) -4.846 kJmol-1, \( \Delta H^\circ \) 10.60 kJmol-1 and \( \Delta S^\circ \) 0.052 kJK-1mol-1) showed that the biosorption of Cd (II) is feasible, spontaneous, endothermic and highly disordered in nature under the experimental conditions. These findings indicate that the leaf of Calotropis procera could be employed in the removal of Cd (II) from industrial effluents.

Key words: Calotropis procera, Cadmium, Adsorption isotherm.