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Editors
Radoje V. Pantovic
Zoran S. Marković

EcoIst '15

Hotel "PUTNIK", Kopaonik, SERBIA
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UNIVERSITY OF BELGRADE
TECHNICAL FACULTY BOR

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MODIFIED CORN SILK AS BIOSORBENT FOR Pb(II) IONS REMOVAL FROM AQUEOUS SOLUTION

Marija Petrovic*, T. Sostaric, M. Stojanovic, J. Milojkovic, M. Mihajlovic, J. Petrovic, M. Stanojevic

Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, SERBIA

*m.petrovic@itnms.ac.rs

ABSTRACT

In this work, corn silk was chemically modified by 0.5 M HNO_3 and used as biosorbent for removal of Pb (II) ions from aqueous solutions. The effect of biosorbent dosage was studied in batch experiments with 25 mL of aqueous lead solution of concentration 200 mg/L, at pH 5, 120 min of contact time and room temperature. The modified corn silk was characterized by pH_{PZC} The maximum biosorption capacity was found to be 39.5 mg/g at 0.025 g of biosorbent dosage. The biosorption capacity decreased with increasing of biosorbent dosage.

Key words: biosorption, modified corn silk, Pb(II), biosorbent dosage, pH_{PZC}.

INTRODUCTION

Industrial wastewater is considered as one of the major pollutants of the environment. Currently, heavy metal pollution has become one of the most important environmental problems. Lead is one of heavy metals and a widely used in many industries such as petrochemical, pulp and paper, electronic, refineries, mining activities, battery manufacturing, alloy and steel industries [1-4]. The wastes from these industries usually contain a large amount of lead which discharged into the environment through soils and water streams and accumulates along the food chain. It is one of the most toxic metal ions which accumulate mainly in bones, brain, kidney and muscles resulting in a high risk to human health, as high concentrations of lead will cause many diseases such as anemia, encephalopathy, hepatitis and nephritic syndrome [5]. It is therefore, very important to remove Pb(II) from wastewater before disposal.

Several conventional methods have been used for the removal of heavy metals from wastewater such as coagulation, chemical precipitation, chemical oxidation/reduction, adsorption with activated carbon [6,7]. However, these methods have some disadvantages such high operating cost and they may generate toxic sludge. Hence, from a food safety viewpoint, there is a demand for green adsorbents. Therefore, there is a growing interest in developing low-cost and high efficiency alternative technologies for wastewater treatment.

In recent years, removal of heavy metals using biomaterials as adsorbents has gained significant interest due to their high effectiveness, low cost, and simplicity. Extensive review of available literatures suggested that number of low cost natural biosorbents such as agave bagasse, rice straw, rice husk, wheat stem, olive pumice, olive stone, barley straw, coconut shell, corn cob, apricot stone, cashew nut shell, grapefruit peel [8-18] etc., have been used for the removal of heavy metal ions from wastewater. To enhance the removal efficiency and to reduce organic contents of low cost natural biosorbents, different modification techniques have been utilized by previous researchers.

The present work promotes chemically modified corn silk as non-conventional, low-cost and novel biosorbent for lead removal from aqueous solution. The main aim of this review is to reveal effect of biosorbent dosage on the biosorption of Pb(II).

MATERIALS AND METHODS

Corn silk (CS) was obtained from the local cornfields near Belgrade (Serbia) in October 2013. Collected biomaterial was milled and sieved into particle size less than 0.2 mm. Powdered CS (0.5 g) was modified in 10 ml of 0.5 M HNO_3 and the suspensions were shaken for 4 h (250 rpm) and washed until pH neutral [19]. Afterward the modified corn silk (MCS) was dried at 70°C stored and used for further experiments.

The pH_{PZC} of MCS was determined by following procedure: KNO_3 (p.a. grade) in concentration of 0.1 M was used as background electrolyte and initial pH values (pH_i) of KNO_3 solution (50 mL) were adjusted from 2 to 12 by adding small volumes of 0.1 M HNO_3 and / or 0.1 M KOH; in each initial solution 0.1 g of MCS was added and the suspensions were shaken for 24 h at room temperature, filtered through filter paper and pH of each supernatant was measured (pH_f) [20].

Lead solution was prepared by dissolving precise amount of Pb $(NO_3)_2x3H_2O$ (analytical grade) in distilled water using standard flasks. The pH value was adjusted by adding small volumes of 0.1M KOH and / or 0.1M HNO_3.

In order to study the effect of important parameters like biosorbent dosage on the biosorbent capacity of Pb(II) removal, batch experiments were performed by mixing of different amount of MCS (0.025 to 0.3 g) in 25 mL of lead solution of concentration 200 mg/L. The mixture including the lead solution and MCS were shaken during 120 min in mechanical shaker (250 rpm) at room temperature and at pH 5. At the end of the given contact time suspensions were filtered and concentration of final Pb(II) remaining in the filtrate was analysed by Atomic Adsorption Spectrophotometer (Perkin Elmer, AAnalyst 300).

Using Eq. (1) the biosorption capacity of the MCS, q (mg/g) was calculated:

$$q = (C_i - C_{eq}) \cdot V / m \qquad (1)$$

where V is Pb(II) solution volume (L), m is mass of the MCS (g), and C_i and C_{eq} (mg/L) are the initial and final concentration of the Pb(II) ions in the solution, respectively.

The biosorption efficiency was determined using equation (2):

$$R\ (\%) = \frac{C_i - C_{eq}}{C_i} x100 \qquad (2)$$

where C_i and C_{eq} (mg/L) are the initial and final concentration of the Pb(II) ions in the solution, respectively

RESULT AND DISCUSSION

The pH at which sorbent surface charge takes a zero value is defined as the point of zero charge (pHpzc). The experimental data are given in Fig. 1. As can be seen from Fig. 1, the plateaus of the curve $pH_f = f(pH_i)$ obtained at pH 4.35 show the pH_{PZC} of MCS. It means that at solution pH higher than 4.35, MCS surface is negatively charged and could interact with cations while at solution pH lower than 4.35, MCS surface is positively charged and could interact with anions. Since lead biosorption by the MSC was studied at pH 5, the results obtained for the point of zero charge indicated that the surface of MSC is negative at investigated pH values. Therefore, electrostatic attractions between negatively charged surface of MSC and Pb^{2+} ions could take place and contribute to biosorption [21].

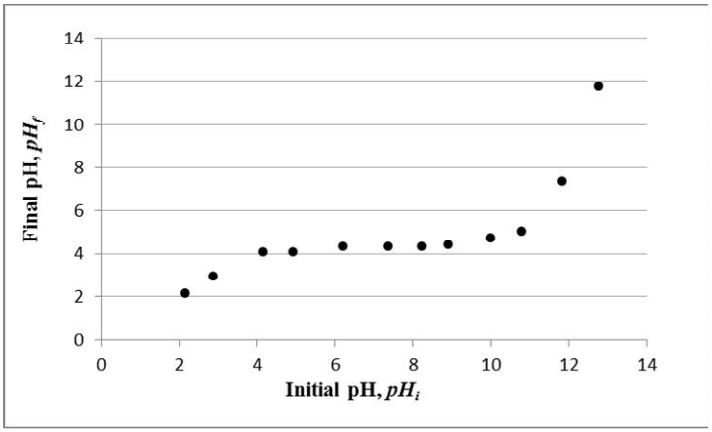

Figure 1. pH_f as a function of pH_i for modified corn silk

Biosorption of lead by modified corn silk

The effect of MCS dosage on Pb (II) ions biosorption was investigated and experimental results are given in Fig. 2.

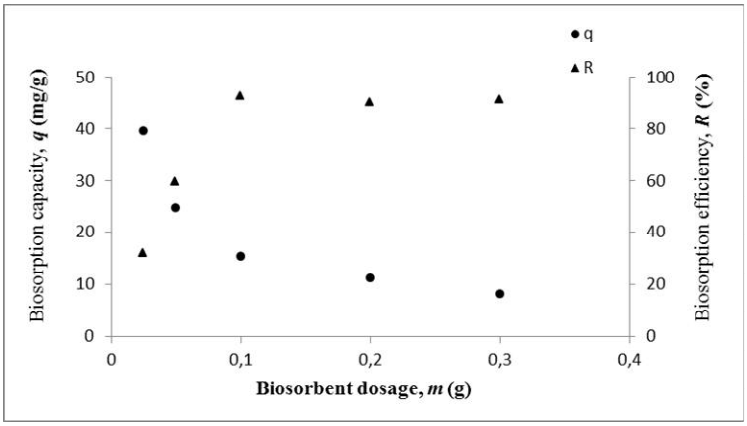

Figure 2. Effect of MCS dosage on the biosorption capacity and biosorption efficiency of Pb (II) ions (initial metal concentration 200 mg/L; pH 5, contact time 120 min and room temperature)

As can be seen (Fig. 2) when the MSC dosage increased from 0.025 to 0.30 g the biosorption capacity decreased from 39.5 to 8.17 mg/g. This phenomenon may be due to is an increasing of MCS dosage at constant Pb(II) ions concentration may cause unsaturation of the adsorption sites. At the other hand, the biosorption efficiency of Pb(II) removal increased from 32.21 to 92.99 % with an increase of adsorbent dosage from 0.025 to 0.30 g. This is due to increasing of the total number of adsorption sites available for Pb(II) ions adsorption with increase of MSC dosage [22].

CONCLUSION

The aim of this paper was to promote chemically modified corn silk as efficient, low cost and locally available biosorbent for the removal of Pb (II) ions from aqueous solutions. The results show that the biosorbent dosage is significant factor influencing the process of biosorption. When the MSC dosage increased from 0.025 to 0.30 g the biosorption capacity decreased from 39.5 to 8.17 mg/g. This study is shown that MSC can be used as an alternative adsorbent for Pb(II) ions removal from aqueous solution due to its high value of biosorption capacity.

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REFERENCES

1. Jalali, R, Ghafourian, H, Asef, Y, Davarpanah, SJ, Sepehr, S, Removal and recovery of lead using nonliving biomass of marine algae, Journal of Hazardous Materials, 253–262, 2002.
2. Gupta, VK, Gupta, M, Sharma, S, Process development for the removal of lead and chromium from aqueous solutions using red mud-an aluminium industry waste, Water Research, 1125-1134, 2001.
3. Conrad, K, Hansen, HCB, Sorption of zinc and lead on coir, Bioresource Technology, 89–97, 2007.
4. Bahadir, T, Bakan, G, Altas, L, Buyukgungor, H, The investigation of lead removal by biosorption: An application at storage battery industry wastewaters, Enzyme and Microbial Technology, 98–102, 2007.
5. Lo, W, Chua, H, Lam, KH, Bi, SP, A comparative investigation on the biosorption of lead by filamentous fungal biomass, Chemosphere, 2723-2736, 1999.
6. Bital, M, Shah, JA, Ashfaq, T, Gardazi, SMH, Waste biomass adsorbents for copper removal from industrial wastewater – a review, Journal of Hazardous Materials, 322–333, 2013.
7. Bulut, Y, Tez, Z, Removal of heavy metals from aquaeous solution by sawdust adsorption, Journal of Environmental Sciences, 160–166, 2007.
8. Velazquez-Jiminez, LH, Pavlick, A, Rangel-Mendez, JR, Chemical characterization of raw and treated agave bagasse and its potential as adsorbent of metal cations from water, Industrial Crops and Product, 200-206, 2013.
9. Ding, Y, Jing, D, Gong, H, Zhou, L, Yang, W, Biosorption of aquatic cadmium(II) by unmodified rise straw, Bioresource Technology, 20-25, 2012.
10. Bansal, M, Garg, U, Singh, D, Garg, VK, Removal of Cr(VI) from aqueous solutions using pre-consumer processing agricultural waste: A case study of rice husk, Journal of Hazardous Material, 312-320, 2009.
11. Tan, G, Yuan, H, Liu, Y, Xiao, D, Removal of lead from aqueous solution with native and chemically modified corncobs, Journal of Hazardous Material 740–745, 2010.
12. Krishnani, KK, Meng, X, Christodoulatos, C, Boddu, VM, Biosorption mechanism of nine different heavy metals onto biomatrix from rice husk, Journal of Hazardous Material, 1222–1234, 2008.
13. Fiol, N, Villaescusa, I, Martinez, M, Miralles, N, Poch, J, Serarols, J, Sorption of Pb(II), Ni(II), Cu(II) and Cd(II) from aqueous solution by olive stone waste, Separation and Purifitacion Technology, 132–140, 2006.
14. Pehlivan, E, Tran, HT, Ouédraogo, WKI, Schmidt, C, Zachmann, D, Bahadir, M, Sugarcane bagasse treated with hydrous ferric oxide as a potential adsorbent for the removal of As(V) from aqueous solutions, Food Chemistry, 133–138, 2013.
15. Sousa, FW, Oliveira, AG, Ribeiro, JP, Rosa, MF, Keukeleire, D, Nascimento, RF, Green coconut shells applied as adsorbent for removal of toxic metal ions using fixed-bed column technology, Journal of Environmental Management, 1634–1640, 2010.

16. Petrović MS, Šoštarić TD, Pezo LL, Stanković SM, Lačnjevac ČM, Milojković JV, Stojanović MD, Usefulness of ANN-based model for copper removal from aqueous solutions using agro industrial waste materials, CICEQ (2014) doi:10.2298/CICEQ140510023P.
17. Kumar, PS, Ramalingam, S, Kirupha, SD, Murugesan, A, Vidhyadevi, T, Sivanesan, S, Adsorption behavior of nickel(II) onto cashew nut shell: Equilibrium, thermodynamics, kinetics, mechanism and process design, Chemical Engineering Journal, 122–131, 2011.
18. Torab-Mostaedi, M, Asadollahzadeh, M, Hemmati, A, Khosravi, A, Equilibrium, kinetic, and thermodynamic studies for biosorption of cadmium and nickel on grapefruit peel, Journal of the Taiwan Institute of Chemical Engineers, 295–302, 2013.
19. Zhu, X, Yu, H, Jia, H, Wu, Q, Liu, J, Xia L, Solid phase extraction of trace copper in water samples via modified corn silk as a novel biosorbent with detection by flame atomic absorption spectrometry, Analytical Methods , 4460-4466, 2013.
20. Milonjić, SK, Ruvarac, ALj, Šušić, MV, The heat of immersion of natural magnetite in aqueous solutions. Thermochimica Acta, 261–266, 1975.
21. Fiol, N, Villaescusa, I, Determination of sorbent point zero charge: usefulness in sorption studies. Environmental Chemical Letters, 7, 79–84, 2009.
22. Tong, KS, Kassim, MJ, Azraa, A, Adsorption of copper ion from its aqueous solution by a novel biosorbent *Uncaria gambir:* Equilibrium, kinetics, and thermodynamic studies, Chemical Engineering Journal 145-153, 2011.