RESUMO - BIOTECNOLOGIA AMBIENTAL E REMEDIAÇÃO

REUSE OF EFFLUENT DECONTAMINANT BASED ON FORAGE PALM (OPUNTIA FICUS-INDICA) FOR ENERGY APPLICATIONS

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The low treatment rates of contaminated water resources (<30%) in developing and least developed countries is a problem that requires safe and low-cost emergency remediation, as the UN warned in 2017. For this reason, there is growing interest in the use of biodegradable biopolymers with adsorbent properties. Opuntia ficus-indica, commonly known as forage palm, is an abundant cactus in the semi-arid northeast of Brazil (~500,000 hectares) that has attracted attention for being rich in carbohydrates that favour effluent decontamination mechanisms. The literature has explored its ability to retain toxic metals, which are commonly discharged by the textile and battery industries. However, this solution poses other challenges: "how to deal with this contaminated natural waste?". In this paper we present an alternative way of reusing palm extract used in the decontamination of water contaminated with toxic metals: the production of active material (carbon) for the construction of electrodes for energy storages, such as supercapacitors. To do this, the dried palm extract was stirred for two hours at a rate of 1 mg/mL in simulated effluent containing 1 mmol/L of Pb2+, Cd2+ and Ni2+ in 0.1 mol/L HCl. The

contaminated extract was dried and pyrolysed for 2 hours in an inert atmosphere of argon at a temperature of 500 °C and a ramp of 10 °C/min. The material was then pressed into a cavity electrode for electrochemical measurements in 1 mol/L H3PO4. The methodology was also replicated for the pure extract. In the infrared analysis (ATR-FTIR), characteristic palm bands were observed, related to its high functionalisation. In the extract without contamination (EWC), the band between 2980-3700 cm-1 was identified, from the stretching of the -OH and -NH groups present in the alcohols, carboxylic acids, amines and retained moisture. At 1613 cm-1, there was stretching of the unsaturated carbon structure, as well as other bands in the 1800-800 cm-1 region of the oxygen and nitrogen groups. Compared to the spectrum of the contaminated extract (EC), the N-O and C-O-H (carboxyl) bands were suppressed, which can be correlated with the intermolecular interaction of these groups with the metal ions. After pyrolysis of EWC (PEWC) and EC (PEC), an intense band at 1406 cm-1 indicates that amorphous carbon has been obtained. Raman analysis confirmed this transformation, with the ratio of the areas of the characteristic D and G bands (AD/AG), which indicates the degree of structural disorder, being 4.6 for PEWC and 2.0 for PEC. The lower degree of disorder in PEC may be related to the decontamination method adopted. Electron microscopy with elemental mapping (SEM-EDS) analyses revealed a porous morphology with the presence of calcite crystals, also detected by Raman. A Pb content of around 2 at% was also identified. In the electrochemical analysis, a signal was observed, reaching a current in the µA range, indicating that the carbon obtained had electrical conductivity. The prospects are to activate the carbon and exploit the signals from the functional groups, as well as exploring the effects of the presence of metal ions in the PEC. In this way, we can obtain devices with higher charge storage capacities.

Palavras-chave: forage palm; effluents; toxic metals; supercapacitors; carbon.