Environmental Engineering and Management Journal

July 2016, Vol.15, No. 7, 1571-1580
http://omicron.ch.tuiasi.ro/EEMJ/

"Gheorghe Asachi" Technical University of Iasi, Romania

OPTIMIZATION OF THE BIOSORPTION OF Cr^{3+}, Cd^{2+} AND Pb^{2+} USING A NEW BIOWASTE: *Zea mays* SEED CHAFF

Jonathan Oyebamiji Babalola[1]*, Martins Osaigbovo Omorogie[1,2], Adesola Abiola Babarinde[3], Emmanuel Iyayi Unuabonah[4,5], Vincent Olukayode Oninla[1]

[1]Department of Chemistry, University of Ibadan, Ibadan, Oyo State, Nigeria
[2]National Center For Nanoscience and Technology, Chinese Academy Of Sciences (CAS), 100190, Beijing,China
[3]Department of Chemical Sciences, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria
[4]Department of Chemical Sciences, Redeemer's University, 110115, Redemption City, Mowe, Ogun State, Nigeria
[5]Institüt fur Chimie, Universität Potsdam, D-14476, Germany

Abstract

This study highlights the potential use of yellow *Zea mays* seed chaff (YZMSC) biomass as a biosorbent for the removal of Cr^{3+}, Cd^{2+} and Pb^{2+} ions from aqueous solutions. Fourier transformed Infrared analysis of the biomass suggests that YZMSC biomass is basically composed of cellulose and methyl cellulose. The biosorption capacities, q_{max}, of YZMSC biomass for Cr^{3+}, Cd^{2+} and Pb^{2+} are 14.68, 121.95 and 384.62 mg/g respectively. Biosorption equilibrium was achieved at 20, 30 and 60 min for Cr^{3+}, Cd^{2+} and Pb^{2+} respectively. YZMSC biomass was found to have higher biosorption capacity and overall kinetic rate of uptake for Pb^{2+} than for Cd^{2+} and Cr^{3+}. However, Cr^{3+} had better initial kinetic rate of uptake by the biomass than Pb^{2+} and Cd^{2+}. The Freundlich equilibrium isotherm model was found to describe equilibrium data better than Langmuir model suggesting that biosorption of these metal ions could be on more than one active site on the surface of YZMSC biomass. Kinetic study predicted the pseudo-second kinetic model as being able to better describe kinetic data obtained than either modified pseudo-first order or Bangham kinetic models. Biosorption of Cr^{3+}, Cd^{2+} and Pb^{2+} onto YZMSC biomass was endothermic in nature with large positive entropy values. Biosorption of these metal ions onto YZMSC biomass was observed to be feasible and spontaneous above 283 K. Optimization of biomass weight for the removal of these metal ions suggest that 384 kg, 129 kg and 144 kg of YZMSC biomass is required for the removal of 95% of Cr^{3+}, Cd^{2+} and Pb^{2+} metal ions respectively from 100 mg/L of metal ions in 10 tonnes of aqueous solutions.

Key words: biomass, biosorption, optimization, yellow *Zea mays*

Received: March, 2012; Revised final: April, 2013; Accepted: April, 2013

* Author to whom all correspondence should be addressed: e-mail: bamijibabalola@yahoo.co.uk; Phone: +234-803-454-0881