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Chemometric formulation of bacterial consortium-AVS for improved decolorization of resonance-stabilized and heteropolyaromatic dyes

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HIGHLIGHTS

- Bacterial consortium was formulated with three rapid dye decolorizing strains.
- The bacterial consortium formulation was done using mixture design matrix under DOE.
- Biotransformation of dyes was characterized by UV–vis, HPLC and FT-IR analysis.
- Toxicity of dyes and their metabolites were assessed on plant growth parameters.

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ABSTRACT

A bacterial consortium-AVS, consisting of *Pseudomonas desmolyticum* NCIM 2112, *Kocuria rosea* MTCC 1532 and *Micrococcus glutamicus* NCIM 2168 was formulated chemometrically, using the mixture design matrix based on the design of experiments methodology. The formulated consortium-AVS decolorized acid blue 15 and methylene blue with a higher average decolorization rate, which is more rapid than that of the pure cultures. The UV–vis spectrophotometric, Fourier transform infra red spectrophotometric and high performance liquid chromatographic analysis confirm that the decolorization was due to biodegradation by oxido-reductive enzymes, produced by the consortium-AVS. The toxicological assessment of plant growth parameters and the chlorophyll pigment concentrations of *Phaseolus mungo* and *Triticum aestivum* seedlings revealed the reduced toxic nature of the biodegraded products.

1. Introduction

Rapid urbanization, industrialization and technological innovations in various disciplines have led to the problem of environmental pollution. The increasing use and release of large amounts of synthetic dyes into the environment causes public concern and legislation problems, and is a serious challenge to environmental scientists (Forgacs et al., 2004). O'Neill et al., 1999 mentioned that annually 16.8% of textile dyes are lost in the effluents. On the basis of the chemical structure of the chromophoric group, dyes are classified as azo, anthraquinone, triphenylmethane, phathalocyanine dyes etc., (Zollinger, 1991).

The triphenylmethane (TPM) group of textile dyes has a complex aromatic molecular structure, which resists degradation in the environment, resulting in direct and indirect exposure of the human population to high concentration of these dyes. On the basis of their potential for adverse human health effects, the United States Food and Drug Administration listed several TPM dyes as priority chemicals for carcinogenicity testing by the National Toxicology Program in 1923 (Culp and Beland, 1996). The TPM dyes are more complex, due to the presence of additional phenyl rings in their molecular structure. These resonance-stabilized ring structures impart intense color to fabrics but make the dyes highly recalcitrant and less susceptible to microbial attack. The heteropolyaromatic thiazine based methylene blue has various harmful effects, and when high concentrations of this dye in the solid form, come into contact with the human eye, have been known to cause corneal and conjunctival injury. Methylene blue

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