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BANAPEWA: BANANA PEEL AS AGRICULTURE WASTE ADSORBENT IN REMOVING DYE COLOUR

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ABSTRACT

Researchers have recently started to concentrate on using waste materials to study the effectiveness of adsorbent media in dye colour treatment. If improperly disposed of, the wastewater from the *batik* textile industry can contaminate the water, thus endangering both human health and the environment. Banana peel, commonly known as Banapewa, was applied in this study as a waste adsorbent to minimise dye effluents. To ascertain the impact of varying contact time (0 to 180 minutes) and dosage, experiments were carried out at room temperature using batch study (0.05 to 0.4 g). A HACH DR2800 Spectrometer was used to determine the quantity of MB present in the samples. The results reveal that the percentage of methylene blue (MB) solution removal increases from 34.69% to 86.88% as the banana peel dosage is increased from 0.05 g to 0.3 g in 100 ml of MB solution. The optimum contact hour for the adsorption process was 150 minutes, in which 86.22% of the MB solution was removed. The kinetic research analysis shows that the adsorption of MB followed a pseudo-second order kinetic with an R^2 of 0.9934. In addition, the equilibrium isotherm investigation revealed that the Freundlich model fits better than others, with an R^2 of 0.7688. This suggests that Banapewa has the potential to reduce the dye concentration in *batik* textile industrial wastewater and furthermore could lead to reducing the dye concentration below non-drinking water standard while also providing a cost-effective, environmentally friendly adsorbent in the treatment of *batik* industrial wastewater. Banapewa is thus recommended for commercialisation as an alternative natural waste adsorbent.

Keyword: *waste adsorbent, batik textile industry, banana peel, methylene blue and batch study*

1. INTRODUCTION

The *batik* textile business in Kelantan is expanding quickly in response to the rising demand throughout Malaysia. This industry discharges a high rate of contaminated wastewater because it utilises a lot of water. The illegal disposal of these industries' effluents has threatened human health and has severely affected the environment. The presence of contaminants in the water body, such as toxic compounds and organic dyes, may contribute to human cancer and tumour development (Pang & Abdullah, 2013).

Adsorption is one physical technique frequently used in textile wastewater. Adsorption is unquestionably the most efficient and cost-effective treatment option available today. Waste from agriculture (Mohammed, 2013) and industry (Bhatnagar et al., 2011), as well as activated carbon (El-Barghouthi et al., 2007), can be employed as adsorbents to treat wastewater. Every adsorbent used to remove contaminants from wastewater has its own benefits and drawbacks. The most effective adsorbent for wastewater treatment is an activated carbon since it is the most effective conventional method and can remove up to 99% of contaminants. However, activated carbon is expensive, unsustainable, and not recyclable.

Farmers' waste or biomass waste has been used as an adsorbent for decades (Ali, 2017). Examples include rice husk, tea waste, wheat bran, sugarcane bagasse, sugar beet pulp, soybean hulls, clay, natural zeolite, sawdust, peanut shells, and fruit peels. Fruit waste can effectively cleanse contaminated wastewater by acting as an adsorbent (Mohammed & Chong, 2014). In this study, the potential of banana peel as an adsorbent fruit waste to treat dye colour from the *batik* textile industry wastewater is investigated. Due to the fact that the peel is typically wasted and not used for commercial purposes, this adsorbent is classified as a low-cost material. Additionally, because banana peel is biodegradable and good for the environment, it is an environmentally beneficial material. The banana is a common fruit that is grown all over the world.

In contrast to earlier studies, which employed banana peels in the form of powder (Moubarak et al., 2014; Amel et al., 2012), the current study used banana peels that had not been chemically treated in the form of small cut pieces (0.5-1.0cm) weighing between 0.05 and 0.4g. In this study, raw banana peel was employed as an abandoned agricultural waste adsorbent to treat textile wastewater. It has the potential to be used at lower dosages where the treated water is saved to be returned into the water body.

2. METHODOLOGY

The banana peel that is frequently wasted at local fried banana stands was gathered. To remove dirt like dust and soil, the adsorbent was washed repeatedly in distilled water. The adsorbent was then divided into small pieces between the sizes of 0.5 and 1 cm, and dried for 24 hours in convection at 109°C using the BINDER ED 720 model. The wastewater sample was taken from the pond at the Pasir Mas, Kelantan, *batik* textile industry and kept in sealed containers after the cloth dyeing process had finished. To prevent dilution and to ensure the sample is free from further contamination, the containers were previously rinsed with the effluent. The samples were then kept in a 4 °C refrigerator while the initial colour values were calculated.

To guarantee the consistency of beginning colour values for each sample in this study, synthetic *batik* textile wastewater was simulated to be near the effluent from the *batik* industry located in Kelantan. The synthetic wastewater was created by combining 21.0 mg of Methylene Blue powder with 1000 ml of deionized water to produce a sample of Methylene Blue water that had a PtCo value between 320 and 341 and matched the initial colour of the wastewater from *batik* textiles. To assess the effectiveness of banana peels in eliminating MB from synthetic wastewater, batch adsorption research was conducted. In this batch study, two factors were investigated: varying dosage and varying contact time. This study also examined the effects of varying the dosage from 0.50 g to 0.4 g and the contact time from 0 to 180 min at a speed of 150 rpm.

A mathematical model called a kinetic study is used to explain how an adsorbent adheres to an adsorbate and how that adsorption occurs. From the adsorption equilibrium analysis, the behaviour of the adsorption mechanism is then assessed by utilising the pseudo-first order, pseudo-second order, elovich kinetic, and intra-particle diffusion. In many prior studies, isotherm models like Langmuir and Freundlich are frequently used. To further interpret the distribution of metal ions between phase solids and phase liquids in this study, another model, namely Temkin, is included. Designing an efficient water treatment system heavily relies on understanding kinetics and the adsorption mechanism (Siddiqui et al., 2018).

3. FINDINGS

Figure 1 indicates the effect of dosage and contact time adsorption of MB in the synthetic wastewater. In general, an increase in the media dosage employed in the batch study results in an increase in the Methylene Blue removal %. Due to varying contact times, there is typically a considerable impact on the removal effectiveness of MB during the agitation process that involves a mixture of adsorbents and Methylene Blue solution. The % of Methylene Blue removal increases as the contact duration increases from 15 minutes to 150 minutes, according to the study.

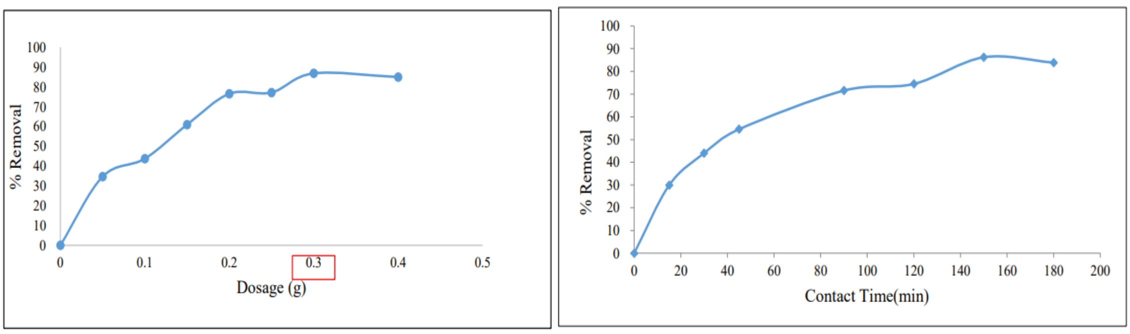

Figure 1 Percentage of Colour Removal in Relation to Dosage (Left) and Contact Time (Right)

Model	**Kinetic parameters**				**Data from linear plot**		
		$q_{(exp)}$ (mg/g)	*$q_{(cal)}$ (mg/g)*	*Difference*	*m*	*c*	*R^2*
Pseudo First-Order	*k_1 (1/min)*						
	0.0186	98	90.3231	7.6769	0.0081	1.9558	0.9825
Pseudo Second-Order	*k_2 (g mg^{-1} min^{-1})*						
	0.00031	98	117.7563	-19.7563	0.0085	0.3371	0.9934
Elovich Kinetic	*β*	*α*			*0.038*	*1.4609*	*0.9881*
	26.316	*1.89 x 10^{15}*	-	-			
Intra-Particle Diffusion	*C*	*k_i*			*0.1465*	*1.6967*	*0.9627*
	1.6967	*0.1465*					

Table 1 Data Collected from the Adsorption Kinetic Models

Model	**Constant parameter**		**Linear Equation**	***R^2***
Langmuir	***Qo***	**b**	y = 0.0036x + 0.4333	0.672
	0.0036	0.4333		
Freundlich	K_F	***n***	y = 0.5157x + 1.0569	0.7688
	0.5157	1.0569		
Temkin	A_T	b_T	y = 66.25x – 174.81	0.7187
	66.25	174.81		

Table 2 Data Collected from the Adsorption Isotherm Models.

Table 1 demonstrates that compared to other kinetic models, the pseudo-second order provides the most compatibility while Table 2 shows that in comparison to other models, the Freundlich isotherm model provides the best fit.

4. CONCLUSION

The findings indicate that as the adsorbent dosage is increased, more Methylene Blue is removed from the solution. The adsorption mechanism will get saturated and less effective as the adsorption increases. The optimal percentage of Methylene Blue removal in this study is 86.88% for various dosages, where the optimum dosage is 0.3g, and 86.22% for various contact times, where the optimum contact times are 150 minutes. The pseudo-second-order model with correlation R^2= 0.9934 offers the best fit for the adsorption kinetic model. The Freundlich isotherm model generated the highest correlation coefficient R^2 for the adsorption equilibrium isotherm analysis, with a value of 0.7688. It is conceivable that the batch study's final MB, which ranges from 18.11 mg/L to 18.24 mg/L, complies with the Environmental Quality (Industrial Effluent) Regulations 2009. Therefore, the banana peel has the potential to be used as an agriculture waste adsorbent to remove Methylene Blue from *batik* textile wastewater since it is affordable, environmentally benign, and locally available.

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