Adsorptive treatment of hazardous methylene blue dye from textile wastewater using banana peel waste as a cellulosic adsorbent: Isotherm study

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EXTENDED ABSTRACT

In this paper, the use of banana peel as a cellulosic adsorbent has been investigated to remove the cationic dye (Basic Blue 159) from textile effluent.The banana peel particles were characterized by FESEM and FTIR. Batch adsorption experiments were carried out as a function of pH, contact time and the mass of adsorbent and mixing speed. Equilibrium adsorption isotherms and kinetics were investigated. The Langmuir, Freundlich,Tempkin were used. The results show that experimental data fitted very well to Langmuir model. Results indicate that banana peel could be used as an adsorbent to remove the cationic dyes from contaminated water courses.
Key Words: banana peel – adsorption isotherm -kinetic– cellulosic material

1. INTRODUCTION

The color removal from textile wastewater is one of the major pollution problems. As a result, textile wastewater treatment has become an important issue [1]. Banana peel(Bp) is a solid waste with high carbohydrate content, around 60% of dry matter. It is thus possible that it supports fungal growth [2]. Adsorption has been found to be superior to other techniques for water re-use in terms of initial cost, simplicity of design, use of operation and insensitivity to toxic substances [3]. The aim of this work is to study the adsorption of Basic Blue 159 (BB159) from aqueous solution onto Bp as a cellulosic material. Basic Blue159 (BB 159) was chosen as a model dye.

2. EXPERIMANTAL

2.1. Equilibrium Studies

0.4 gram of adsorbent was used for adsorption of BB159 at 60 min, pH 9, mixing speed 200 rpm. The quantities of dye adsorbed on the Bp at equilibrium were calculated using the equation 1:

$$q_e = (C_0 - C_e)\,{}^{V}\!/_{W} \qquad (1)$$

Where q_e is the amount of dye adsorbed on the adsorbent (mgg^{-1}) at equilibrium, C_0 and C_e are the initial dye concentration and equilibrium dye concentration (mgL^{-1}), respectively. V is the volume of the BB159 solution (L) and W is the weight of adsorbent (g).

3. RESULT AND DISCUSSION

3.1. Characterization of adsorbent

Figure 1 shows the FTIR of Bp particles. In Figure 1 the peaks around 3444.64 cm^{-1}, 2923.34 cm^{-1}, 1733.88 cm^{-1} and 1037.36 cm^{-1} resulted from O-H stretch, C-H stretch, C=O stretch and C-O stretch, respectively.
The FESEM of Bp were recorded and are shown in Figure 2.it is clearly seen that the caves, pores and surfaces of adsorbent were covered by dye.

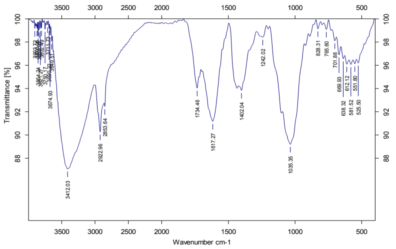
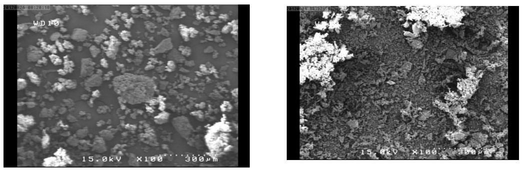


Figure 1: FTIR spectrum of Bp

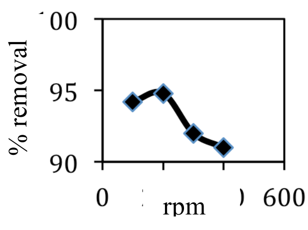


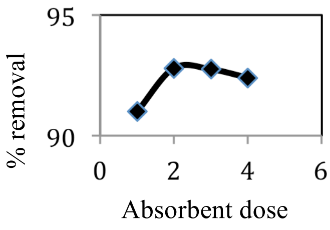
(a) (b)

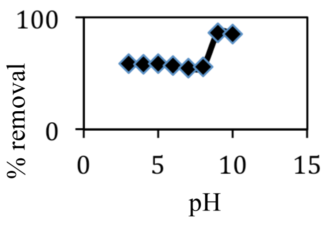
Figure 2: FESEM of (a) Bp and (b) dye adsorbed Bp

3.2. Effect of mixing speed, absorbent dosage, pH

According to Figure 3, increase of the mixing speed from 100 rpm to 200 rpm leads to increasing in dye removal percentage. The experimental data shows that higher mixing speed (300 and 400 rpm) causes to decrease of the dye removal percentage. It seems that increase in mixing speed leads to increase in turbulence and decrease in contact of dye molecules to adsorbent particles. The removal of BB159 by Bp were studied by changing the quantities of sorbents (0.2, 0.4, 0.6, 0.8 g) for the initial dye concentration of 100 mgL^{-1} at room temperature, pH 9 and mixing speed 200 rpm for 60 min. The results (Figure 4) indicated that increase in mass of adsorbent to 0.4 g leads to increasing in BB159 removal percentage. Figure 5 shows the effect of pH on removal percentage of BB159 by Bp. It was revealed that the decolorization efficiency increased with the increase of pH and reached a maximum level at the pH of 9.0.







The expression of the Langmuir model is given by Equation 2:

Figure 3: Effect of mixing speed **Figure 4**: Effect of adsorbent dose **Figure 5**: [illegible] of pH

(2)

Where Q is the maximum amount of the dye adsorbed on adsorbent, C_e is the equilibrium concentration of dye solution, q_e is the amount of dye adsorbed on adsorbent at equilibrium, and b is Langmuir constant.
The well-known expression for the Freundlich model is given as (equation 3):

$$\log q_e = \log K_f + \frac{1}{n} \log C_e \qquad (3)$$

Where K_f is the Freundlich constant, 1/n is the heterogeneity factor. Another popular equation for the analysis of isotherm is that proposed by Tempkin isotherm (Equation4) [7]:

(4)

$$q_e = \frac{RT}{b}(\ln K_{T_e} C_e)$$

Table 1: Equilibrium values for the BB159 biosorption on Bp

models	Isotherm constants		
Langmuir	**q_m(mg g^{-1})**	**b (L mg^{-1})**	**R^2**
	500	10	0.98
Freundlich	**Q**	**N**	**R^2**
	2964.31	1.05	0.9784
Tempkin	**K_{Te}**	**B**	**R^2**
	265.07	59.48	0.9528

4. CONCLUSION

In this research the removal of basic blue BB159 from aqueous by Bp was studied. Bp was characterized by performing particle size distribution, FESEM, FTIR analysis. The adsorption was highly dependent on various operating parameters, like the absorbent dosage, pH and mixing speed.The results show that the best removal percentage observed, 0.4 g adsorbent, 200 rpm and pH 9. The results show that the equilibrium data fitted very well by Langmuir model.

5. REFERENCES

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