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Biosorption of anionic and cationic azo dye onto red macro alga: Determination of the significant variables using resolution V fractional factorial design

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ABSTRACT

Naturally inspired biosorbent from macro algae species are favored because of its excellent biosorptive capability and low cost. The present investigation reports the potential of red macro-alga, *E. spinosum* as a biosorbent to remove both anionic and cationic azo dyes, namely Acid Yellow 17 (AY17) and Methylene Blue (MB) from aqueous solution. A resolution V fractional factorial design (2_V^{5-1}) analysis was employed to study the main effects and interaction of variables on the biosorption process. Factorial matrix with five variables; pH (2–12), dosage (0.4–2 g/L), initial concentration (50–200 mg/L), contact time (5–120 min) and temperature (30-50 °C) at two levels were conducted in batch study. Pareto charts and ANOVA (within 95% confidence level) were applied to examine the relationship and significance between independent variables and their interactions. A regression model with $R^2_{AY17} = 0.9998$ and $R^2_{MB} = 0.9995$ was implemented to fit the experimental data. The results obtained indicated that the most significant variables that affected biosorption process were initial concentration and the dosage of the dyes. Experimental screenings are crucial in optimization studies. The remarkable performance of *E. spinosum* as biosorbent to absorb both dyes shows a great potential to be implemented for local marine macro alga as an alternative. Resource for biosorption process.

1. Introduction

Among the hazardous azo dyes, Acid Yellow 17 (AY17) and Methylene Blue (MB) are major pollutants in the environment due to their extensive application in daily activities. AY17 is an anionic monoazo dye that is commonly used as an additive in household products such as dishwashing liquid, shower gel, shampoo, multipurpose cleanser and alcohol-based perfumes (Gao et al., 2010; Njoku et al., 2014). Conversely to AY17, MB is categorized as a cationic diazo dye. Owing to its high adsorption ability, MB is extensively utilized in textile industry, painting and printing (Albadarin and Mangwandi, 2015). Upon entering aquatic ecosystems, azo dye molecules affect the aesthetic appearance of natural water bodies. Moreover, azo dyes molecules are to chemical and biological transformations that produce carcinogenic and genotoxic end-products (Balakrishnan et al., 2016; Morshedi et al., 2013).

Therefore, it has become a worldwide concern to search for suitable wastewater treatments that can eliminate azo dyes. Despite various approaches of treatment (ie: coagulation-flocculation, membrane filtration, advanced oxidation), most studies focused on effective and yet low-cost treatment procedures. Adsorption process for dye removal is well known for its effectiveness, ease of operation and innovativeness (Zbair et al., 2018). During adsorption, dye molecules accumulate at the external/internal adsorbent surface via chemical and biological mechanisms (Asfaram et al., 2017). Commercial activated carbon performance in adsorption process is undeniable. However, activated carbons imposed high cost in their treatment application and regeneration (Jiuhui, 2008), sometimes treated as single used. Hence, its disposal will lead to secondary pollution (Asfaram et al., 2017; Ozbay and Yargic,

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