BACTERIAL EXTRACELLULAR POLYMERIC SUBSTANCE MEDIATED TREATMENT OF RESIDUAL DYES

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Introduction:

Dye wastewaters, after treatment, are either reused or released into the sewer systems/water bodies. Even though there is residual concentration of dyes in treated effluents within the permissible wastewater discharge limits, continuous accumulation causes negative penalties on aquatic life, human health and ecosystems. Release of treated textile effluents to water bodies results in reducing oxygen levels close to zero, endangering organisms, sulfide seepage leading to land infertility, increased infertility in humans and elevated amounts of dyes in water (Afroze and Sen, 2018).

One of our guide's earlier student projects was on isolation of bacteria on motor garage soil and their application in degradation of petroleum crude oil. When *Lysinibacillus* sp. SS1, isolated from motor garage soil samples, was grown in a minimal medium supplemented with PCO and trace amount of glucose, exopolymeric substance (EPS) was produced in response to PCO, extracted and purified. The purified EPS possesses the ability to adsorb residual concentrations of malachite green dye (97.2% of 2.5 mg/L) in 30 min and methyl green dye (98.92% of 8 mg/L) in 30 min individually.

Hence, the proposed research works aims at using this bacterial EPS for reduction of residual dyes in treated textile wastewaters before their discharge into sewer systems/water bodies. This project offers simple solutions to damaging effects on the environment, human beings and aquatic life. Unique properties of EPS such as biodegradability, eco-friendliness, stability at various temperatures and pH, along with minimal use of energy can be targeted for simultaneous removal of trace dyes.

Objectives:

The following research objectives have been established with mixture of methyl green (MG) and malachite green (MLG) as model dyes.

1. To study the effect of process parameters on multi-dye removal by EPS of *Lysinibacillus* sp. SS1
2. Analysis of mechanism of multi-dye removal – adsorption, adsorption with biodegradation
3. To study effects of metals and multivalent cations on multi-dye removal
4. To test efficacy of bacterial EPS in multi-dye removal in simulated treated textile dye wastewater & toxicity analysis

Methodology:

The effect of process parameters like pollutant concentration, EPS weight, temperature, pH, agitation speed and incubation time on multi-pollutant removal were studied using the OFAT approach. Also, the effect of other metals and ions on the removal were studied. This is essential for the design of the process of treatment. There are two mechanisms of dye removal i.e., adsorption, adsorption with degradation. The mechanism of dye removal by EPS was identified by analysis of UV-Vis spectrum of treated and untreated dye solution. Then, the kinetics, isotherms and thermodynamics of multi-pollutant adsorption by EPS were detailed.Since the textile wastewater consists of metals and multivalent cations, their effect on multi-dye removal by bacterial EPS were studied by performing experiments in their presence.The removal efficacy of EPS in treatment of various simulated discharged textile wastewater containing dyes was investigated. Additionally, the toxicity of untreated and treated simulated discharged textile wastewater will be studied on pulse seeds on exposure to untreated and treated synthetic industrial effluent were compared.

Results and Conclusions:

In this study, simultaneous adsorption of residual amounts of malachite green (MLG) and methyl green (MG) was carried out by extracellular polymeric substance (EPS) produced by *Lysinibacillus sp.* SS1 in response to petroleum crude oil stress. Previous studies suggested that there are strong electrostatic attractions between the surface functional groups of the adsorbent and cationic dyes. UV-Vis spectrum of aqueous solution after 30 min of incubation revealed the reduction in peak area of the dyes without any appearance of new peaks. This indicated that removal of both dyes by EPS-SS1 was adsorption only. The effect of process parameters (dye concentration, EPS, temperature, agitation speed, pH, contact time) on the adsorption was evaluated using OFAT approach. Under optimum conditions of initial dye concentration = 5 mg/L, EPS = 100 µg, temperature = 40 ºC, pH = 6, contact time = 40 minutes, the maximum uptake capacities were 233.13 mg/g and 246.92 mg/g for MG and MLG respectively. OFAT experiments revealed that pH and agitation speed did not affect the adsorption process. Adsorption kinetics, thermodynamics and isotherm models were employed to understand the mechanism of dye removal. The presence of co- existing cations and metals in the solution resulted in the nominal reduction of uptake of dyes by the EPS. Phyto-toxicity study via germination of seeds verified the efficacy of the EPS in eliminating the dye species multi-adsorptive systems.

Scope for future work:

The work can be further extended by studying the adsorption of various other combinations of dyes by EPS secreted and the results can be compared. The project can be further upgraded with including three dyes and studying the simultaneous adsorption of all the three dyes present in the aqueous solution by EPS -SS1. The efficacy of the EPS as an adsorbent can be tested with the help of simulated wastewaters with various compositions. The efficacy of EPS as an adsorbent secreted from other sources can be compared with EPS - SS1.