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# Tea industry waste activated carbon as a low-cost adsorbent for methylene blue removal from wastewater

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## Abstract

*The possible utilization of tea industry waste activated carbon (TIWAC) as an inexpensive, eco-friendly bio adsorbent for methylene blue (MB) removal from wastewater was studied. Phosphoric acid was used as the activating agent for the preparation of TIWAC and Scanning Electron Microscopy and Fourier Transformed Infrared Spectroscopy were used to characterize TIWAC. In this work batch experiments were carried out at pH 7 and at temperature of 30±2 ℃ to study the efficiency of MB adsorption on to TIWAC under different conditions such as TIWAC dosage, MB concentration, pH of the solution, and agitation time. The adsorption characteristics of the sorbent was tested with Freundlich and Langmuir adsorption models and the kinetic studies were conducted to determine the order of the adsorption process. The adsorption capacity of MB and the maximum % removal of MB by TIWAC were found to be 233.51 mg $g^{-1}$ and 77.8% respectively at the optimized adsorption conditions (TWAC dosage= 0.001 g, MB concentration= 300 mg/L, agitation time=6 hrs) at pH 7. Isotherm data were satisfied Langmuir model than Freundlich model and kinetic data were best fitted with the pseudo first order model. Most importantly, the Langmuir constant, the maximum adsorption capacity value ($q_0$); obtained for adsorption of MB onto TIWAC was 303.3 mg $g^{-1}$, which is significantly greater than that of the adsorption of MB by various other bio-sorbents reported in the literature. Bench-scale fixed-bed column experiments were also carried out at various flow rates to study the practical usability of the adsorbent and it was found out that the breakthrough time was decreased with increasing flow rate. The results of this study indicate that TIWAC is an effective and environmental friendly adsorbent for removal of dye from wastewater.*

**Keywords:** Tea waste activated carbon, Methylene Blue, Sorption, Isotherm studies.

## Introduction

Color is an important aspect in human world. As synthetic dyes have many advantages due to its low manufacturing cost, intense colors, and better resistance to environmental factors over natural dyes, synthetic dyes have used in various industrial applications including textile, printing, rubber, leather, food, drug, cosmetics, etc[1].

The effluent released by those factories contains a significant percentage of dye molecules. It is estimated that total world dye production is about 800,000 tons/year of which 50% are textile dyes[2]. There are more than 100,000 commercially available dyes and about 10-15% of the used dyes are discharged into the environment through wastes[3]. These dyes are harmful to the environment, as they are resistant to bio-degradation processes and carcinogenic[4]. Colored effluents discharge by various industries can cause severe effects on water resources, soil fertility, and aquatic biota. Most of the countries have environmental regulations on decolorizing the dye-containing effluents prior to discharge.

Currently, various chemical and physical practices are used to treat dye containing wastewaters[5]. However, many of these methods are not cost effective and cannot be used effectively to remove different types of dyes. Due to the several advantages compared to the conventional dye removal methods, adsorption methods using activated carbons are widely used to eliminate or mitigate dye compounds from wastewaters. Even though commercial activated carbon is widely used to remove dye by adsorption, its high production cost has encouraged scientists to find more cost-effective alternatives. Among the alternatives for commercial activated carbon, activated carbon derived from agricultural waste has received the attention as a promising dye adsorbents due to its natural abundance, renewability and biodegradability[6].

In this research, tea factory waste was used to prepare TIWAC and studied its dye adsorption potential. Tea is one of the major plantation crops in Sri Lanka and spreads in both low country and up country[7]. During the tea production procedure overgrown shoots, and petiole are finally formed in to tea factory waste. For instance, during the process of black tea production, 3-5% of waste tea is generated[8]. Currently there are no effective methods to manage waste tea in Sri Lanka.

Therefore, in this study, the possibility of using tea industry waste activated carbon (TIWAC) as a low-cost sorbent for