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Biochar from olive pits for adsorption of pollutants in wastewater

Silveira, F. M. *; Silva, M. J. *; Blanc, G. F. C.*

* SENAI Institute of Environmental and Chemical Technology - Rua General Potiguara, 201, CIC, CEP: 81050-500, Curitiba - Paraná, Brazil.

Highlights:

- Use of biochar for wastewater treatment.
- Production of biochar from agroindustry waste from the olive sector.
- Adsorption of wastewater contaminants.

Keywords: Biochar; wastewater; waste.

INTRODUCTION

Faced with the environmental emergency in which we live, the need for studies on the use of products that enable the remediation of environmental damage becomes increasing. Agroindustry is an expanding sector and, like other sectors, needs to align its activities with its environmental commitment in the face of the emerging emergency. The olive industry is an example, which brings solid and liquid waste into its process, such as pits, olive pomace, as well as washing water and other by-products, which must be treated or reused to prevent environmental damage from its bad direction.

The large generation of olive pits in the agro-industrial process makes this renewable and low-cost residue available to produce biochar. Olive pits are woody (woody endocarp) and ligninocellulosic (porous) residues, which enable the production of biochar with a high surface area (CAMBUIM, 2009).

Studies indicate that biochar has a high number of sites for surface adsorption and cation exchange and a highly developed porous structure (ZIELIŃSKA & OLESZ ZUK, 2015). Thus, signaling as a good adsorbent material for heavy metals, nutrients, organic compounds, among others. Even after the activation process, biochar is more cost-effective than activated carbon and can achieve higher or similar efficiency, as well as being an environmentally friendly carbonaceous material (SHI et al, 2020).

According to Spath et al. (2021), biochar from olive waste had a removal efficiency of 62% for analgesics, anti-inflammatories, antiretrovirals and antibiotics and ciprofloxac found in residential wastewater. Highlighting the potential of biochar as an adsorbent for different types of pollutants.

The use of biochar to treat wastewater, while disposing of industrial waste, benefits the environment and the entire production chain, towards the circular economy.

METHODOLOGY

The seeds were collected in a company in the oil sector, which has an annual production of 22000 tons. The kernels were previously dried in an oven at ±105ºC for 24 hours and then ground in a disc mill and passed through a 0.3mm sieve for physical/chemical analysis of its composition

For the process of carbonization and activation of biochar, bench tests were carried out to define the ideal temperature and time for pyrolysis in a muffle furnace, with temperatures ranging from 250 to 600ºC, in addition to the physical and chemical forms of activation. For physical activation, the kernels were subjected to pyrolysis in a nitrogen gas atmosphere, with a flow rate of 180ml/min for 1 hour. The determination of the optimal pyrolysis temperature of biochar is essential to achieve good results in the adsorption of pollutants. For chemical activation, the kernels were impregnated with phosphoric acid H_3PO_4 and then pyrolyzed in an inert atmosphere.

For the adsorption analyses, assays were carried out with methylene blue dye, in varying concentrations. These tests were carried out in a thermomagnetic stirrer for 20 minutes, with heating of approximately 25ºC. From this process, qualitative and quantitative analyses were made by means of a UV/VIS spectrophotometer.

From the data obtained, adsorption tests of surfactants contained in the effluent of the oil company and in a liquid sample were carried out, with the following heavy metals: arsenic, cadmium, total chromium, lead and zinc, to evaluate the adsorption effectiveness of biochar produced from olive pits.

RESULTS AND CONCLUSIONS

The qualitative adsorption assays with biochar were satisfactory, with almost total removal of methylene blue dye.

From concentrations 2; 3; 3,5; 4; 4.5 mg/L of methylene blue were obtained by spectrophotometry, the absorbance data to obtain the equation of the line for the concentrations analyzed.

The relationship between the dependent variable and the independent variable is given by the equation:

$$y = 0.1945x+0.0893 \qquad (R^2 = 0.9935)$$

Os resultados das curvas de adsorção com o adsorvente produzido, indicaram qual eram as melhores concentrações para os ensaios de adsorção Figura 1 e Figura 2.

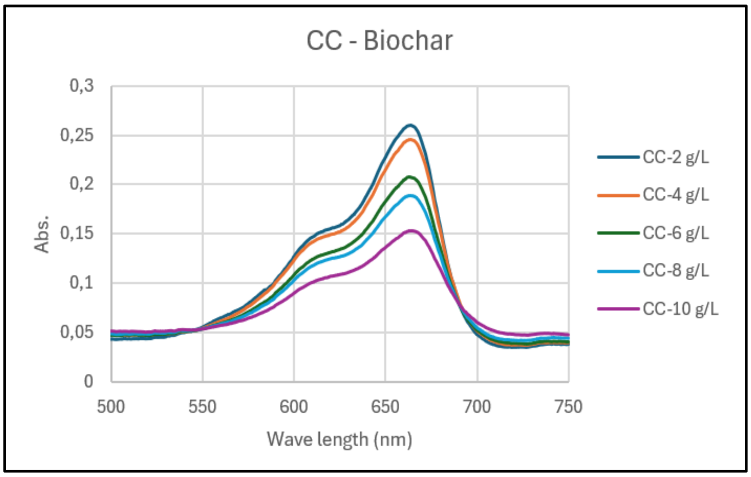

Figura 1. Absorbance with different concentrations of biochar

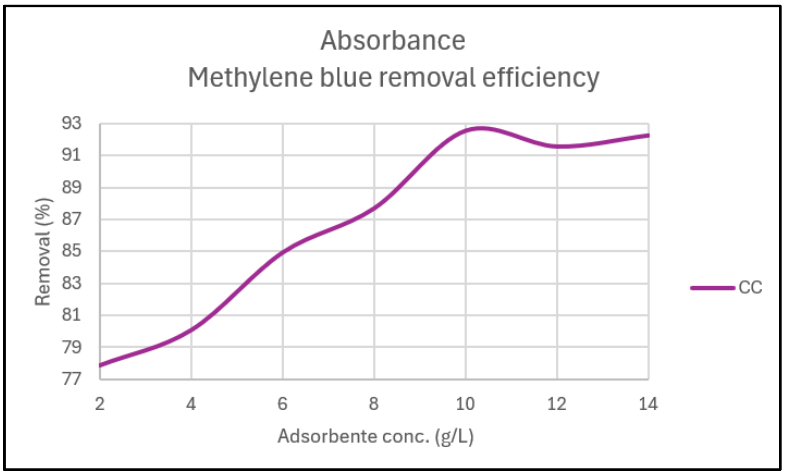

Figura 2. Methylene blue removal efficiency

For the adsorption of the surfactants contained in the company's effluent, with biochar at a concentration of 6g/L, a removal of 18% was obtained. For the adsorption of heavy metals, the removals ranged from 33 to 46% with a concentration of 4g/L of biochar as shown in the Table 1.

Parameters	Initial concentration (mg/L)	Final concentration (mg/L)	Removal (%)
Surfactants	3,71	3,04	18,00
Arsenio	2,12	1,40	33,96
Cadmium	2,16	1,32	38,89
Total Chrome	2,22	1,31	40,99
Lead	1,80	0,97	46,11
Zinc	2,07	1,34	35,27

Table 1. Adsorption of surfactants and heavy metals with biochar.

According to the results observed, it is understood that the production of biochar from olive pits can bring, in addition to environmental benefits, cheaper and more abundant solutions, enabling the reuse of a waste followed by its use as a filtering element for wastewater from the industrial process, meeting sustainability and bioeconomy requirements.

For further studies, it is suggested the economic analysis of the use of biochar as a filtering medium, in addition to the study of the disposal of biochar after the adsorption of pollutants.

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