Efficiency evaluation of some agricultural waste materials for the biosorption of Cu(II) and Cr(VI) from water in a fixed-bed column

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1. Introduction – As a result of intensive anthropogenic activities, population growth and unplanned urbanization, enormous quantities of organic and inorganic pollutants are discharged into the environment every year. The primary hazardous substances of concern regarding their environmental load and health effects are heavy metals. Heavy metal pollution of aquatic ecosystems, including resources of drinking water and water intended for food processing, have been of increasing interest. Biosorption technology is a promising strategy, as it utilizes industrial and/or agricultural wastes to passively remove metals from aqueous media, and they represent efficient, cost-effective and environmentally friendly alternatives to traditional adsorbents such as activated carbon (Calero et al., 2009; Hasfalina et al., 2012; Mata et al., 2009; Thilagan et al., 2015).

2. Experimental - In this paper, the efficiency of some agricultural waste materials (sugar beet shreds, poplar wood sawdust and wheat straw) for the removal of Cu(II) and Cr(VI) from aqueous solution was evaluated. Experiments were performed in a fixed-bed column, in the down-flow mode with flow rate set to approximately 12 mL/min. The values of independent variables used for evaluating the biosorption of Cu(II) and Cr(VI) ions are given in Table 1.

Table 1	Adsorbent dosage [g]		pH of inlet solution		Concentration of inlet solution, C_0 [mg/L]	
Sugar beet shreds	Cu(II)	10	Cu(II)	4.5	Cu(II)	100
	Cr(VI)	10	Cr(VI)	2.0	Cr(VI	50
Poplar sawdust	Cu(II)	10	Cu(II)	4.5	Cu(II)	100
Wheat straw	Cu(II)	6	Cu(II)	4.5	Cu(II)	100

The consecutive aliquots of 50 to 150 mL were collected at the bottom of the column, and they were analyzed for the content of the Cu(II) or Cr(VI) (C), according to the standard methods of volumetric titrations. The column adsorption process is described by the breakthrough curve, obtained from the plot of C_t/C_0 versus time (t). The data obtained from the breakthrough curve were used to calculate the efficiency of the adsorption process *(EAP)*, as the ratio of the amount of metal ion adsorbed (q) and the amount of metal ion fed into the column (w), as follows:

$$EAP(t) = \frac{q(t)}{w(t)} \cdot 100 = \frac{\int_0^t \left(1 - \frac{C_t}{C_0}\right) dt}{t} \cdot 100$$

3. Results and Discussion - In order to calculate the adsorption efficiency, the moment when the metal ion concentration in the effluent reaches 90% of the inlet concentration was used. The obtained results showed that the most efficient metal ion removal was performed by removing Cu(II) ions using poplar wood sawdust, 69. 26%. It was followed by the copper removal using sugar beet shreds and wheat straw, 61.56% and 56%, respectively. The least efficient was removal of chromium(VI) ions by sugar beet shreds, 40.44%.

4. Conclusions - Sugar beet shreds, poplar wood sawdust and wheat straw can be successfully used as inexpensive, effective and abundant adsorbent for heavy metal removal from water intended for human direct or indirect consumption.

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5. References

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