ÁREA TEMÁTICA: Prevenção de poluição em recursos hídricos; Biomassas

PERFORMANCE EVALUATION OF AGROINDUSTRIAL WASTE BIOSORBENT FOR BISPHENOL-A REMOVAL IN AQUEOUS SOLUTION

Arthur Hoffmann dos Santos[1] (arthurhoffs@hotmail.com), Samuel Santos[2] (e-mail), Diana Fernanda Caicedo[1], Michael dos Santos[1], Luís Antonio Mazzini-Fontoura[2] (e-mail), Irineu Brum[3] (e-mail)

1 Mining, Metallurgical and Materials Engineering Graduate Program, School of Engineering, Universidade Federal do Rio Grande do Sul, Brazil

2 Product Research and Development Center, School of Industrial Chemistry, ULBRA, Brazil

3 Metallurgy Department, School of Engineering, Universidade Federal do Rio Grande do Sul, Brazil

ABSTRACT

Abstract: This study aims the evaluation of the use of peanut shell (PS) biomass from an agroindustrial waste as a low cost alternative adsorbent for the removal of bisphenol-A (BPA) from aqueous solutions. The effect of operating parameters such as adsorbent granulometry and adsorbent dosage were studied on a laboratory scale and the removal analysis was determined by UV-Visible spectrophotometry. The optimum conditions for BPA removal was obtained in granulometry above 60 mesh using 1.5 g of adsorbent. The result of maximum removal efficiency in these conditions was 83.6%. The data obtained with this study shows that the PS adsorbent was effective for BPA removal in aqueous solutions.

Keywords: Water quality; Biosorbents; Biomass; Bisphenol-A; Waste management.

1. INTRODUCTION

Water is a commodity of great importance for the maintenance of ecosystems and public health, and this must be conserved in a great quality. In surface waters, there is a wide presence of organic and inorganic contaminants, mainly from effluents and industrial and agricultural sources [1]. In recent decades, the occurrence of micropollutants, also referred as emerging contaminants, has become a worldwide issue and relevance. These contaminants are present in trace concentrations varying between ng L^{-1} and µg L^{-1}, constituting a wide and growing variety of pollutants including pharmaceuticals and personal care products, steroid hormones, industrial chemicals and agrochemicals, among others [2,3].

Of these, the most important are endocrine disruptors chemicals (EDC) which are substances and compounds capable of deregulating and affecting endocrine system functions [3]. The plasticizer bisphenol-A (BPA) is one of the main studied EDC, and is widely used industrially and commercially, being present in interior coating of canned food products, dental sealants, electronic equipment, thermal papers, and polycarbonate plastics. This compound has the ability to bind and recognize the cellular estrogen receptor, which can cause environmental impacts and damages to public health such as endocrine disorders, reproductive organs, infertility and obesity [4,5]. Several studies have presented the occurrence of BPA in environmental matrices such as air, soil, sediments, effluent treatment plants and activated sludge from these stations [4]. Several treatment techniques to the EDC removal in aquatic matrices can be used, such as advanced oxidative processes, biological processes, membrane separation and adsorption [6]. Adsorption is a simple, efficient and widely used technique for removal of these contaminants. Zeolites, activated carbon, clays and vegetal agroindustrial residues are some common adsorbents. Biosorbents are easily found in nature and have several advantages such as low cost, robustness, ease of application and use, including the high efficiency in the removal of contaminants in aqueous solutions [7,8]. Peanut shells are agroindustrial residues that can be used as adsorbent [8]. In Brazil, peanut (*Arachis hypogaea L.*) production in 2016/2017 was higher than 450 thousand tons [9]. In this sense, the peanut shell use as bioadsorbent, besides providing value to the waste, can be an appropriate way of disposing it. Considering the related BPA impacts to the environment and public health, this paper evaluated the efficiency of BPA removal in aqueous solution through adsorption process, using peanut shell biomass as adsorbent.

2. OBJECTIVE

The effect of peanut shell biomass granulometry and dosage on the BPA adsorption were the variables studied.

3. METODOLOGY

3.1. Adsorbent

The waste of peanut shells used in this study was collected from a peanut and glucose processing company, located in the municipality of Santo Antônio da Patrulha, Brazil. The waste was firstly washed several times with water to remove dirt and dried in the oven at 50 ºC for 24 h. Twigs and straws were manually separated in order to work only with the peanut shells (PS). After that, the PS were grounded and sieved to obtain particle size in the bands: above 42 mesh (3); between 42 mesh and 60 mesh (2), and below 60 mesh (1).

3.2. Adsorbate solution

For this study, BPA was obtained from Sigma-Adrich and used without further purification. BPA stock solutions were prepared by dissolving BPA in methanol (J. T. Backer), and further dilution with distilled water to the concentration of 1,250 g L^{-1}. Analytical solutions were obtained by dilution.

3.3. Adsorption experiments

The adsorbent was added to 100 ml of a 12.5 mg L^{-1} BPA aqueous solution A (solution A1). In parallel, the same mass is added to the same volume of pure water (solution A2). The blends are shaken for 1 hour on a Wagner type stirrer in 200 ml screw cap vials and then filtered.
The experiments were performed according to Doelert's two-variable experimental design, with the combinations presented in Table 1.

Table 1. Adsorption experiments: mass (m) and particle size (G) of the adsorbent.

Point	m (g)	G
1.1	0.9	2
1.2	0.9	2
1.3	0.9	2
2	0.3	2
3	0.6	3
4	1.2	3
5	1.5	2
6	1.2	1
7	0.6	1

3.4. Removal analysis

Concentration of BPA in the aqueous solution (solution 1) after adsorption was determined by molecular absorption spectrophotometry in UV-Visible by external standardization and calibration by analytical curve. Reference solutions were produced in experiments identical to adsorption in pure water without BPA (solution 2). Absorbance readings from solution 1 were performed at 275 nm in triplicate in 1 cm quartz cuvettes using solution 2 as reference. In the construction of the analytical curve, the absorbances of the analytical solutions were also measured in triplicate, but using distilled water as reference.

4. RESULTS AND DISCUSSIONS

The effects of adsorbent granulometry level and amount on the BPA removal from aqueous solutions are summarized on the Table 1.

Table 2: Adsorption efficiency on the of BPA removal (%): the effect of granulometry level (G) and mass of adsorbent (m).

	m (g)				
G	0.3	0.6	0.9	1.2	1.5
3		34.9		74.2	
2	17.7		64.3		83.6
1		63.7		76.2	

Adsorptions experiments were performed in 1 h period. Although the short period, removals were observed as high as 84 %. As expected, the smaller the particle size (granulometry size 1), the higher the efficiency. By its turn, the adsorption was increased when a higher amount of adsorbent was used [10].

5. CONCLUSION

Powdered peanuts shells were evaluated as adsorbent for BPA removing from aqueous solutions. Experiments have demonstrated the high ability of peanuts shells as bioadsorbent, and BPA removal as high as 84 % were observed. As expected, lower granulometry and higher amounts of the adsorbent increased the contaminant removal from aqueous solution.

REFERÊNCES

[1]PETRIE, B., BARDEN, R., KASPRZYZK-HORDERN, B. **A review on emerging contaminants in wastewaters and the environment: Current knowledge, understudied areas and recommendations for future monitoring.** Water Research. April 2015, Vol. 72, Pages 3-27.
[2]LUO, Y., GUO, W., NGO, H. N., NGHIEM, L.D., HAI, F.I., ZHANG, J., LIANG, S., WANG, X. C. **A review on the occurrence of micropollutants in the aquatic environment and their fate and removal during wastewater treatment.** Science of the Total Environment. 2014, Vols. 473-474, p. 619–641.
[3]NAIDU, R., ESPANA, V. A. A., LIU, Y., JIT, J. **Emerging contaminants in the environment: Risk-based analysis for better management.** Chemosphere. 154, 2016, Vols. 350-357.
[4]YU, X., XUE, J., YAO, H., WU, Q., VENKATESAN, A. K., HALDEN, R. U., KANNAN, K. **Occurrence and estrogenic potency of eight bisphenol analogs in sewage sludge from the U.S. EPA targeted national sewage sludge survey.** Journal of Hazardous Materials. 299, 2015, Vols. 733–739.
[5]NUNES, J. A. C. **Efeitos da exposição ao bisfenol A na função testicular e reprodutiva** [Dissertação]. Covilhã : Universidade da Beira Interior, 2014.
[6]RODRIGUEZ-NARVAEZ, O. M., PERALTA-HERNANDEZ, J. M., GOONETILLEKE, A., BANDALA, E. R. **Treatment technologies for emerging contaminants in water: A review.** Chemical Engineering Journal. 323, 2017, Vols. 361–380.
[7]HARTONO, M. R., ASSAF, A., THOUAND, G., KUSHMARO, A., CHEN, X., MARKS, R. S. **Use of Bamboo Powder Waste for Removal of Bisphenol A.** Water, Air, & Soil Pollution. 226: 382, 2015.
[8]BOUMCHITA, S., LAHRICHI, A., BENJELLOUN, Y., LAIRINI, S., NENOV, V., ZERROUQ, F. **Application of Peanut shell as a low-cost adsorbent for the removal of anionic dye from aqueous solutions.** Journal of Materials and Environmental Sciences. V. 8, Issue , Page 2353-2364, 2017.
[9]COMPANHIA NACIONAL DE ABASTECIMENTO (CONAB). **Acompanhamento da Safra Brasileira de Grãos. V.5 – Safra 2017/18 – N.7 – Sétimo levantamento.** Abril, 2018. Avaiable in:

https://www.conab.gov.br/index.php/component/k2/item/download/16780_e7a4a52ee1db76aa1a8cfda9b2343c48. Accessed in: 11 de abril de 2018.

[10]NASCIMENTO, R. F., LIMA, A. C. A., VIDAL, C. B., MELO, D. Q., RAULINO, G. S. C. **Adsorção: Aspectos teóricos e aplicações ambientais.** Imprensa Universitária. Fortaleza, 2014.