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Modeling and optimization of biosorption of lead (II) ions from aqueous solution onto pine leaves (*Pinus kesiya*) using response surface methodology

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ABSTRACT

In this work, the central composite design in response surface methodology by the Design-Expert software was used for optimizing the removal of Pb(II) ions from aqueous solution by pine leaves *(Pinus kesiya)*. Effects of $pH_{solution}$, adsorption time and initial Pb(II) ions concentration on adsorption capacity were investigated. Experimental data were fitted by using five nonlinear isotherm models including Langmuir, Freundlich, Sips, Temkin and Dubinin–Radushkevich. The maximum Pb(II) adsorption capacity (q_{max}) estimated from the Langmuir isotherm model was 31.04 mg/g, which is higher than other biomaterials such as barley straw, *Cucumis sativus* peel, coconut tree sawdust, etc. Kinetic studies indicated that the uptake of Pb(II) occurred on the Elovich model within two stages. Thermodynamic studies at different temperatures showed the biosorption to be endothermic and spontaneous. The study concluded that *P. kesiya* can be a good adsorbent for removing Pb(II) from aqueous solution.

Keywords: Response surface methodology (RSM); *Pinus kesiya*; Adsorption; Isotherm; Kinetics

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