

Biosorption of Cu (II) using dried *Garcinia quaesita* rinds: equilibrium, kinetic, and thermodynamic investigations

W. A. E. Ayodya^{1,2}, K. A. D. D. Sakunthala^{1,2}, W. P. R. T. Perera^{1,3}, T. Abeysinghe⁴, J. A. Liyanage^{1,2}
and W. A. P. J. Premaratne^{1,2*}

¹CKDu Information and Research Centre, University of Kelaniya, Kelaniya, Sri Lanka.

²Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka.

³Department of Indigenous Medical Resources, Gampaha Wickramarachchi University of Indigenous Medicine, Yakkala, Sri Lanka.

⁴Department of Chemistry, Faculty of Natural Sciences, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka.

* jeewa@kln.ac.lk

Dried fruit rinds of *Garcinia quaesita* (Goraka) are a prevalent food additive found in the Asian food context. This study includes a preliminary study of investigating the Copper (Cu^{2+}) adsorption potential of dried fruit rinds of *G. quaesita*. Goraka rinds collected were cleaned with deionized water, air-dried in shade, powdered, and screened to a particle size less than 2 mm. To optimize different influencing parameters, such as initial Cu^{2+} concentration, adsorbent dosage, contact time, pH, and temperature, adsorption experiments were carried out *via* batch method. A maximum Cu^{2+} adsorption of (74.0 ± 0.7 %) was obtained under the optimum conditions: 0.06 g adsorbent dosage, initial Cu^{2+} concentration of 0.8 ppm (25.0 mL), pH of 6, 80 minutes of contact time, and 40°C as the optimum temperature. The equilibrium and kinetic studies were best fitted with Langmuir isotherm ($R^2 = 0.9617$) and pseudo-second order-kinetics ($R^2 = 0.9406$), implying a homogeneous surface forming a monolayer, with chemical reaction between adsorbate: metal ion and active sites: -OH and -C=O groups identified from Fourier Transform Infrared Spectroscopy being the

rate controlling step. According to the thermodynamic data, the negative enthalpy value ($\Delta H = -24.36 \text{ kJ mol}^{-1}$) suggests an exothermic adsorption process that is energetically favorable at lower temperatures. Furthermore, the entropy value ($\Delta S = -81.38 \text{ J mol}^{-1} \text{ K}^{-1}$) reflects the metal ion immobilization and increased ordering at the surface upon adsorption. A small positive Gibbs free energy value ($\Delta G = 0.3 \text{ kJ mol}^{-1}$) indicates that the adsorption process occurs near equilibrium, with a minor energy barrier. The adsorption capacity of *G. quaesita* (0.2 mg g^{-1}) highlights its potential for trace-level Cu^{2+} removal. While *G. quaesita* shows potential for trace-level Cu^{2+} removal, its practical application may be limited to pre-cooking or low-temperature conditions, suggesting the importance of further evaluation under actual cooking environments.

Keywords:

Garcinia quaesita; Curry leaves; Copper removal; Biosorbent.