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Removal of Methylene Blue in Aqueous Solution by Using Bioadsorbent from Banana Pseudo Stem

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Abstract

This study aimed to analyse the removal efficiency of methylene blue (MB) in aqueous solution using banana pseudo stem bioadsorbent. The adsorption parameters; solution pH, temperature and bioadsorbent dosage were investigated for the optimum conditions. Fresh chopped banana pseudo stem was oven dried at 105 °C for 24 hours. The percentage MB removal efficiency was calculated using the MB concentration measured with double beam UV-VIS Spectrophotometer. Adsorption experiments showed that the highest percentage MB removal efficiency was achieved at pH 6 (96.1%) and at optimized temperature of 40°C with 96.1% removal. The bioadsorbent removed 96.2% of methylene blue at optimum dosage of 0.2 g. The results indicated banana pseudo stem can be utilized as potential bioadsorbent in removing more than 96 % of methylene blue dye from aqueous solution at varied optimum adsorption parameters.

Keyword: Adsorbent; banana pseudo stem; methylene blue

INTRODUCTION

Methylene blue (MB) dyes is commonly used in industrial sector such as paper printing, cosmetics, biomedical dyes, rubber, plastics, leather and textile [1-2]. More than 15% of dye material is lost as industrial effluent during production and processing processes [3]. The presence of methylene blue in water causing toxicity, carcinogenicity, mutagenicity, and nonbiodegradability hazardous pollutant in the aquatic environment [4-5].

Adsorption has been found to be superior to other methods for methylene blue removal due to its simplicity of design, high removal efficiency, cost saving and environmentally friendly [6]. Research on the potential of agricultural waste as bioadsorbent for treating colour and dyes in wastewater has recently increases due to the efficient and low-cost factor and subsequently resolved the agricultural wastes problem. Corncob [7], rice husk [8], coconut husk [9] and other materials have been utilized as bioadsorbent for the dyes and colourants removal purposes.

Banana (*Musa* spp.) is the second-largest cultivated fruit in Malaysia. Banana wastes are generally abandoned in the plantation and some farmers tend to burn after natural drying, thus creating another environmental pollution issues. Therefore, this study aimed to investigate the potential of banana pseudo stem as bioadsorbent for the removal of methylene blue in aqueous solution. Various adsorption parameters were examined in order to determine the removal efficiency of methylene blue at optimum conditions.

METHODOLOGY

Preparation of banana pseudo stem bioadsorbent (BPSB)

Banana pseudo stem was obtained from Kampung Bestari Jaya, Bestari Jaya, Selangor. All chemicals; methylene blue, HCl and NaOH were purchased from HmbG Chemicals. All prepared methylene blue solution was adjusted to the required pH by using 0.1 N HCl or 0.1 N NaOH. Fresh chopped banana pseudo stems were washed with tap water and finally dried in an oven at 105 °C for 24 hours. The banana pseudo stem bioadsorbent (BPSB) samples were stored in a cabinet desiccator for further adsorptive experiment.

Adsorption experiments

The adsorption of methylene blue (MB) on the BPSB were studied at different parameters; solution pH (3.0 to 9.0), temperature (30 to 60°C) and adsorbent dose (0.05 to 0.3 g). A series of 100 mL of MB solution in 100 mL Erlenmeyer flask was prepared. In each flask, a required amount of BPSB was added into the 100 mL of MB solution. The mixtures were kept at temperature controlled horizontal bench shaking incubator (Protech SI 1000D, Malaysia) and agitated at a speed of 120 rpm for different time intervals. Then the flasks were withdrawn from the shaker and mixtures were filtered using the Whatman 42 filter paper. The concentration of MB solution was measured by using the double beam UV-VIS-Spectrophotometer (Genesys 20 4001/4 California) at 664 nm wavelength. The percentage removal of the MB dye was calculated using the following equation:

$$\%R=\frac{(C_0-C_e)}{C_0}\times 100$$

Equation 1 where, C_0 and C_e are the initial and final concentration of MB in the solution.

RESULT AND DISCUSSION

Figure 1 shows the influence of solution pH on removal efficiency of the MB solution in aqueous solution were investigated between pH 3 - 9. Significant increases were observed from pH 3 and optimized at pH 6 with highest removal efficiency of 96.1 %. This was attributed to its acidic state in bioadsorbent. When the pH of the methylene blue solution rises, the adsorbent surface becomes negatively charged, which increases the adsorption capacity of BPSB [11].

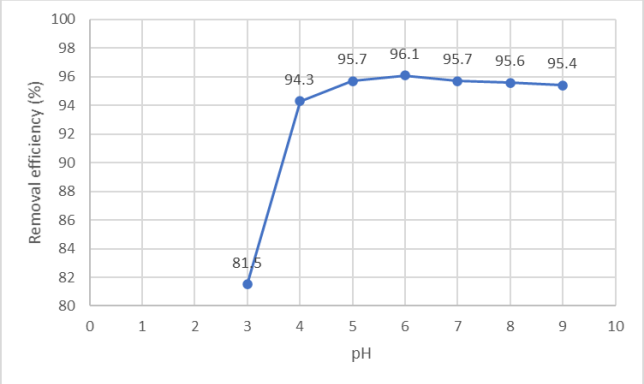

Figure 1: Solution pH influence on removal efficiency of methylene blue in aqueous solution

The removal efficiency of the MB solution was examined at temperature 30°C, 40°C, 50°C and 60°C as indicated in Figure 2. The rise in temperature have increased the MB dye's escape ability due to a weak adsorptive force between the MB dye's molecular structure and the surface adsorption sites [7]. The highest removal efficiency of MB of 96.1 % was recorded at optimum temperature of 40°C.

The influence of bioadsorbent dosage on removal efficiency of the MB solution is shown in Figure 3. At optimum bioadsorbent dosage of 0.2 g showed a maximum removal efficiency of 96.2%. A larger dose of BPSB provides more active sites on the surface, as well as a lower diffusion resistance of the dye onto the BPSB [12].

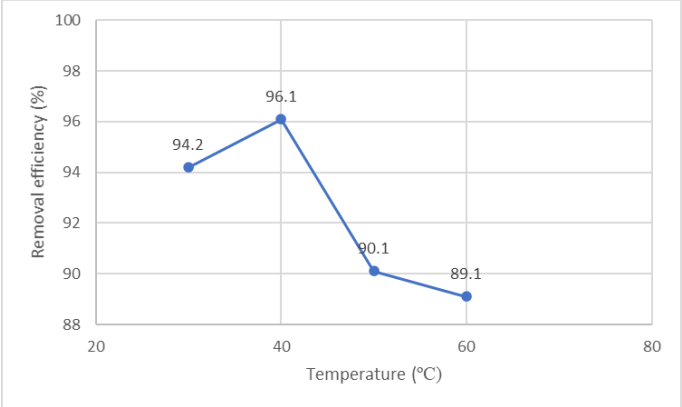

Figure 2: Temperature influence on removal efficiency of the MB solution

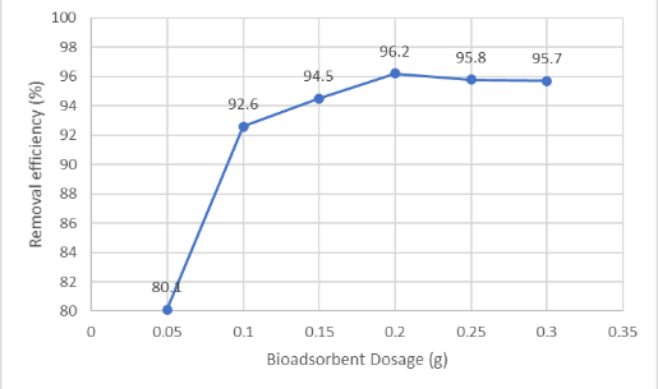

Figure 3: Bioadsorbent dosage influence on removal efficiency of MB solution

CONCLUSION

The methylene blue concentration in aqueous solution can be removed effectively through adsorption method using bioadsorbent from banana pseudo stems. Being as a waste product, the utilization of banana pseudo stem as bioadsorbent significantly eliminates methylene blue dye contamination in water resources and resolves agricultural waste management issues as well.

ACKNOWLEDGEMENT

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