BIOSORPTION OF METHYLENE BLUE BY A BROWN ALGAE

Yeliz Ozudogru Cirik *, Ilknur Ak  and  Tolga Göksan  
COMU Faculty of Marine Sciences and Technology
Terzioglu Campus Canakkale - yelizozudogru@hotmail.com

Abstract

Petalonia fascia, a brown alga, was used as a biosorbent to remove methylene blue (MB) from aqueous solutions. In this study, pH, contact time and initial metal concentration of MB were studied. Langmuir and Freundlich isotherm models were also investigated. The optimum pH value was 7 and the adsorption reached equilibrium at 50 min. According to Langmuir’s model data, the maximum adsorption capacity \( q_m \) was 28.50 mgg\(^{-1}\). Results showed that Petalonia fascia was effectively used as an alternative low cost biosorbent to remove MB from aqueous solutions. <\div>

Keywords: Adsorption, Dardanelles, Algae

Introduction

Industrial wastes are one of the main sources of water pollution [1]. The wastes resulting from dye manufacturing are toxic and can cause serious environmental problems [2], so the removal of dyes from wastewater is important. Dyes are mainly used in textiles, plastics, tanneries, pharmaceuticals, leather, packed food, pulp and paper, paint and electropainting industries. Methylene blue (MB) is an organic and common type of colorant to dye cotton, wool, silk and many other materials. However, the use of MB can cause serious health problems [1,2,3]. In recent years, many low cost materials and techniques have been tested for the adsorption of dyes [4]. From these techniques, biosorption has been suggested as an alternative method due to its efficiency [5,6] and algae have been found to be a potential biosorbent [7]. Petalonia fascia (O.F. Müller) Kuntze is a brown marine macroalgae growing on stones and shells. In this study, removal of MB from aqueous solutions by P. fascia was studied.

Material and Methods

Petalonia fascia was collected from Canakkale Kepez area. The biomass was washed to remove some impurities and dried in an oven at 60°C until constant weight was reached. Dried biomass was ground and sieved. All the chemicals used in the study were analytical grade (Merck). For biosorption experiments, stock methylene blue (MB) solution (1000 mgL\(^{-1}\)) was used and five concentrations (5-10-20-50-100 mgL\(^{-1}\)) were prepared from stock solution using distilled water. For pH and contact time trials, MB concentration was kept constant at 10 mgL\(^{-1}\). The pH adjustments were performed by using 0.1 M HCl or NaOH. The MB concentrations in solutions were determined by spectrophotometer. 100 mg of each biosorbent was placed in a 50 mL Falcon tube and treated with 10 mL of MB solution. The Falcon tubes were shaken at 250 rpm at room temperature for 120 min, then samples were centrifuged at 3000 rpm and supernatants were measured by the spectrophotometer. The % removal of MB concentration was calculated according to Kousha et al. [4].

Results and Discussion

Effect of pH on the adsorption of MB

The % removals of MB in different pH values (3, 5, 7, 9) were given in Figure 1a. Accordingly, removal rates slightly increased between pH 3-9 (96.39% - 97.86%). These results were similar with the findings of the other studies [1,3].

Effect of the contact time on the adsorption of MB

The amount of MB concentration \( q_t \) was calculated according to Cirik et al. [8]. Effect of time on biosorption by P. fascia was given in Figure 1b. Figure 1b shows that the maximum adsorption capacity was found to be 0.981 mgg\(^{-1}\) and adsorption reached equilibrium after 50 min.


<table>
<thead>
<tr>
<th>Langmuir isotherm</th>
<th>Freundlich isotherm</th>
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<tr>
<td>( q_m (\text{mgg}^{-1}) )</td>
<td>( K (\text{mgg}^{-1}) )</td>
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<td>28.50</td>
<td>0.185</td>
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Adsorption Isotherms

The equilibrium data were analyzed with Langmuir and Freundlich isotherms.

The adsorbed amount in P. fascia showed positive correlation with the concentration of MB solution. The maximum adsorption capacity \( q_m \) was 28.50 mgg\(^{-1}\). In this study, the Freundlich isotherm model (\( R^2 = 0.981 \)) showed a better fit than the Langmuir isotherm model (\( R^2 = 0.719 \)) (Table 1). In our study, P. fascia had a greater \( q_m \) value than the other adsorbents [3,9,10] and it could be used as an alternative low-cost material for MB adsorption.

Fig. 1. Effect of pH (a) and contact time (b) on MB adsorption by P. fascia.

References