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Comparative Adsorption of Methylene Blue Dye on Hexane-Washed and Xanthated Spent Grated Coconut (*Cocos nucifera* L.): Isotherms, Thermodynamics, and Mechanisms

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ABSTRACT

A batch system investigated the application of two types of chemically modified biosorbents derived from spent grated coconut (*Cocos nucifera*) powder to adsorb methylene blue (MB) from aqueous solutions. The biosorbents were characterised by spectroscopic and quantitative analyses. The assessment of MB adsorption onto the investigated biosorbents was studied at different experimental conditions with different pHs (2–9) and different initial concentrations of MB (10–400 mg/L) at three different temperatures (298, 308, and 318 K). The maximum adsorption capacity (q_{max}) of xanthated spent grated coconut (XSGC) was higher than that of hexane-washed spent grated coconut (HSGC). The thermodynamic study indicated that the MB adsorption process was spontaneous for both biosorbents. Desorption of MB-loaded biosorbents was carried out using HCl, NaOH, and Na_2EDTA solutions. A desorption ratio of more than 90% was obtained over three adsorption/desorption cycles for HSGC. However, XSGC demonstrated poor MB desorption, implying a stronger MB interaction with XSGC, which could be attributed to H-bonding, Yoshida H-bonding, n-π, and π-π bonding. The study showed that HSGC and XSGC could be applied as biosorbents to remove low MB concentrations from aqueous solutions.

Keywords: adsorption, isotherm, mechanism, methylene blue, spent grated coconut.

INTRODUCTION

Water pollution caused by the excessive release of dyes into bodies of water remains a severe environmental and public problem, particularly since scientists discovered synthetic dyes. Synthetic dyes are known as recalcitrant organic compounds, and they are toxic or carcinogenic. Methylene blue (MB) is an example of a cationic dye commonly used in the textile, paper, leather, plastic, and rubber industries. It is also used as a staining agent in surgery and diagnostic examinations. Other medical applications include treatments for methaemoglobinaemia and cyanide poisoning (Rekha Singh et al., 2020). The presence of MB in wastewater can reduce sunlight penetration into waters, inhibit photosynthesis, impede growth, and increase the toxicity of aquatic biota.

Moreover, MB is responsible for human health problems such as allergic dermatitis, eye irritation, mutagenicity, and carcinogenesis (Gregorio et al., 2019). Therefore, there is an urgent need to install wastewater treatment systems to treat the dye-bearing wastewater before it is discharged directly into the environment to prevent further contamination. The adsorption technique