

**UNIVERSITY OF BELGRADE
TECHNICAL FACULTY BOR**



PROCEEDINGS
XXIV International Conference
Ecological Truth

Editors

Radoje V. Pantovic

Zoran S. Marković

EcoIst '16

12 – 15 June 2016

**Hotel "BREZA" Vrnjacka Banja,
SERBIA**

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Edited by
Radoje V. PANTOVIC
and
Zoran S. MARKOVIC

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CORN COB AND CORN SILK AS BIOSORBENT FOR METAL IONS REMOVAL FROM AQUEOUS SOLUTION: COMPARATIVE ANALYSIS

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ABSTRACT

In this work, corn cob and corn silk were used as biosorbent for removal of Pb^{2+} , Cu^{2+} and Zn^{2+} ions from aqueous solutions. Adsorption experiments were performed in batch mode. Corn cob and corn silk were characterized by scanning electron microscopy (SEM). The maximum biosorption capacities of corn cob was found to be 0.049, 0.053 and 0.021 mmol L⁻¹ for Pb^{2+} , Cu^{2+} and Zn^{2+} ions, respectively. At the other hand, higher values of maximum biosorption capacities: 0.40, 0.22 and 0.19 mmol L⁻¹ for Pb^{2+} , Cu^{2+} and Zn^{2+} ions, respectively, indicates that corn silk has better adsorption characteristics in comparison to corn cob.

Key words: corn cob, corn silk, heavy metals, biosorption, SEM.

INTRODUCTION

Heavy metals contamination of the environment has become an important issue. Waste water from different industries or mining activities was discharged in to environment and the most frequent heavy metals found in wastewaters are lead, chromium, nickel, zinc, cadmium and copper [1,2]. Even though some of these metal ions are essential for human metabolic system, higher concentration can cause health damage [3]. Due to, very important issue is to protect water from heavy metals pollution. The conventional method such as chemical precipitation, ion exchange, membrane filtration, adsorption on activated carbon and electrolytic process were used for removing heavy metals from wastewaters [4]. High operation cost, low efficiency and insufficient for meeting the environmental requirements are main disadvantages of conventional methods [5]. There is a need for investigation and development of new adsorbent materials which are eco-friendly, inexpensive, and possess high adsorption efficiency for heavy metals removal.

In general, the development of new adsorbent materials has been focused on agricultural by-products. These lignocellulosic materials which are produced in large quantity present very serious disposal problems. At the other hand cellulose structure has a large amount of reactive functional groups and can be used for the adsorption of heavy

metals ions. Through the past decades low cost materials such as: peanut hull, sawdust, bark, rice husk [6–9] and others have been widely investigated as adsorbent for heavy metals removal.

Corn waste, are most abundant in agricultural residues, but most of them are disposed of by direct burning in the field, which causes environmental pollution [3]. The purpose of this study was to investigate the potential use of corn waste biomass (corn cob and corn silk) for Pb^{2+} , Cu^{2+} and Zn^{2+} ion removal from aqueous solutions.

MATERIALS AND METHODS OF WORK

Corn silk (KS) and corn cob (OK) was collected from the local fields near Mladenovac (Serbia). KS and OK were washed and dried. Then, collected biomaterials were milled, sieved and storage for further experiments.

Lead, copper and zinc solutions were prepared by dissolving of salts: $Pb(NO_3)_2 \cdot 3H_2O$, $Cu(NO_3)_2 \cdot 6H_2O$ and $ZnSO_4 \cdot 7H_2O$ (p.a. grade), respectively, in deionized water. Initial pH values of solutions were adjusted by adding HNO_3 and KOH solutions (0.1 M) at pH 5.0.

Morphological characteristics of KS and OK were investigated by scanning electron microscopy (SEM). The SEM micrographs are obtained using a JEOL JSM–6610LV SEM model.

Adsorption experiments were performed in batch system. In Erlenmeyer flasks were added 50 mL of metal solution and 0.05 g of KS and 0.3 g of OK. Suspensions were shaken at mechanical shaker during 120 min. At the end of time suspensions were filtered and concentrations of metal ions remaining in filtrate were measured by Atomic Adsorption Spectrophotometer (Perkin Elmer, AAnalyst 300).

The biosorption capacity of the KS and OK was calculated by following equation (1):

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

where: q – biosorption capacity ($mmol L^{-1}$), C_i – initial metal concentration in solution ($mmol L^{-1}$), C_{eq} – final metal concentration in solution ($mmol L^{-1}$), V – volume of metal solution (mL) and m – mass of the biosorbent (g).

RESULT AND DISCUSSION OF RESULTS

In order to analyse surface morphology, OK and KS were characterized by SEM analysis. SEM micrographs are shown at the Figure 1.

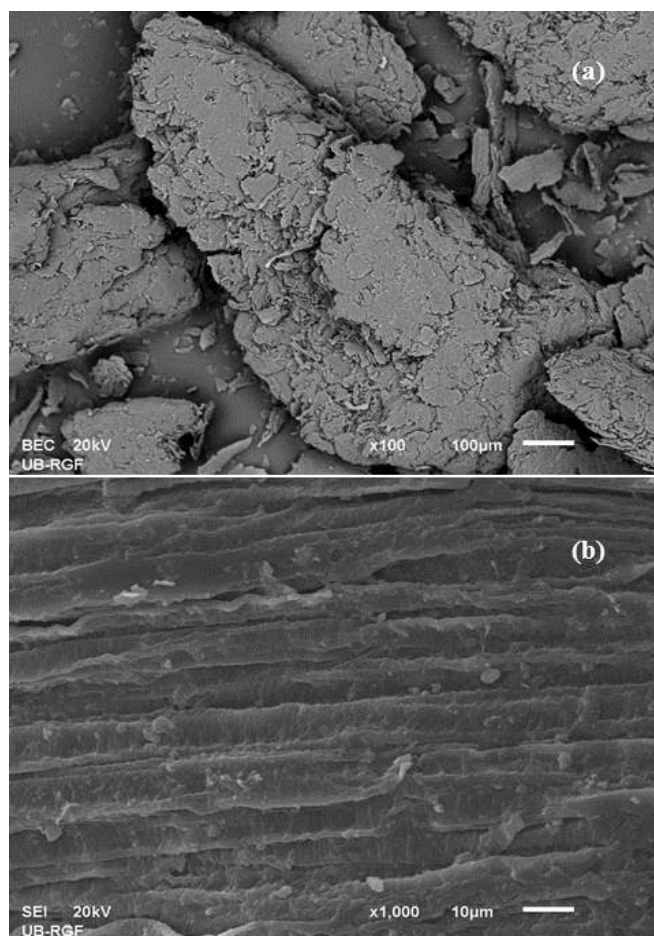


Figure 1. SEM micrographs of (a) OK and (b) KS.

As can be seen (Fig. 1 (a)) the OK has low porosity. At the OK surface are visible only micro channels. Leyva – Ramos et al., have also showed that natural corn cob is nonporous material [10]. At the other hand, KS has coarse surface (Fig. 2(b)) with a lot of channels, which might provide a better diffusion of solution through KS. These characteristic of the KS are favorable for the metal ion adsorption.

The effect of initial Pb^{2+} , Cu^{2+} and Zn^{2+} concentration on the biosorption by the KS and OK was investigated at different metal ion concentration (0.2 to 1.0 mmol L^{-1}) (Fig. 2).

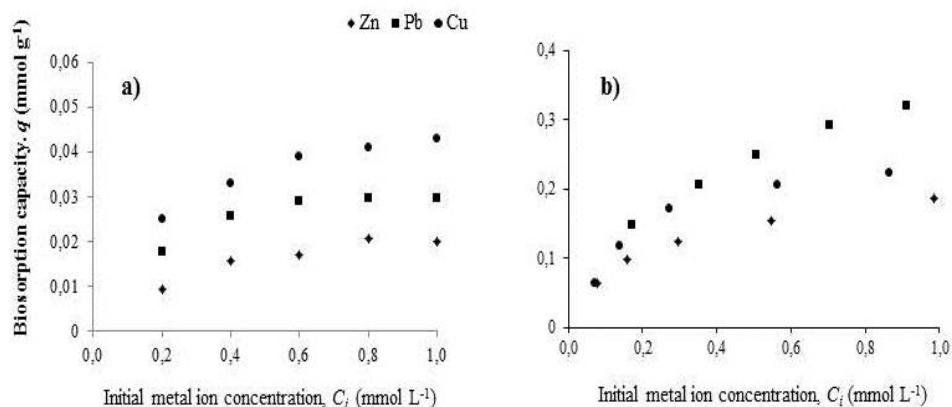


Figure 2. Biosorption capacity of Pb^{2+} , Cu^{2+} and Zn^{2+} ion on OK (a) and KS (b) as a function of initial metal ions concentration.

Isotherm studies provide information about maximum biosorption capacity of sorbent. In this study the experimental results have been correlated with Langmuir isotherm model [11] (eq. 2) and the value of maximum biosorption capacity are given at figure 3.

$$q = \frac{q_{max} K_L C_{eq}}{1 + K_L C_{eq}} \quad (2)$$

where: q_{max} – the maximum amount of metal ion adsorbed on the corn cob ($mmol\ g^{-1}$) and K_L - Langmuir constant ($L\ mmol^{-1}$).

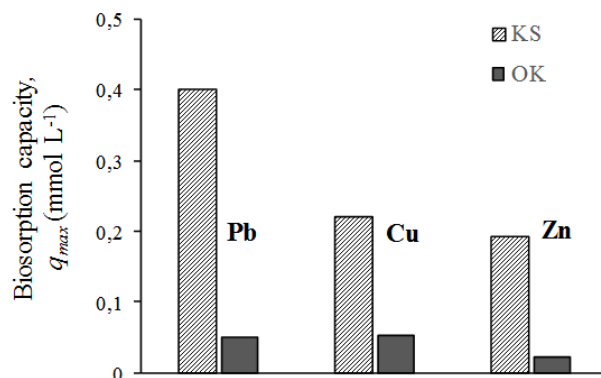


Figure 3. The biosorption capacities of KS and OK for Pb^{2+} , Cu^{2+} and Zn^{2+} ions removal from aqueous solutions.

As can be seen from figure 2, the values of biosorption capacities of KS for Pb^{2+} , Cu^{2+} and Zn^{2+} ions removal from aqueous solutions are higher than biosorption capacities of KS.

CONCLUSION

In this work the biosorption of Pb^{2+} , Cu^{2+} and Zn^{2+} ions on KS and OK was investigated. The results indicate that the corn waste materials are suitable for the investigated metal ions from aqueous solutions. The values of maximum biosorption capacities of KS for Pb^{2+} , Cu^{2+} and Zn^{2+} ions removal are higher than values of maximum biosorption capacities of OK. This indicates that KS has better adsorptive characteristics for heavy metals removal from aqueous solutions.

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