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Present Status of Biodegradation of Textile Dyes

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Abstract

Azo dyes are widely used in textile industries for coloring the fabrics. These industries produced a large amount of wastewater contaminated with azo dyes which may be toxic to all life forms. Therefore, removal of dyes from wastewater is necessary prior to their disposal. The biological methods are an inexpensive and environment friendly way for the degradation of dyes from textile wastewater. Different taxonomic group of microorganisms are used in the biological treatments of textile dyes.

Keywords: Azo dyes; Wastewater; Biodegradation; Azoreductase

Introduction

Synthetic dyes are unsaturated poly-aromatic molecules which are soluble or dispersible in water or solvent and give a permanent color to materials like textile fabrics. These dyes are extensively used in various industries such as textile, paper, food, leather, cosmetics and pharmaceutical industries [1]. Among the different industries, textile industries are the largest consumer of synthetic dyes. Over 10,000 synthetic dyes (including several varieties) with an estimated annual production of 700000 metric tons are commercially available worldwide [2]. These dyes can be classified in a number of ways, including color, intended use, trade name, chemical constitution and on the basis of their application. Chemical classes of dyes generally azo, triphenylmethane and anthraquinone have been utilized more frequently at industrial scale [3]. Among the different synthetic dyes, azo dyes account for more than one half (60-70%) of all dyestuffs produced and are the largest and most commonly group of dyes used in textile industries. Azo dyes are characterized by aromatics substituted with one or more azo groups (-N=N-) [4]. The textile industry is one of the greatest generators of dye containing wastewater. During textile dyeing process all dyes do not bind to the fabric due to inefficiency in dyeing process. The amount of dyes lost through textile wastewater is dependent upon the class of dye utilized, shifting from 2% for basic dyes to 50% for reactive dyes. Roughly, 20% of these unused dyestuffs directly enter in the environment through textile wastewater because a large portion of these dyes escape conventional wastewater treatment processes [5]. The textile industry wastewater has adverse impacts in terms of Total Organic Carbon (TOC), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total suspended solids (TDS), salinity, color, a wide range of pH (5-12) and the recalcitrance of organic compounds, such as azo dyes [6].

Toxicity of dyes

Many synthetic dyes are highly visible at concentrations less than 1mg lit^{-1} in water. The dye concentrations in the textile processing wastewaters are generally in the range of 10-200mg lit^{-1}. The majority of dyes represent a potential danger to all forms of life. These dyes may cause allergic responses, skin dermatoses, eczema [7], and also affect the liver, lungs, vasco-circulatory system, immune system and even the reproductive system of experimental animals as well as humans [8]. The release of these dyes into water bodies is potentially toxic to aquatic life. In addition, many azo dyes and their degradation intermediates are toxic, carcinogenic or mutagenic to life forms [9].

Current treatment processes for removal of dyes

Several methods were adapted for the reduction of dyes to achieve decolorization. The use of one individual process may often not be sufficient to achieve complete decolorization because each technique has its limitations. Various physico-chemical methods such as adsorption, coagulation, precipitation, filtration, oxidation, ozonation, Fenton's reagent, electrochemical destruction and photocatalysis may have potential for treatment of dyes containing textile wastewater but these methods have many drawbacks. These technologies usually involve

complicated procedures and an economically unfeasible [10-11]. It is, therefore, necessary to develop an efficient, cost-effective and viable alternative method for the decolorization and degradation of dyes in textile effluents.

Biological Treatment process

The biological treatment processes using a wide range of microorganisms (bacteria, fungi, yeast and algae) can overcome the limitations because it is cost competitive, produces less amount of sludge and eco-friendly alternative to conventional physico-chemical treatment [12]. Different trophic groups of bacteria (for example, *Pseudomonas, Staphylococcus, Halomonas* etc.) have been reported that can achieve a higher degree of decolorization and degradation of many azo dyes under optimum conditions as compare to other microbes [9-13]. The bacterial system may be capable to decolorize the azo dyes under anaerobic and aerobic condition or involve a combination of the two [14].

Mechanism of bacterial degradation of azo dyes

The initial step in the bacterial degradation of azo dyes is the reductive cleavage of highly electrophilic azo bond under static, anoxic or anaerobic conditions which leads to the formation of colorless aromatic amines. This process may be catalyzed by soluble cytoplasmic enzymes (azoreductase), low molecular weight redox mediators, chemical reduction by biogenic reductants like sulfide, or a combination of them [1]. The resulting products are colorless aromatic amines which are further degraded to simpler non-toxic forms by multiple-step bioconversion occurring aerobically or anaerobically [9]. It has also been reported that the treatment systems composed of mixed microbial populations/consortium have higher level of biodegradation and mineralization due to synergistic metabolic exercises of microbial group and offers significant points of interest over the utilization of pure cultures in the decolorization and degradation of synthetic azo dyes [15].

Conclusion

Azo dyes are the commonly used dyes in textile industries. The improper disposal of these dyes in the environment has serious environmental concern. Several physico-chemical methods have been used for the treatment of dye containing wastewater but these methods have many limitations. As an alternative over physico-chemical methods, biological treatment methods are seen as an attractive solution for the treatment of textile dye containing wastewater.

Conflict of Interest

We have no conflict of interest with anybody working in the area.

References

1. Singh RL, Singh PK, Singh RP (2015) Enzymatic Decolorization and Degradation of Azo Dyes – A Review. Int Biodeterior Biodegradation 104: 21-31.
2. Baban A, Yediler A, Ciliz NK (2010) Integrated water management and CP implementation for wool and textile blend processes. Clean 38(1): 84-90.
3. Khadijah O, Lee KK, Mohd F, Abdullah (2009) Isolation, screening and development of local bacterial consortia with azo dyes decolorizing capability. Malaysian J Microbiol 5(1): 25-32.
4. Singh RL, Gupta R, Singh RP (2015) Microbial Degradation of Textile Dyes for Environmental Safety. In: Advances in Biodegradation and Bioremediation of Industrial Waste, R Chandra (Editor) CRC press, pp. 249-285.
5. Bayoumi MN, Al-Wasify RS, Hamed SR (2014) Bioremediation of Textile Wastewater Dyes Using Local Bacterial isolates. Int J Curr Microbiol Appl Sci 3(12): 962-970.
6. Kuberan T, Anburaj J, Sundaravadivelan C, Kumar P (2011) Biodegradation of azo dye by *Listeria* sp. Int J Environ Sci 1(7): 1760-1770.
7. Su JC, Horton JJ (1998) Alergic contact dermatitis from azo dyes. Autralas J Dermatol 39(1): 48-49.
8. Nikulina GL, Deveikis DN, Pyshnov G (1995) Toxicity dynamics of anionic dyes in air of the work place and long term effects after absorption through skin. Med Tr Prom Ekol 6: 25-28.
9. Singh RP, Singh PK, Singh RL (2014) Bacterial decolorization of textile azo dye Acid Orange by *Staphylococcus hominis* RMLRT03. Toxicol Int 21(2): 160-166.
10. Lade, SH, Waghmode TR, Kadam AA, Govindwar SP (2012) Enhanced biodegradation and detoxification of disperse azo dye Rubine GFL and textile industry effluent by defined fungal-bacterial consortium. Int Biodeterior Biodegradation 72: 94-107.
11. Das MP, Bhowmick M, Reynolds M (2016) Biological decolorization of carcinogenic azo dye: an ecofriendly approach. Int J Pharm Bio Sci 7(3): 1164–1170.
12. Kalyani DC, Telke AA, Dhanve RS, Jadhav JP (2009) Ecofriendly Biodegradation and detoxification of Reactive Red 2 textile dye by newly isolated *Pseudomonas* sp. SUK1. J Hazard Mater 163(2-3): 735-742.
13. Asad S, Amoozegar MA, Pourbabaee AA, Sarbolouki MN, Dastgheib SMM (2007) Decolorization of textile azo dyes by newly isolated halophilic and halotolerant bacteria. Bioresour Technol 98(11): 2082-2088.
14. Cui D, Zhang H, He R, Zhao M (2016) The Comparative Study on the Rapid Decolorization of Azo, Anthraquinone and Triphenylmethane Dyes by Anaerobic Sludge. Int J Environ Res Public Health 13(11): E1053.
15. Saratale RG, Saratale GD, Chang JS, Govindwar SP (2011) Bacterial decolorization and degradation of azo dyes: A review. J Taiwan Inst Chem Eng 42: 138-157.

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