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Opinion

Food Waste Materials Appear Efficient and Low-cost Adsorbents for the Removal of Organic and Inorganic Pollutants from Wastewater

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Opinion

Excessive release of organic and inorganic pollutants, due to urbanization and industrialization is a critical environmental problem worldwide [1]. In fact, discharge of wastewater from industrial activities releases effluents particularly rich in toxic and carcinogenic pollutants. In the last few years, environmental remediation was focused on the use of low cost adsorbents for the removal of metals and metalloids from wastewater.

There are several physic-chemical methods to remove elements from wastewater (chemical precipitation, solvent extraction, reverse osmosis, adsorption, ion exchange and chemical reduction) [1,2]. Adsorption is recognized as an effective and economic method because it offers high efficiency and flexibility in operation [3]. The adsorption phenomenon, in which the transfer of matter is provided from a gas, liquid or dissolved solid phase (adsorbate) to a solid biological adsorbent surface (biosorbent) in contact with it, can be called: "biosorption".

Different biomaterials with high specific surface areas like activated carbons, resins and zeolites have been widely used for heavy metal wastewater treatment. However, to minimize the cost, alternative approaches have been developed using low cost materials such as agricultural waste by-products [4]. These include the use of modified clay [5,6], soil [7], seed powder [8], sugar cane bagasse [9], coffee and tea waste [10,11], neem bark [12] maize tassels [13], modified coconut fiber [14], coconut husk [15], rice husk [16], oil palm shell [17], fly ash, lime, agricultural ash and saw dust [18,19].

Among these low-cost materials, food waste adsorbents compete favourably in terms of cost, efficiency and ease of operation [20]. Moreover, with the aim of sustainable development, recycling food waste, which amounts to US $680 billion in industrialized countries and US $310 billion in developing countries [21], is beneficial. Food waste adsorbents do not require modification reaction like other materials used in adsorption processes [22]; technical applicability and cost advantages are two key factors for the selection of food waste as low-cost adsorbents for treating wastewater.

In recent studies, the adsorption capacity of several food waste materials (banana peel [22], apple peel [23], eggplant peel [24], potato peel [25], orange peel [26], lemon peel [27,28], watermelon peel [29,30], tomato peel [31], coffee waste [10,11,32,33] decaf coffee waste, carob peel and grape waste [34,35]) has been assessed by performing adsorption experiments in heterogeneous operating conditions (Figure 1).

Figure 1:Food waste materials' processing [36].

In a latest study [37], the efficiency of such food waste materials for the removal of metals and metalloids from complex multi-element solutions was evaluated in homogeneous experimental conditions, which allowed comparing the adsorption capacities of the individual adsorbents. The pH selected for the adsorption experiments were pH 2.0 and pH 5.5. The removal efficiency of the food waste adsorbents was also verified on a real polluted matrix; coffee waste and decaf coffee waste resulted the most efficient food waste adsorbents for the removal of Cu, watermelon peel for Pb and grape waste for Ni and Zn. This data confirmed the results obtained by the adsorption experiments performed in synthetic multi-element solutions. Banana peel, watermelon peel and grape waste resulted the most efficient and the least selective adsorbents for the removal of most of the metals and metalloids. Furthermore, the adsorbent surfaces of the food waste materials were analysed by FTIR spectroscopy and showed different types and amounts of functional groups, which demonstrated to act as adsorption active sites for various elements [37].

Considering the high efficiency of the examined low-cost adsorbents for the removal of inorganic pollutants, preliminary studies were conducted in our lab for assessing the potential of the investigated food waste materials to adsorb volatile organic compounds from a real polluted matrix of leachate. Some recent studies have shown the efficiency of low cost materials for the removal of industrial organic dyes [33,38,39], polycyclic aromatic hydrocarbons [40] and phenolic compounds [41]. However, the food waste adsorbents' efficiency for the removal of volatile organic compounds was not investigated.

Our preliminary studies showed good adsorption capacities of the examined food waste materials for aliphatic and aromatic hydrocarbons. Therefore, it is worth to carry out further studies about volatile organic compounds' removal by food waste adsorbents.

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