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# A Simple Adsorption Test of Organic Dyes and Heavy Metals on Natural Plant

**A. Ait sidi mou[1]*, M. Daoudi[2], M. E. Ghanjaoui[1], B. El Gamany[3], R. Ait belal[4]**

[1]Laboratory of Physical Chemistry and Bioorganic Chemistry, Faculty of Sciences and Techniques of Mohammedia (FSTM), Morocco
[2]Departement of physics, Faculty of Sciences and Techniques settat, Morocco
[3]Laboratory of Materials, Electrochemistry and Environment, Faculty of Sciences Ibn Tofail University of Kenitra, Morocco
[4]Science Engineer Laboratory for Energy (LabSIPE), National School of Applied Sciences, Chouaïb Doukkali University, El Jadida, Mo-rocco
*Corresponding author E-mail: aitsidimou_aziz@yahoo.fr

**Abstract** The adsorption of pollutant is currently cited by several studies. This work examines the use of natural takaout plant for the adsorption of organic dyes and heavy metals from aqueous solution. The characterization of specific surface and pore size distribution of this plant was studied by scanning electron microscopy. The images show that in fact, this material has a large porosity and a specific surface important. The adsorption of methyl orange and methylene blue was studied by use of an amount of takaout powder and the adsorption of copper and mercury was verified by the electrochemical method. The results, showed that the takaout adsorb on cationic medium, while the methylene blue was eliminated until 96.44%. The results, showing that the takaout is an important material for elimination of methylene blue, copper and mercury from water aqueous solution.

**Keywords** Adsorption, heavy metals, organic dyes, takaout plant

## Introduction

In a country full of rich flora in a very important manner such as Morocco, the valorization of the sector of natural plants has become indispensable. So, initiatives and actions have been taken to give the added value to these plants and integrate them into a sustainable development and harmonious.

Organic dyes are compounds used in many industrial sectors such as dyes for leather, paper, textiles, wood, silk, plastics, cosmetic industries, food and pharmaceutical industries [1]. The effluents colored as methylene blue and methyl orange caused an aesthetic and sanitary problem because a large number of dyes are toxic as the hazardous organic com-pounds [2-5]. Organic dyes are the persistent organic pollutants. Their elimination certainly needs appropriate methods [6]. On other hand, heavy metals are defined as those metals and metalloids generally considered to be of sufficient distribution and abundance as to be in some way environmentally or biologically significant as a toxic substance. These include metals such as lead (Pb), chromium (Cr), copper (Cu), cadmium (Cd), nickel (Ni), silver (Ag), mercury (Hg), and zinc (Zn) [7].

Among the processes for wastewater treatment of organic dyes and heavy metals, adsorption has proven to be the most effective [8, 9]. Activated carbon is one of the most widely used as adsorbents [10-16].
However, the cost of producing activated carbon is very expensive [17]. For this reason, several works are carried out by different researchers preferred the preparation of adsorbent materials from renewable natural resources because of its high efficiency and cost effectiveness [18-21].
Moreover, the elimination of the organic dyes and the metal in general, copper in particular, in given environment is onerous [22].
The main idea of our work was to assess the adsorption capacity of takaout plant against two organic dyes, methyl orange with anionic character and methylene blue with cationic character and two heavy metals such as copper and mercury.

## Materials and Methods

### Dyes and Heavy Metals Studied

The organic dyes studied are methyl orange with anionic character and methylene blue with cationic character and the heavy metals are copper and mercury. All chemicals were of analytical reagent grade and all solutions were prepared with distilled water.

### Adsorbent Material

Takaout plant (Tamarixaphylla) was obtained from the village of ighremazogar 10 Km from province of agdaz, it is located in the Souss-Massa-Draa region, about 65 km south of Ouarzazate and 92 km north of Zagora**.**

### Adsorption tests and analytical methods

Takaout powder, crushed using a mortar until a fine particle was obtained. An amount of takaout (1 g) is placed in each solution of the same concentration (25 ppm), followed by stirring for 3 h, Then decanting overnight (17 h), and finally the mixture was centrifuged to remove the suspended matter in the liquid. The residual concentration of each of the dyes was determined by ultraviolet spectroscopy (UV) using an atiunicam UV2 model. The residual content of dye was determined by interpolation using calibration curves previously established.
The second method based on the voltammetry, which a specific potential is applied to a working electrode as a function of time and the current, while electrode reactions at electrode-solution interfaces can be interpreted. Carbon paste electrode (4 mm diameter) served as the working electrode, a platinum plate as counter electrode, and saturated electrode calomel (SEC) as reference electrode.
The electrode was placed in the measurement cell containing a selected concentration of mercury in 0.1 M acetate buffer and of copper CuSO4 in 0.1 M HCl. An initial potential of -0.9 V for mercury and of -0.6 V for copper were applied for 120 s. Following the preconcentration step, the rotation of the electrode was stopped and the solution was left to equilibrate for 10 s. The electrode potential is stepped reversibly between -0.2 V to 0.3 V for mercury and –0.6 V to 0.4 V for copper at 50 mV $s^{-1}$ using square wave voltammetry.

## Results & Discussion

### Adsorbent Characterization

Scanning electron microscopy (SEM) is a microscopy technique capable of producing high-resolution images of the surface of a sample based essentially on electron-matter interactions. Figure 1 shows the images of the plant takaout obtained by scanning electron microscopy. As it can be seen, the presence of macropores approximately the same size, and a well-defined and homogeneous distribution due to large porosity and a specific surface of material.
The different sizes present in takaout are minimum pore: 4.2 µm; mean pore: 22.43 µm; maximum pore: 83.3 µm.

The takaout has a large specific surface and present a high potential for adsorption. In addition, the pore size distribution (4-83 µm) was found important and facilities the adsorption process. As we know the surface area increases by the decreases of particle size.

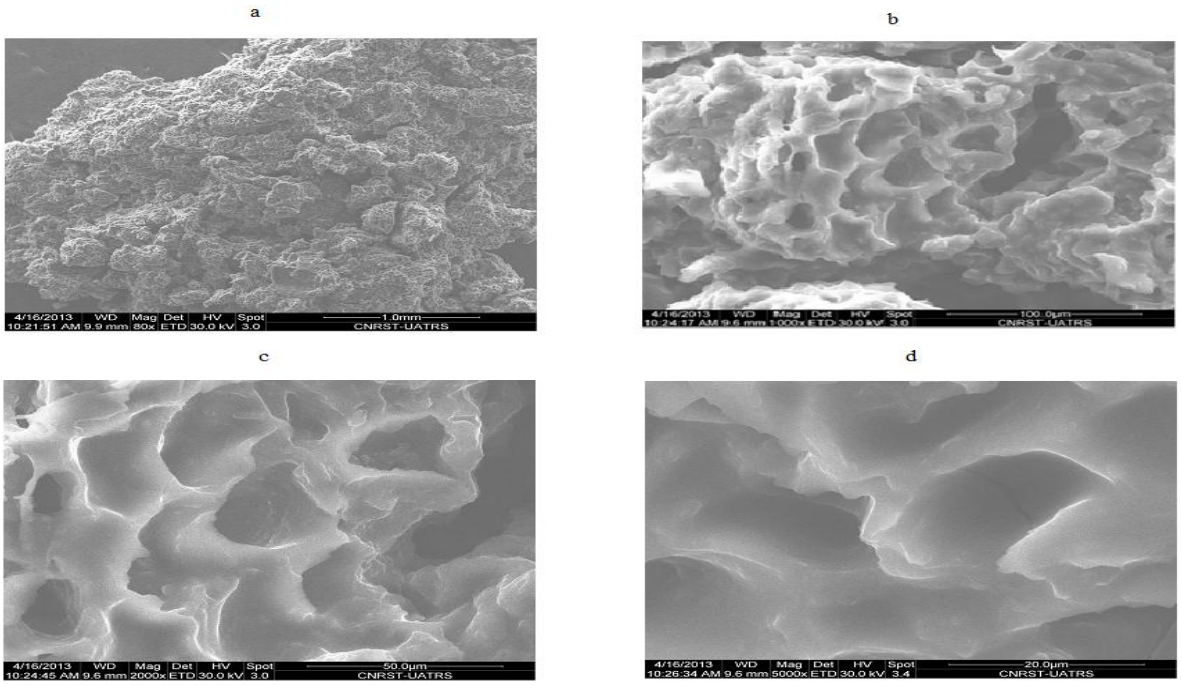


*Figure 1: Scanning electron microscopy of plant takaout; a: 1 mm (80x), b: 100µm, c: 50 µm, d: 20 µm.*

**Adsorption of Organic Dyes**

The adsorption capacity is mainly due to the specific surface area of the adsorbent. This facilitates the accessibility of a large number of free sites of support for molecules [20]. In fact, the adsorption yield is all the greater when the particles of the adsorbent are finer [22]. It can be seen in figure 2, that the takaout adsorbs in a cationic medium (methylene blue) almost 96.44%, with a change in color.

The highest adsorption percentage 96.44% is mainly due to availability of a large number of free sites. The adsorption capacity of adsorbent can be explained by the diffusion phenomena of matter that adsorb substances onto its surface with the help of intermolecular forces.

*Figure 2: Adsorption test in methylene blue and methyl orange after adsorption*

**Adsorption of Heavy Metals**

The carbon paste electrode modified with takaout was found to have high affinity towards mercury and copper. The proposed method is simple, sensitive, highly selective, applicable for the determination of $Hg^{2+}$ and $Cu^{2+}$. The mechanism is based on the formation of ligands between takaout and the metal, which the metal was fixed at the surface of the electrode. Figure 3A (b) shows an anodic peak of mercury recorded at 0.12 V. Figure 3B (b) shows an anodic peak of copper (II) at 0.053V. which can prove the results obtained above, which takaout adsorbs in a cationic medium as the methylene blue, that in fact this plant has adsorption properties.

The difference observed of currents, indicate that the takaout play an important role in accumulation of mercury and copper process on electrode surface and significantly increase of sensitivity for metals determination. Current value increases due to greater number of sites available for adsorption of mercury and copper at the electrode surface. The influence of other metal ions, which can potentially introduce some competition with the ions of mercury (II) at the sites of complexation for the extract of takaout. When the metal ion specifically adsorbed on the electrode surface, then solvated molecules reside around the metal ions instead of the interface. The influence of metal ions, which can compete for complexation at binding sites on the takaout and form a stable complex.

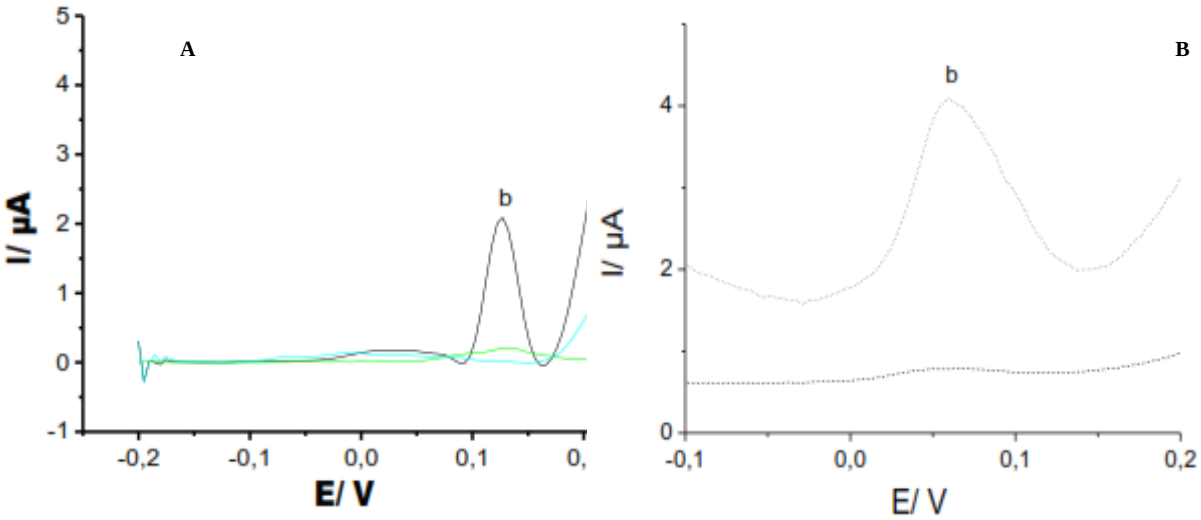


*Figure 3: Adsorption of metals on electrode surface: A. takaout-mercury and B. takaout-copper.*

**Conclusion**

In this study, the adsorption capacity of takaout plant was tested upon organic dyes (methyl orange with anionic character and methylene blue with cationic character) and heavy metals (copper and mercury). The proposed material was found to have high adsorption capacity to remove methylene blue, copper and mercury from aqueous solutions. The results mainly explained by the aromatic amino groups compound present in plant, which is the responsible of adsorption process in cationic character solutions. In the future, a phytochemical study will be carried out for identification of the plant takaout.

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