Biosorption of phenolic compounds from aqueous solutions using pine (Pinus densiflora Sieb) bark powder

ABSTRACT

The present study describes the development of a new bioadsorbent from lignocellulosic wastes of agricultural origin. The biosorption capacity of an agricultural solid waste, pine bark (Pinus densiflora Sieb.), to remove phenolic compounds (phenol, 2-chlorophenol (2-CPh), and 4- chlorophenol (4-CPh)) from aqueous solutions under batch equilibrium conditions was investigated. The morphological characteristics of the biosorbent were evaluated by BET surface area analysis, Fourier transform infrared spectroscopy (FTIR), elemental analysis, an X-ray diffractometer (XRD), and a scanning electron microscope (SEM). Batch experiments were conducted to investigate the effect of initial pH (2 to 10), contact time, initial concentration of adsorbate (50 to 200 mg/L), and biosorbent dosage. The biosorption of phenolic compounds decreased with increasing pH, and the highest biosorption capacity was achieved at a pH of 6.0. Biosorption equilibrium was established in 120 min. The biosorption equilibrium data were fitted and analyzed with Langmuir, Freundlich, and Dubinin-Radushkevich isotherm equations, as well as four adsorption kinetic models. The kinetics data fitted well into the pseudo-second-order kinetic model, with a correlation coefficient greater than 0.993. The maximum monolayer biosorption capacity of pine bark for phenol, 2-CPh, and 4-CPh was found to be 142.85, 204.08, and 263.15 mg/g, respectively, as calculated by the Langmuir model at 30 ± 1 °C. Pine bark could be used as a new effective, low-cost biosorbent material with good uptake capacity and rapid kinetics for the removal of phenolic compounds from aqueous media.

Keyword: Biosorption; Pine bark powder; Phenolic compounds; Kinetics; Isotherm models