

Microbes as remediating agents in detoxification of dyes

Abstract

Dyes are colored substances being used to color various types of fabrics and materials from ancient time. During their use in the coloring of various types of materials as well as during their synthesis; they come out in the environment as such or in the form of toxic by-products and by mixing in aqueous system generate various types of problems to organisms living in that aqueous environment as well as human beings using that polluted water in any way. Several techniques are being used in the present time to solve such environmental problems. In this direction, many researches are also running on the green use of microbial technology in bioremediation of toxic, carcinogenic and extremely harmful unused dye's products as well as its by-products by elimination or degradation or de-colorization. This mini-review discusses about the some recent researches done in this field in order to solve this problem and future aspect of the use of this green technology.

Keywords: dyes, microbes, bacteria, fungi, bioremediation, decolorization

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Introduction

Dyes are colored substances mostly used for coloring the different types of fabrics and other materials in order to give them an attractive and stable look. They may be of synthetic or natural in origin. In the present time of the industrialization; synthetic dyes are used extensively for coloring the various materials. Different types of dyes, their functions and chemistry is not so important here as discussion on searching the solution for its harmful pollution effects.¹ During their use for coloring, they may come out as unused molecules or as their by-products in the outer aqueous environment and generate pollution which may be very harmful for lives living in that system. In order to remove these toxic substances, several research works are running continuously all over the world on bioremediation technology. Fungi, bacteria, fungal and bacterial associated enzymes and other green sources have attained a great attention for their biological and green roles in the field of bioremediation of different types of pollutants.^{2,3} Green technology using the microbial system for the treatment of such pollutants is proving their effectiveness due to their potential role without producing any additional pollution to environments. This paper has been objectively written in order to provide a brief discussion on some important recent works done on microbial based detoxification of various toxic dyes.

Microbes

Microbes or microorganisms are the microscopic in nature and may exist as unicellular form or as colony of cells. All unicellular organisms come into this category. All the archaea (prokaryotes lacking cell nuclei) and bacteria are microbes and are almost always microscopic while most protists, some fungi and some micro-animals and plants like eukaryotes are also found in microscopic nature.⁴ Figure 1 is showing a schematic representation of phylogenetic tree.⁴

Microbial bioremediation of dyes

Microbes play significant role in the field of bioremediation and may be very fruitful in saving environment from the different types of pollution.⁵⁻²³ Many publications of authors have also valuable information in the field of microbial bioremediation.⁵⁻⁹ Use of microbes in the treatment of dyes is bright research area of the green chemistry

sector because it neither requires any drastic conditions nor produces any toxic pollutants or toxic by-products. Significant researches in this field have been performed and several are also running worldwide. Authors have discussed here about some important recent year (2020) works or reviews in this field.

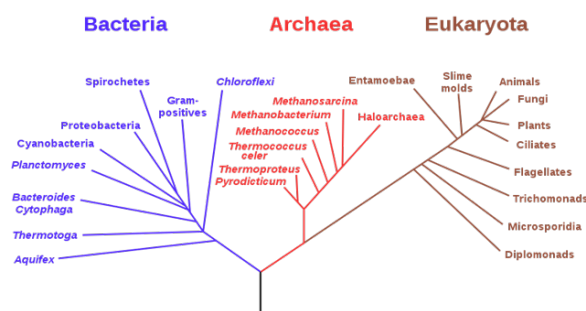


Figure 1 Carl Woese's 1990 phylogenetic tree based on rRNA data.

Decolorization of triazo dye, direct blue 71

Zin et al.,¹⁰ worked on title "Microbial Decolorization of Triazo Dye, Direct Blue 71: An Optimization Approach Using Response Surface Methodology (RSM) and Artificial Neural Network (ANN)".]. During their study, they found that the mixed bacterial culture decolorized the Direct Blue 71 dye's triazo bond without the presence of carbon and nitrogen sources in anaerobic condition, amazingly. Proper optimization study has been successfully performed by them. In optimized condition, they obtained 86.13% and 86.5% validated de-colorization as predicted by RSM and ANN.¹⁰

Detoxification of sulfonated diazo dye RB5

Al-Tohamy et al.,¹¹ worked on title "Performance of a Newly Isolated Salt-Tolerant Yeast Strain *Sterigmatomyces halophilus* SSA-1575 for Azo Dye Decolorization and Detoxification" and effectiveness of the halo-tolerant yeasts, ecofriendly treatment of harmful pollutants and dye waste water has been shown by the result of this study. During study, halo-tolerant yeast strain *S. halophilus* SSA-1575 was identified and 10 characterized which was able to effectively detoxify the sulfonated diazo dye RB5.¹¹

Mixed dyes reactive red 21 and reactive orange 16

Mishra et al.,¹² performed a nice work on bacterial based biodegradation of reactive azo dyes coupled with bio-energy generation from model wastewater". Bacteria *Pseudomonas aeruginosa* 23N1 was used for degradation study of mixed dyes Reactive Red 21 and Reactive Orange 16. Effective de-colorization of real textile wastewater was found by the bacteria used in the study.¹²

Reactive black 5, direct blue 71 and disperse red I

Ishchi & Sibi¹³ performed a novel work on *Chlorella vulgaris* based azo dye-degradation and studied its optimization and kinetics. They used different dyes like Reactive Black 5, Direct Blue 71 and Disperse Red 1 in order to examine the degrading capability of this microalgae and their result showed its azo dye degrading potential.¹³

Reactive black 5

Sheela & Sadasivam¹⁴ performed work on title "Dye degradation potential and its degradative enzymes synthesis of *Bacillus cereus* SKB12 isolated from a textile industrial effluent" in which they isolated a bacterium identified as *Bacillus cereus* SKB12. Effective dye degradation of Reactive Black 5 was observed by the use of this bacterium. Their result suggests that this bacterium may be possibly used as agent for the treatment of effluents containing textile dyes.¹⁴

Decolorization of reactive black 5 and reactive red 152

Seyedi et al.,¹⁵ nicely used haloalkaliphilic bacteria (from textile wastewater) for decolorization study of Reactive Black 5 and Reactive Red 152 azo dyes. Three bacterial strains among isolated 50 bacterial strains isolated from effluents showed excellent decolorization capabilities for these two dyes. Consortium of these three isolates showed 87% decolorization for Reactive Black 5 while 85% decolorization for Reactive Red 152.¹⁵

Varjani et al.,¹⁶ nicely reviewed about the techniques that have been used for solving the problems of dyes pollution. Roy et al.,¹⁷ nicely discussed about the role of two bacterial strains in the treatment of malachite green. A review written on title "Recent myco-dye decolorization studies (mini-review)" by Chaurasia & Bharati¹⁸ has a brief discussion on the role of fungi or fungal associated enzymes in the bioremediation of toxic dyes. In this direction they nicely demonstrated the different recent works done by different researcher on fungi or fungal enzyme for dyes de-colorization and degradation. Current status and prospects in the field of bioremediation of dyes is nicely assessed and described by Ihsanullah et al.¹⁹ Table 1 shows about the some recent works in the field of microbial based bioremediation of dyes.

Table 1 Some recent works on microbial bioremediation of dyes

S. No.	Microbes	Detoxification/decolorization/degradation of dyes	Ref.
1	Mixed bacterial culture	Direct Blue 71	Zin et al. ¹⁰
2	<i>S. halophilus</i> SSA-1575	Sulfonated diazo dye RB5	Al-Tohamy et al. ¹¹
3	<i>Pseudomonas aeruginosa</i> 23N1	Mixed dyes Reactive Red 21 and Reactive Orange 16	Mishra et al. ¹²
4	<i>Chlorella vulgaris</i>	Reactive Black 5, Direct Blue 71 and Disperse Red I	Ishchi & Sibi ¹³
5	<i>Bacillus cereus</i> SKB12	Reactive Black 5	Sheela & Sadasivam ¹⁴
6	Haloalkaliphilic bacteria	Reactive Black 5 and Reactive Red 152	Seyedi et al. ¹⁵
7	Bacteria-fungi consortium	Red-S3B	Shakeel et al. ²⁰
8	Mushrooms	Dye decolorization (Review)	Gulzar et al. ²¹
9	Bio-membrane	Textile dyes	Day et al. ²²
10	Tree bark scrape fungus	Non-textile dyes	Sayyed et al. ²³

Conclusion

Above discussions nicely demonstrate about the role of microbes in treatment of pollution generated by dyes directly or indirectly. Efficiency of microbes in the depollution of dyes wastes can receive well recognition but it requires more researches in this field for proving its concrete applicability in this sector. Green technologies using microorganism may be very useful for the purpose of bioremediation highly toxic dyes molecules and their by-products, that's why, it is a very attractive field of environmental science for researchers.

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Conflicts of interest

No conflict of interest was reported by the authors.

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