Industrial Crops & Products 181 (2022) 114823

Contents lists available at ScienceDirect

Industrial Crops & Products

journal homepage: www.elsevier.com/locate/indcrop

Development of organic porous material from pineapple waste as a support for enzyme and dye adsorption

Sangeetha Veeramalai [a], Nurfadhila Nasya Ramlee [a], Hilman Ibnu Mahdi [b], Nor Hasmaliana Abdul Manas [a,c], Aizi Nor Mazila Ramli [d,e], Rosli Md Illias [a,c], Nur Izyan Wan Azelee [a,c,*]

[a] School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Skudai, 81310 Johor, Malaysia
[b] PT Global Amines Indonesia, Kapten Darmo Sugondo No.56 Street, Indro Legi, Kec. Gresik, Kabupaten Gresik, East Java 61124, Indonesia
[c] Institude of Bioproduct Development (IBD), Universiti Teknologi Malaysia, UTM, 81310 Skudai, Johor, Malaysia
[d] Faculty of Industrial Sciences and Technology, College of Computing and Applied Sciences, Universiti Malaysia Pahang, 26300 Kuantan, Malaysia
[e] Bio Aromatic Research Centre of Excellence, Universiti Malaysia Pahang, 26300 Kuantan, Malaysia

ARTICLE INFO

Keywords:
Pineapple waste
Biochar
Activating agent
Dye adsorption
Enzyme immobilization

ABSTRACT

The transformation of agricultural wastes such as pineapple waste into valuable product such as biochar will be of great advantage. Biochar is a black carbon produced by pyrolysis which can act as good adsorbent for organic substances due to the high porosity characteristic. Due to the instability and the non-recyclability factor of free enzymes, the use of immobilized enzyme is getting more attraction. Furthermore, biochar or activated carbon (AC) has been widely used in industries to adsorb pollution such as dye. In this study, process pyrolysis was used to convert pineapple waste biomass (PWB) into useful adsorbent such as biochar (BC) and activated carbon (AC) for lipase immobilization and RBBR dye adsorption. Several steps such as impregnation of PWbB with nitric acid, and process pyrolysis of pineapple waste at various temperatures and residence time have been performed. Studies of characterization of biochar such as Thermogravimetric analysis (TGA), Brunauer – Emmett – Teller (BET), Fourier Transform Infra-Red (FTIR) and Scanning Electron Microscopy (SEM) were accomplished to analyze the differences in performance. The performance of BC in lipase immobilization and RBBR dye adsorption were investigated by varying parameters i.e. initial concentration, physical size of PWB (grounded and non-grounded pineapple waste (PW) biomas) and physical size of BC (crushed and non-crushed BC). The achievements of generated BC were compared with commercial AC. The result shows the highest amount of protein adsorbed during immobilization was achieved at F500 1 h PWbB (92.99%). Meanwhile, the maximum dye removal was achieved at F 600.5 h PWbB (83.59%). Adsorption kinetics studies insinuate that the overall process follows the pseudo-first-order where the process was influenced by intraparticle and film diffusion while equilibrium isotherm studies is best described by Langmuir isotherm models. As a conclusion, the conventional liability burden of pineapple waste is possible to be transformed into valuable commodity especially for waste treatment.

1. Introduction

Biochar (activated carbon) is a material that is produced from carbonaceous source materials, such as coal (Zhao et al., 2011) coconuts (Laine and Calafat, 1989) empty oil palm fruit branches (Amosa, 2015) and wood (Ghani et al., 2013). Activated carbon has a strategically large surface area, high pore volume and a network of sub-microscopic pores where adsorption takes place internally (Liew et al., 2018). Utilizing waste materials as low-cost adsorbents is appealing since it tends to decrease waste disposal costs and leads to global preservation. Agricultural products containing cellulose have the ability to absorb a range of pollutants. Due to its exceptional chemical properties, abundant availability, renewability, and low cost, such materials are both economical and environmentally friendly (S.Tran et al., 2015) Much attention has recently been devoted to the use of plant biomass to manufacture engineered materials, which includes both technical and

* Corresponding author at: School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Skudai, 81310 Johor, Malaysia.
E-mail address: nur.izyan@utm.my (N.I.W. Azelee).

https://doi.org/10.1016/j.indcrop.2022.114823
Received 12 October 2021; Received in revised form 14 February 2022; Accepted 18 March 2022
Available online 30 March 2022