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REVIEW ARTICLE

Novel Method for Remediation of Toxic Dyes in the Environment

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ABSTRACT

The toxic dyes released from various industries, such as sugar, pharmaceutical, paint, leather industries, etc. cause harmful effects on the environment and many living organisms. The solution to solve this problem is the need of the hour. The biological approach for removing toxic dyes in the environment is very eco-friendly and economical. This is a sustainable approach. The microorganisms, i.e., bacteria, actinobacteria, fungi, algae and yeasts, can be used to remove or degrade toxic dyes in the environment.

Keywords: Biosorption, Economical, Eco-friendly, Environment, Sustainable.

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INTRODUCTION

Many toxic dyes cause soil and water pollution and are serious issues that need immediate solutions (Henagamage, 2019). The toxic dyes include azo dyes, acid orange, acid red, solvent red, etc. (Tang *et al*., 2022). The removal of dyes by chemical methods has disadvantages, viz., costly, causes pollution, and is time-consuming. The biological approach for the removal of these toxic dyes in the environment is eco-friendly, easy and economical (Vikrant *et al*., 2018). The toxic dyes are released from various industries such as paint, food, leather, pharmaceutical, etc. (Fig. 1). These dyes enter the water bodies and soil, causing both pollution. The microorganism's bacteria, actinobacteria, fungi, yeasts, algae, etc. can be used for the removal of toxic dyes from the environment. There is a report on the remediation of dyes using microorganisms (Tripathi *et al*., 2023).

Microbial Biomass

The biomass of microorganisms can be used for the removal of toxic dyes from polluted water and soil (Bharathi *et al*., 2022). The microorganisms can be grown in media on a rotary shaker and the biomass can be harvested and used for the removal of toxic dyes in the environment. This is called as "biosorption". In the group of microorganisms, the fungi are more effective in biosorption. Microorganisms' live and dead biomass can be used for biosorption. The dead biomass can be prepared by the treatment of acids (e.g. hydrochloric acid - HCl) or alkali (e.g. sodium hydroxide - NaOH) or solvents (e.g. formaldehyde - HCHO). The biosorption process for the removal of toxic dyes in the environment can be used globally. The use of fungi and algae for the removal of toxic dyes is called mycoremediation and phytoremediation, respectively.

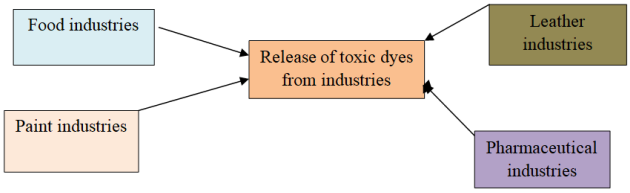

Figure 1: Industries responsible for the release of toxic dyes

Mechanism for the removal toxic dyes in the environment

The exact mechanism behind the biosorption is not yet known. The microorganisms on their surface have functional groups e.g. -OH, -COOH, -NH_2, -CH, -CH_2, etc. These functional groups can be responsible for the removal of toxic dyes in the environment. The other mechanism can be the 'degradation' of toxic dyes into simpler forms. The microorganisms can degrade the complex form of dyes into simpler forms, reducing the toxicity of many dyes (Akansha *et al.,* 2023).

Microorganisms for the removal of toxic dyes

The list of microorganisms for the removal of toxic dyes is represented in Table 1.

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Table 1: List of microorganisms for the removal of toxic dyes

Bacteria	*Actinobacteria*	*Fungi*	*Yeasts*	*Algae*
Pseudomonas sp.	*Streptomyces* sp.	*Aspergillus* sp.	*Saccharomyces* sp.	*Spirogyra* sp.
Bacillus sp.	*Nocardia* sp.	*Penicillium* sp.	*Candida* sp.	*Chlorella* sp.
Burkholderia sp.		*Rhizopus* sp.		
Acinetobacter sp.		*Cladosporium* sp.		
Serratia sp.				

Microbial enzymes for degradation of toxic dyes in wastewater

The microorganisms produce enzymes such as cellulase, laccase, manganese and lignin peroxidase (Zafar *et al.*, 2022) which can help in the degradation of toxic dyes present in wastewater. These enzymes can directly degrade the toxic dyes and reduce their toxicity (Pande *et al*., 2019, Pham *et al.,* 2023).

Anaerobic microorganisms in the removal of toxic dyes

Methanogenic bacteria play an important role in the degradation of toxic dyes. Mainly the anaerobic bacteria use dye decolorization method, during which various carbon sources are the energy source (Manu and Chaudhari, 2002). Glucose is the best carbon source in the decolorization process. In anaerobic conditions, the redox mediator is azo reductase which binds the membrane of the cell. During the decolorization process, the dye accepts electrons and color change in the dye is seen.

CONCLUSION

The best solution is the biological approach for removing toxic dyes present in waste water, effluents and released from various industries. The work on large-scale studies still needs to be carried.

Conflict of interest

The author declares there is no conflict of interest.

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