Removal of textile dyes with carbon produced from industrial food waste

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Nowadays, the waste recycling is a key factor to the circular economy. The municipal solid waste is mainly composed by food waste which is a topic of growing interest. The idea of using these wastes to be environmental decontamination agents is also a concept that has been developed. At the same time, the contamination of aquatic environments by coloured agents is a problem that continues to be present in the public discussion, especially when it comes from textile industries. One of the classic methods to remove coloured compounds from industrial wastewater is the use of adsorbent materials, with activated carbon being the most used material.

Combining the two issues, waste and wastewater treatment, have emerged in recent years several studies concerning the application of various waste types to produce adsorbent materials and more specifically carbons.

The results present in the literature demonstrates that this approach has been thoroughly tested and applied in numerous types of food waste, usually named low-cost adsorbents (De Gisi *et al*, 2016, Gupta and Suhas, 2009, Anastopoulos and Kyzas, 2014). In the Table 1 several studies are presented together with information on the efficiency expressed by the adsorbed amount in mg of dye per gram of adsorbent, q_m.

Table 1. Adsorption of dye with adsorbents produced with waste.

Adsorbents	Dye	q_m (mg/g)	References
Orange peel carbon	Methylene blue	7.3 – 18.9	Khalfaoui *et al*, 2014
Banana peel	Methylene blue	111.11	Moubarak *et al*, 2014
Banana peel	Basic Blue 9	20.8	Annadurai *et al*, 2002
Walnut shell carbon	Basic Blue 9	3.53	Aygun *et al*, 2003
Vegetable waste carbon	Anionic and cationic textile	131.6 - 1000	Peláez-Cid *et al*, 2016
Orange peel carbon	Basic Blue 9	1	Fernandez *et al*, 2014

The adsorption efficiency of the produced carbons depends on multiple aspects, not only of the carbon source used, but also of the methodology used in their production. Aspects of sample pre-processing which includes steps such as washing, drying and sifting may prove to be critical. An example is the adjustment of the samples granulometry that will be carbonized. The carbonization step is of extreme importance, at the practical level the temperatures can be varied between 400 and 900 ° C or using other methods like microwaves. Also, the surface chemistry of the carbons affects its effectiveness and depends on the starting material, the method used in its production and possible further treatments with oxidative agents.

The combination of all these variables means that multiple aspects of the carbons production must be combined to generate samples with potential application. In parallel and often neglected are the aspects of minimization of production costs with reduction of the steps number, energy expenses and additional reagents.

The present work shows an initial approach in the process of carbons production optimization obtained from different food waste, like banana peels, peanuts and walnuts shells. The raw materials for carbons production were obtained from different commercial establishments in Lisbon region to ensure a real waste source.

Therefore, several carbons samples were produced from food wastes and were applied as adsorbents for dye removal such as a textile dye, Blue Mordent-9. The tested food wastes include walnut, peanuts shells and bananas peels that underwent different grinding, sifting and calcination operations to obtain carbons. The dried fruit shells samples were first crushed in a ball mill. The banana peels were previously dried and then crushed in a blade mill. After grinding the samples were sieved allowing the separation on different particle sizes from 212 μm to 1 mm.

These operations were designed to minimize economic component of carbons preparation. In the evaluation of carbons ability to remove the textile dye, adsorption isotherms were carried out and the Langmuir model was applied in order to obtain quantitative results for the different samples. Figure 1 presents Langmuir isotherm applied to food waste carbons sample in dye adsorption.

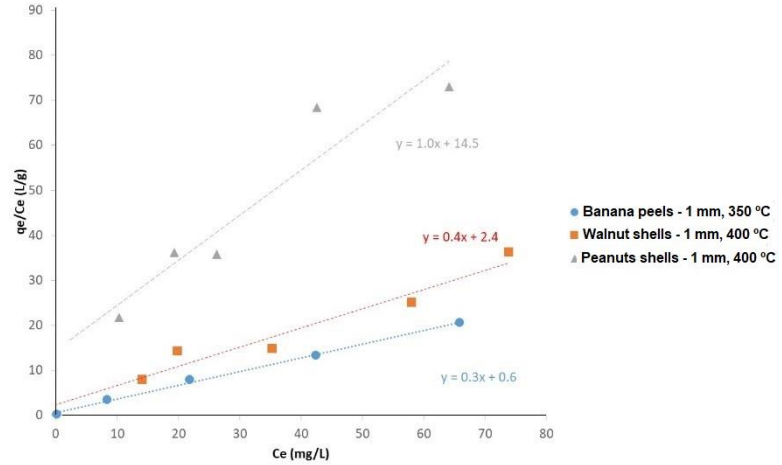

Figure 1. Langmuir isotherm applied to food waste carbons sample in dye adsorption

The results reveal the low adsorption capacity of the samples tested when compared to commercial activated carbon, but with the possibility of being maximized with modifications in the preparation methods, namely of surface chemistry modification by oxidative treatments or increase the adsorbent porosity by incorporation of other reagents before the carbonization step. The present work is still under development.

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