

# The removal of basic violet 3 by Fruit of Lufa from aqueous phase in a batch process

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## Abstract

In this study Fruit of Lufa (FL) was evaluated for its ability to remove of basic dye, basic violet 3, from a aqueous solution in a batch process. The influence of operating conditions such as initial concentration of the dye, pH and solution temperature on dye removal is discussed. The results show that the increases of initial concentration pH have a positive impact on the removal of dye. However, for the solution temperature has a negative effect to remove of dye. Lagergren Pseudo-first-order and Blanchard pseudo-second-order models were used to fit the experimental data.

**Keywords:** Elimination, Basic violet 3, Fruit of lufa, kinetics, modelling.

## 1. Introduction

Effluents from the dyeing and dye manufacturing industries are the important sources of water pollution, because dyes in water undergo chemical as well as biological changes which consume dissolved oxygen and destroy aquatic life. Moreover, some dyes and their degradation products may be carcinogenic and toxic [1,2] . Therefore, it is necessary to treat the dye effluent prior to the in all over the world focused in the field of pollution control and management. A number of methodologies of varying degree of success have been developed to manage water pollution. Some of them involve coagulation, foam floatation, ion exchange, sedimentation, solvent extraction, adsorption, electrolysis, chemical oxidation, disinfection, chemical precipitation and membrane process [3–5]. The study of biosorption is of great importance from an environmental point of view, as it can be considered as an alternative technique for removing toxic pollutants from. Fruit of Lufa (FL) as a cheap material used as biomass for the removal of basic violet 3 (BV3) from aqueous media in batch process. The effects of various experimental parameters such as initial dye concentrations, initial solution pH, and temperature on removal BV3 were examined. The kinetics biosorption data were analysed and modelled by Lagergren Pseudo-first-order, and Blanchard pseudo-second-order models.

## 2. Materials and methods

### 2.1. adsorbate and biosorbent

The FL was washed with distilled water several times to remove dirt particles and water soluble materials. The washed materials were then completely dried in an oven at 50°C for 3 days. The dried sponge was then cut into small pieces and sieved to desired mesh size (0.5–1 mm). Finally, the obtained material was then dried in an air circulating oven at 50°C for 7 days and stored in a desiccator until use.

The adsorbate is the basic violet (BV3) is a cationic dye [C.I. number 42555; Basic Violet 3, chemical formula:  $C_{25}H_{30}N_3Cl$ , FW: 407.97 g/mol,  $\lambda_{max}$ : 583 nm (mesurated)] was obtained from Sigma chemical. The solution pH was adjusted using 0.1N HCl or NaOH aqueous solutions

## 2.2. Procedures

The initial concentration of BV3 solution was 30 mg L<sup>-1</sup> for all experiments, except for those carried out to examine the effect of initial dye concentration. For dye removal kinetic experiments, the batch method was used because of its simplicity. About 0.1 g of FL was contacted with 50 mL of dye solution in a sealed flask agitated vigorously by a magnetic stirrer using a water bath maintained at a constant temperature. At predetermined intervals of time, samples filtrate of the mixture was withdrawn analysed by a UV–Vis spectrophotometer for the concentration of CV. The flasks were placed in a thermostatic water bath in order to maintain a constant temperature and stirring was provided at 300 rpm to ensure equilibrium was reached. Samples of solutions were filtrate and analysed for the remaining dye concentration with a UV–Vis spectrophotometer.

The amount of biosorption at any time,  $q_t$  (mg g<sup>-1</sup>) was calculated by:

$$q_t = \frac{(C_0 - C_t)}{m} \times V \quad (\text{Eq.1})$$

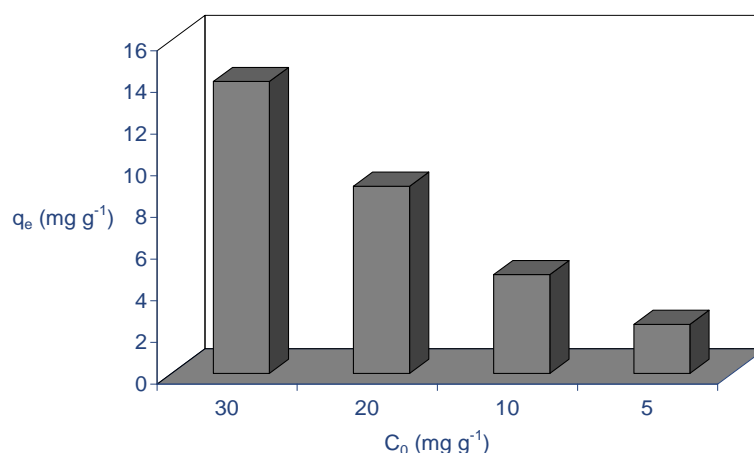
Where  $C_0$  and  $C_t$  (mg L<sup>-1</sup>) are the liquid phase concentrations of dye at initial, and any time, respectively,  $V$  (L) is the volume of the solution and  $m$  (g) is the mass of used biosorbent.

## 3. Results and discussion

### 3.1 Effect of operating conditions

#### 3.1.1 Effect of initial CV concentration and contact time

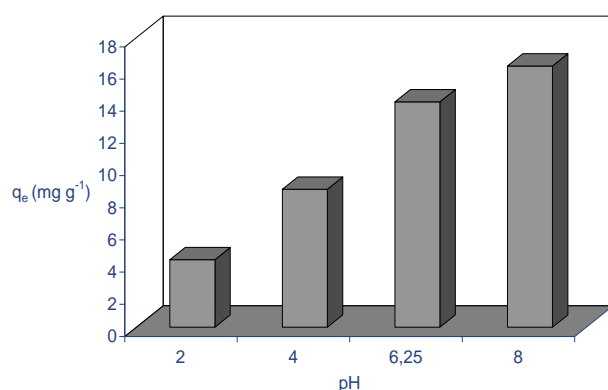
The effects of contact time and BV3 initial concentration on the biosorption uptake using FL at 20°C are shown in Fig.1. From this figure, it was shown that the biosorption of BV3 increased with an increase in initial dye concentration and this confirmed strong chemical interactions between BV3 and FL. This is due to increasing concentration gradient, which acts as increasing driving force to overcome all mass transfer resistances between the aqueous solution and solid phase [6].



**Fig. 1.** Effect of concentration and contact time on the biosorption of BV3 on FL

### 3.1.2 Effect of initial solution pH

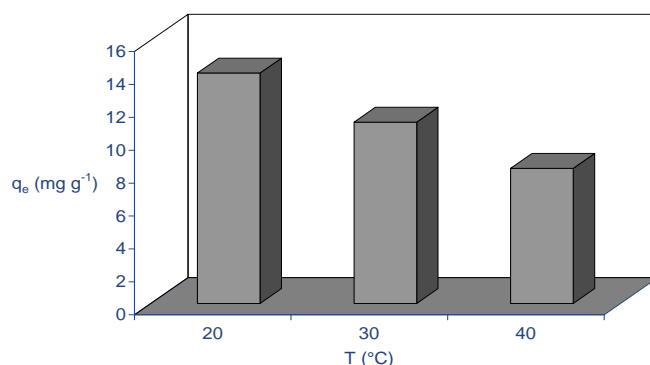
Fig. 2 shows the effect of initial pH on the removal of BV3. It was observed that the removal of BV3 was pH-dependent. BV3 is cationic dye, which exists in aqueous solution in the form of positively charged ions. As a charged species, the degree of its biosorption by the biosorbent is primarily influenced by the surface charge on the biosorbent. The lower biosorption of dye at acidic pH is due to the presence of excess  $H^+$  ions that compete with the dye cation for biosorption sites. As the pH of the system increases, the number of available positively charged sites decreases while the number of the negatively charged sites increases. The negatively charged sites favour the biosorption of dye cation due to electrostatic attraction. Higher removal of BV3 in the alkaline pH range has been reported by other workers as well [6].



**Fig.2.** Effect of initial solution pH on the removal of BV3 on FL

### 3.1.3 Effect of temperature

Fig. 3 shows the effect of temperature on the biosorption of BV3 on FL. It was observed that the biosorption uptake slightly decreases with an increasing temperature. From the result, an increase in temperature from 20 to 40°C decreased the biosorption capacity from 14.01 to 8.22 mg g<sup>-1</sup>, respectively. This phenomenon indicates that the biosorption process is exothermic in nature.



**Fig.3.** Effect of temperature on the biosorption of BV3 on FL

## 3.2 Biosorption kinetics studies

Lagergren equation was used to investigate the suitability of pseudo-first-order kinetic model and obtain rate constants. This equation can be written as:

$$\ln \frac{q_e - q}{q_e} = -K_1 t \quad (\text{Eq.2})$$

where  $q_e$  (mg g<sup>-1</sup>) and  $q_t$  (mg g<sup>-1</sup>) are the amount of dye sorbed at equilibrium and at any time  $t$ , respectively, and  $k_1$  (min<sup>-1</sup>) is the rate constant for Lagergren-first-order sorption. The  $k_1$  values, the correlation coefficients  $r$ , the predicted and experimental

$q_e$  values are given in Table 2. As seen in Table 2, the correlation coefficient values for BV3 biosorption on FL have changed in the range of 0.978 and 0.986. Also, the experimental  $q_{e,exp}$  values were not agree with the calculated  $q_{e,cal}$  values obtained from the linear plots. These results have shown that the experimental data do not agree with the pseudo-first-order kinetic model.

Pseudo-second-order kinetic model can be expressed as follows:

$$\frac{t}{q} = \frac{1}{K_2 q_e^2} + \frac{1}{q_e} t \quad (\text{Eq.3})$$

where  $k_2$  ( $\text{min gm}^{-1}$ ) is the rate constant for the pseudo-second-order adsorption kinetics and  $h = k_2 q_e^2$ , where  $h$  is the initial adsorption rate ( $\text{min mg g}^{-1}$ ). The parameters of the pseudo-second-order were regrouped in Table 2. As seen in this that the correlation coefficient values have changed in the range of 0.996 and 1. Also, the experimental  $q_{e,exp}$  values were agree with the calculated  $q_{e,cal}$  values obtained from the linear plots. These results have shown that the experimental data do agree with the pseudo-second-order kinetic model.

Table 2

Parameters of the kinetic models for the removal of BV3 on FL

Kinetics models	Initial concentration $C_0$ of BV3 ( $\text{mg L}^{-1}$ )			
	5	10	20	30
<b>Lagergren pseudo-first-order</b>	<b>2.35</b>	<b>4.78</b>	<b>9.28</b>	<b>14.01</b>
$q_{e,exp}$ ( $\text{mg g}^{-1}$ )	5.32	1.23	7.53	34.66
$q_{e,cal}$ ( $\text{mg g}^{-1}$ )	0.169	1.111	0.052	0.067
$k_1$ ( $\text{min}^{-1}$ )	0.989	0.978	0.998	0.986
r				
<b>Pseudo-second-order</b>	2.42	4.78	9.28	14.12
$q_{e,cal}$ ( $\text{mg g}^{-1}$ )	0.052	0.094	0.050	0.031
$k_2$ ( $\text{gm}^{-1}\text{min}^{-1}$ )	0.30	2.16	4.46	6.16
$h$ ( $\text{mg g}^{-1}\text{min}^{-1}$ )	0.999	1.000	0.999	0.996
r				

#### 4 Conclusions

The results obtained in this study demonstrated the potential use of FL for the removal of BV3 dye from aqueous solutions. The results show that the increases of initial concentration pH have a positive impact on the removal of dye. However, for the solution temperature has a negative effect to remove of dye. The biosorption kinetics of the BV3 onto the FL is well described by the pseudo-second order model.

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## Registration

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**Poster Presentation**



**Topic: 3**

**Title:** The removal of basic violet 3 by Fruit of Lufa from aqueous phase in a batch process