Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 200 (2017) 399–407

Procedia Engineering

www.elsevier.com/locate/procedia

3rd International Conference on Natural Fibers: Advanced Materials for a Greener World, ICNF 2017, 21-23 June 2017, Braga, Portugal

VALORISATION OF NATURAL FIBRES FROM AFRICAN BAOBAB WASTES BY THE PRODUCTION OF ACTIVATED CARBONS FOR ADSORPTION OF DIURON

Emílio Tchikuala[a,b,]*, Paulo Mourão[a], João Nabais[a]

[a]Centro de Química de Évora, Instituto de Investigação e Formação Avançada, Departamento de Química, Escola de Ciências e Tecnologia, Universidade de Évora, Rua Romão Ramalho nº59, 7000-671 Évora, Portugal

[b]Departamento de Ciências Exactas, Universidade Katyavala Bwila, Rua José Falcão nº67, 1725 Benguela, Angola

Abstract

In this work we report the use of a natural fibrous biomass, the African Baobab, as precursor to produce activated carbons tailored for the removal of a pollutant frequently found in water streams, the herbicide Diuron. The precursors used were Baobab wastes, namely bark, wood and seeds, collected in Angola. The activated carbons produced by physical activation with carbon dioxide showed an interesting porosity with apparent surface area and pore volume, up to $2130m^2g^{-1}$ and $0.99cm^3g^{-1}$, respectively. All the activated adsorbents are of microporous nature, with mean pore width between 0.69 and 1.94nm. Selected samples were tested for the adsorption of Diuron from liquid-phase. The maximum adsorption capacity reached $400mgg^{-1}$ for sample BS-62. This work shows the suitability of using Baobab wastes to produce activated carbons, which can be considered a new route to the valorization of its wastes, with good properties for the adsorption of Diuron.

Peer-review under responsibility of the scientific committee of the 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World.

Keywords: African Baobab; Fibrous biomass; Activated carbon; Adsorption; Diuron;

1. Introduction

The scientific name for Baobab is *Adansonia Digitata*, as a tribute to the French Explorer and botanist, Michel Adanson (1727-1806), who observed a specimen in 1749 on the island of Sor, Senegal. The African Baobab can reach 30m high and 7m diameter with a lifespan of several hundred years. This tree in also known as the African Tree of Life because during the rainy season it absorbs and stores water, up to $7m^3$, in the trunk with the production of a rich fruit in the dry season. The fruits, flowers, leaves, shoots, roots of seedlings and even the tree roots are

- Corresponding author. Tel.: +351 266 745 311.
- *E-mail address:* tchikuala@hotmail.com

1877-7058 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the scientific committee of the 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World
10.1016/j.proeng.2017.07.056

edible. The inner bark furnishes a fiber that can be made into ropes, twisted into strings for musical instruments, and woven into cloth. The fiber is so strong as to give rise to a common Swahili saying, “as secure as an elephant bound with a baobab rope”. This fibrous structure of Baobab is very useful for many applications amongst which we can find medicinal, nutritional, clothing, protection, among others [1, 2]. Nevertheless, in the adsorption field studies or applications are practically non-existent, with only few examples of biosorbents [3-5], and one or two references to the production of activated carbons (ACs) [6, 7].

ACs have been one of the most important materials used all over the world for centuries and they are nowadays one of the most relevant adsorbent materials in our society and in diverse areas of human activity. ACs are used in a wide range of applications performed in gas and liquid medium that include, among others, medicinal uses, gas storage, pollutants removal, gas separations and odours removal [8-11].

The lignocellulosic (LC) materials (comprising wood, coconut shells, peat, agricultural residues, and other plant substances) are the single largest source of precursors for the industrially manufactured ACs with an annual worldwide production of over 175,000 tons/year. The composition of biomass is rather complex, but it is generally accepted that the LC materials are basically composed of three components, namely, polysaccharides (cellulose and hemicellulose), lignin and extraneous matter, namely extractives and ash [12]. In some cases, the fibrous nature of biomass is significant, which opens the door to new applications.

The originality of this work is the use of a novel precursor, namely the bark, wood and seed from the Baobab, containing a high content of natural fibres, in the production of ACs and its application to remove a herbicide with a broad use in agriculture, Diuron (3-(3 4-dichlorophenyl)-1,1-dimethylurea), from aqueous solutions. To the best of our knowledge the use of Baobab for the production of activated carbon (AC) by activation with carbon dioxide was never reported before. Another relevant aspect of the work is the valorisation of agriculture wastes to produce an added value material like ACs. It is noteworthy to mention that the Baobab used in this work was collected after its use by the local population in Benguela Region (Angola).

Angola, like many developing countries, has seen an expansion of agriculture that has lead to the introduction of emerging pollutants into the water streams and soil by the extensive use of pesticides and herbicides, like Diuron that has a significant use in Angola. Concerns regarding Diuron have been frequently reported worldwide. For example, in France, Diuron was found to be one of the most used products commonly found as a contaminant [13]. In Germany, recurring detection of Diuron residues in drinking water supplies has led to prohibition of Diuron usage in confined areas where excess water can flow into drainage pipes and sewer [14]. Diuron is classified as a potential human carcinogen by USEPA [15] and considered as a highly toxic, persistent priority substance by the European Union (EU) [16].

Nomenclature

BB	Baobab Bark
BW	Baobab Wood
BS	Baobab Seed
A_{BET} (m^2/g)	Apparent surface area
A_S (m^2/g)	External area determined by the alpha-s method
V_S (cm^3/g)	Pore volume determined by the alpha-s method
V_0 (cm^3/g)	Micropore volume determined by the DR method
L_0 (nm)	Mean pore size determined by the DR method
pzc	Point of zero charge
ACs	Activated carbons
XRD	X-ray diffraction
BET	Brunauer-Emmtt-Teller
α_S	Alpha-S
DR	Dubinin-Radushkevich
FTIR	Fourier Transform Infrared