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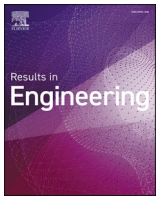

Research paper

Synthesis and characterization of surface modified montmorillonite for nano-adsorption of phenolic compounds from olive mill wastewater as a novel valorization strategy

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ABSTRACT

In this study, to recover phenolics from olive mill wastewater (OMW), adsorption was performed by raw montmorillonite (Mt) and three modified-Mt forms. The Mt was modified with tetradecyl trimethylammonium bromide (TTB), cetyl trimethylammonium bromide (CTB), and didodecyl dimethylammonium bromide (DDB). The effect of adsorption time, pH and adsorbent dosage (AD) on the adsorption efficiency (AE) of phenolics from OMW were investigated. Experimental results revealed that the maximum AE (93.43%) was obtained by TTB-modified Mt at pH= 4.7, and AD = 0.66 g/L. The Mt and TTB-modified Mt were characterized by X-ray diffraction (XRD) and Fourier transform infrared (FT-IR) spectroscopy before and after adsorption in optimum situation in order to establish the adsorption behavior-properties relationship. The results showed there was successful adsorption of phenolics on TTB-modified Mt. The equilibrium data of adsorbed phenolics was fitted well to Langmuir models (R^2= 0.9914) and the kinetic data indicated that the best fit of experimental data was pseudo-second order model (R^2=0.9988). Finally, a continuous system for recovering the phenolics from OMW was designed; the maximum AE corresponded to an AD = 0.3 g, a flow rate = 1 mL/min and a total phenolics concentration = 15 mg/L which yielded an AE = 100%. In conclusion, we successfully modified Mt to create a promising nanoadsorbent capable of adsorbing valuable compounds, such as phenolic compounds, from wastewater and byproducts of the food industries.

1. Introduction

The Olive mill wastewater (OMW), a by-product of olive processing industries such as olive oil extraction, contains high levels of phenolics (up to 10 g/L), including tyrosol, hydroxytyrosol, phenolic acids, secoiridoids, flavonoids, and lignans [1–3]. These phenolics exhibit valuable properties such as antioxidant, anti-inflammatory, anticancer, and antihypertensive effects, making them potentially useful in the food, cosmetics, and pharmaceutical industries as natural additives [4]. Despite this, olive oil factories around the world waste over 3200 tons of phenolics annually through wastewater [5]. On the other hand, phenolics in OMW are toxic to plants, bacteria, and aquatic organisms [6,7]. Therefore, the recovery of phenolics from OMW offers both economic and environmental benefits. By extracting valuable by-products from OMW, this process not only contributes to reducing waste but also aids in the more efficient treatment of OMW by aerobic and anaerobic bacteria, as the removal of phenolics enhances biodegradation. Modified montmorillonite (m-Mt), due to its high adsorption capacity and selectivity, is being explored as an effective nanoadsrobent for phenolic recovery, addressing both environmental and economic concerns.

Several processes have been used for recovery of phenolics from OMW which have some *pros* and *cons* in terms of economic and environmental points, processing time and efficiency aspects. These methods include solvent extraction [8], membrane processes [9] and adsorption

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