



Biosorption of anionic azo dyes (DR5B, DB71, and RB5) onto *aspergillus* sp. RFC-1: Kinetics, isotherms, and chemisorption thermodynamics studies

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ABSTRACT

This study investigates the biosorption mechanism of three azo dyes Direct Red 5B (DR5B), Direct Blue 71 (DB71), and Reactive Black 5 (RB5) using *Aspergillus* sp. RFC-1 fungal biomass as an effective, sustainable biosorbent. The native fungal biomass, characterized by a highly interwoven, porous mycelial network with abundant exposed functional groups, exhibited an exceptional maximum monolayer adsorption capacity q_{max} of 182.20 mg/g for DR5B, significantly outperforming DB71 and RB5. Morphological (SEM) analysis confirmed that the adsorption process severely altered the DR5B-loaded biomass surface due to heavy monolayer deposition and pore filling, correlating with the highest q_{max} of 182.20 mg/g. The BET analysis showed a drastic reduction in surface area and pore volume after biosorption of DR5B, DB71 and RB5, confirming that dye uptake occurred mainly through pore-filling and surface coverage mechanisms. Equilibrium data across all dyes were best described by the Langmuir isotherm model (R^2)($R^2 > 0.99$), indicating a uniform, monolayer adsorption mechanism onto energetically equivalent sites. Kinetic analysis revealed that the process follows a Pseudo-Second-Order (PSO) model ($R^2 > 0.9978$), suggesting chemisorption involving electron sharing/exchange as the rate-limiting step. Furthermore, the DR5B and DB71 systems were found to be spontaneous and endothermic ($H^\circ > 0$), with the strong endothermicity of DR5B of $H^\circ = +58.56$ kJ/mol pointing to a significant thermal activation barrier and strong chemical interaction. These findings establish RFC-1 as a promising, high-capacity biosorbent, particularly for the challenging DR5B dye, governed by a chemisorption-controlled, monolayer mechanism.

Abbreviations

List of Abbreviation

DR5B	Direct Red 5B
DB71	Direct Blue 71
RB5	Reactive Black 5
PFO	Pseudo-First-Order
PSO	Pseudo-Second-Order
SEM	Scanning Electron Microscopy
FTIR	Fourier Transform Infrared Spectroscopy
BET	Brunauer–Emmett–Teller
pH _{zpc}	Point of Zero Charge

Keywords

Azo dyes
Biosorption
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Langmuir isotherm
Pseudo-second-order (PSO)
Thermodynamics

1. Introduction

Dyes are synthetic or natural organic compounds which provide bright and lasting color to other substances, they are used in several industries like the food industries, pharmaceuticals, cosmetics, textiles, rubber, plastic, leather and paper [30]. They may accumulate in a sediments and wastewater discharge points and affect the ecological

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