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ACTIVATED CARBON DERIVED FROM BAMBOO WASTE (*B. vulgaris* AND *G. albociliata*) USING POTASSIUM HYDROXIDE AS AN ADSORBENT FOR THE REMOVAL OF HEAVY METALS AND DYES

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ABSTRACT

Water pollution is worsening and increasing the threat to humans due to the toxic heavy metals and dyes discharged from industrial activities and urbanizations. Due to that, wastewater treatment is required to ensure the safety and cleanliness of the water for general use. The adsorption process by activated carbon is a common method used to treat water pollution. Activated carbon has wide applications and advantages. Its demand has increased significantly, especially in removing heavy metals and dyes in wastewater treatment. This is due to its simple applications, environmentally friendly, and high efficiency. However, commercial activated carbon is rather expensive. Agricultural waste with non-economic value provides cheaper production costs for activated carbon production, especially bamboo waste. Bamboo waste is a much cheaper, fast-growing, and sustainable resource. Furthermore, it is also abundantly available in Malaysia. Therefore, producing activated carbon derived from agricultural sources provides a better alternative. As such, local bamboo species from *Bambusa vulgaris* and *Gigantochloa albociliata* were used in this study to produce activated carbon. The bamboo charcoal was chemically impregnated with KOH as an activating agent in a 1:1, 1:2, and 1:3 ratio and activated in the muffle furnace at 500 °C and 600 °C. The heavy metals and dyes were removed using AAS for heavy metals and UV-Vis for dyes, respectively. The activated carbon produced was characterized by surface functional groups (FTIR) and morphology (SEM). Their IR spectrum indicates essential functional groups for the adsorption process. The SEM images of the activated carbon produced show apparent porosity on the activated carbon surface that enhances the removal process. Both *B. vulgaris* and *G. albociliata* activated carbon showed excellent performance in removing Zn, Fe, Ni, Cr, MB, and MO, up to 99.9 % of Zn removal. Similarly, both species of activated carbon produced show an excellent percentage removal up, to 99.2 % for methylene blue and is higher than for that methyl orange. The bamboo-activated carbon produced showed unique surface morphology characteristics that helped to enhance the removal process of the contaminants. To conclude, the activated carbon derived from local bamboo was successfully produced at a lower cost with chemical activation using KOH and lower activation temperature to conserve energy. This study has also established optimal parameters for producing activated carbon and the removal process for the heavy metals (Cu, Zn, Fe, Ni, and Cr) and dyes (MB and MO) removals. This study presents the first report on the various applications of activated carbon as an excellent adsorbent for removing heavy metals and dyes. In addition, the findings of this study validate that the activated carbon utilized from bamboo waste can be a better alternative material to produce cheaper and high-quality activated carbon to meet the high global demand for activated carbon.

Keywords: *Activated carbon, B. vulgaris, G. albociliata, heavy metals, dyes, removal.*

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CHAPTER 1

INTRODUCTION

1.1 Research Background

1.1.1 Water Pollution

Earth is referred to as a blue planet because it is covered with water for around 70% of its surface (Jain *et al.*, 2021). Water is one of the essential sources of livings since it is required for completing daily activities such as drinking, cooking, hygiene, and more. However, to this day, water pollution is a concern in developing nations, and most of the country's rivers and lakes are tainted (Ismail *et al.*, 2019). Due to specific behaviours, including urbanization, industrialization, and agricultural practices, the dumping of highly polluted wastewater has increased over the past few decades (Renuka *et al.*, 2013; Carolin *et al.*, 2017). Industrial, household, and agricultural operations all produce wastewater that contains harmful contaminants (Crini and Lichtfouse, 2019).

A considerable amount of contaminated and polluted water is produced and flows into large water bodies, making them filthy. Nearly all essential sources require good-quality water, especially for industrial purposes (Jain *et al.*, 2021). Consequently, environmental safety has become a significant issue for the scientific community due to the expanding usage of organic chemicals in numerous industrial and agricultural sectors (Ismail *et al.*, 2019). Moreover, the erosion of natural water supplies, the substantial environmental burden caused by water contamination, water scarcity, and its limited availability is rising nowadays (Carolin *et al.*, 2017).

The environmental problems brought on by fast industrialization and globalization are starting to bother people (Gunatilake, 2015). About 40% of the population is experiencing water scarcity due to rapid urbanization, climate change, resource use, and food demand (Calzadilla *et al.*, 2011; Carolin *et al.*, 2017). In addition, rural populations worldwide confront numerous issues, but the two biggest ones are a lack of supplies and the contamination of drinking water with microbiological and chemical toxins (Ismail *et al.*, 2019).