Biosorption of Pb(II), Cu(II), and Ni(II) ions onto novel lowcost *P. eldarica* leaves-based biosorbent: isotherm, kinetics, and operational parameters investigation

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**ABSTRACT**

In this study, the novel low-cost *Pinus eldarica* leaves-based biosorbent (Pe) was introduced to remove heavy metal ions from aqueous media. The Pe ability of Pb(II), Cu(II), and Ni(II) ions biosorption was investigated in aqueous solutions. The maximum sorption capacity was 40, 26, and 33 mg g\textsuperscript{-1} for Pb(II), Cu(II), and Ni(II), respectively, that was so promising. Experiments were carried out in lab-scale batch reactors as function of initial pH (pH\textsubscript{0}), initial concentration of heavy metal ions (C\textsubscript{0}), and contact time (t). The statistical analysis was applied to determine the significant parameters, rank of parameter influences, and type of influences. The adsorption kinetics data were modeled using the pseudo-first, pseudo-second-order, and intraparticle diffusion kinetics equations. The pseudo-first-order and pseudo-second-order kinetics equations described the adsorption kinetics very well. Finally, the equilibrium data were described by 15 isotherm models with different number of parameters from two to five. The results revealed that the Langmuir and Fritz–Schlunder models provided the best correlation of the experimental data.

**Keywords:** Biosorption; *Pinus eldarica* leaves; Heavy metals; Isotherm; Kinetics