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# Bioremediation of Textile Dye Wastewater of Sanganer in Jaipur

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**ABSTRACT:** Synthetic dyes are extensively used by textile industries leading to the generation of enormous volumes of coloured effluents post dyeing and printing process. People are using synthetic colors and textile dye industries are producing huge volumes of wastewater, creating aquatic pollution all over the globe. Dyes in wastewater often lead to calamities viz. the incidence of bladder tumors has been reported to be particularly higher in dye industry workers than in the general population. These anthraquinone dyes and their metabolites released in the effluents are both carcinogenic and mutagenic to life forms. The study area selected was textile cluster units of Sanganer, Jaipur region. These clusters units at Sanganer, Jaipur use lot of water during dye processing and then the untreated waste water from these units is directly discharged into drains, ponds, lakes and rivers. Bioremediation is a process used to treat contaminated media, including water, soil and subsurface material, by altering environmental conditions to stimulate growth of microorganisms and degrade the target pollutants. Cases where bioremediation is commonly seen is oil spills, soils contaminated with acidic mining drainage, underground pipe leaks, and crime scene cleanups. These toxic compounds are metabolized by enzymes present in microorganisms. Bioremediation can be carried out by microbes that are naturally present in the environment or adding nutrients, this process is called biostimulation. Researchers are currently investigating ways to augment contaminated sites with nonnative microbes—including genetically engineered microorganisms—specially suited to degrading the contaminants of concern at particular sites.

**KEYWORDS:** textile, dye, sanganer, bioremediation, microbes, wastewater

## I. INTRODUCTION

Sanganer textile industry in Jaipur is one of the largest handloom manufacturing zone from western India covers more than 154 block printing units. It is because of the toxic nature of effluents generated by textile cluster, it has gained much attention. However, existing physio-chemical technologies to clean up polluted water or soil are expensive and cause secondary problems in terms of disposal. Moreover azo dyes have been linked to human bladder cancer, splenic sarcomas, hepatocarcinomas and nuclear anomalies in experimental animals and chromosomal aberrations in mammalian cells. Some azo dyes induce liver nodules in experimental animals and there are a higher numbers of bladder cancers in dyeing industries workers. Nevertheless, studies have shown that certain group of microorganisms produce enzymes to degrade dyes, decolorize and metabolize them. Microbial bioremediation of textile wastewaters is sought after as an eco-friendly and sustainable alternative to the conventional treatment methods. Given the adaptive nature of microorganisms to xenobiotic pollutants, a large number of microorganisms, including bacteria, fungi, yeasts, algae or microbial consortia and microbial communities have been tested for the biodecolourization, biodegradation and mineralization of various types of textile dyes and wastewaters in recent years.[1]



**Sanganer handblock printing**

The isolation of aerobic bacterial strains capable of degrading different dyes has been carried out for more than two decades. Biodegradation of the dye by certain groups of fungi during dye removal has been extensively demonstrated. Ligninolytic enzymes secreted by white rot fungi bind non-specifically to the substrate and therefore can degrade a wide variety of recalcitrant compounds and even complex mixtures of pollutants including dyes.[2]

## II. OBSERVATIONS

Different algal sp. (*Chlorella* sp. *Oscillatoria* sp. etc) have also been investigated to check the efficiency of their azoreductase enzymes for disintegration of textile based azo dyes. According to some studies, the algal azo reductases have been shown to produce aromatic amines by breaking down azo bond of azo dye compounds. In relation to this, there are some algae that can carry out the direct degradation of azo dyes instead of converting them into aromatic compounds first. Bacterial azo dye degradation involves an electron donor and sequence of enzymatic steps aided by azoreductase that catalyze the cleavage of azo linkages. Lignin-degrading system (LDS) of fungi has been reported for effective degradation of variety of industrial dye wastewaters. Fungi can be classified on the bases of its degradation efficacy [3] under following terms:

- Ligninolytic fungal degradation
- Fungal biosorption
- Mycorrhizal fungal degradation



**Textile Industry dye wastewater**

In general, the diseases provided by textile dyes comprise from dermatitis to disorders of the central nervous system or may be related to the substitution of enzymatic cofactors that result in the inactivation of the enzymatic activities themselves. The acute toxicity to textile dyes is caused by oral ingestion and inhalation, especially by exposure to dust triggering irritations to the skin and eyes. The workers who produce or handle reactive dyes may have contact dermatitis, allergic conjunctivitis, rhinitis, occupational asthma or other allergic reactions. The latter are the result of the formation of a conjugate between human serum albumin and the reactive dye, which acts as an antigen producing immunoglobulin E (IgE) antibodies, which combine with histamine. Some dyes reveal mutagenic potentiality. The textile dyes may offer carcinogenicity, especially those of the azo and nitro type, and its effects manifest themselves over time. In humans, dyes are capable of generating chemical cystitis, irritation of the skin and digestive tract, respiratory and renal failure, among others.[4]



**Allergic conjunctivitis**

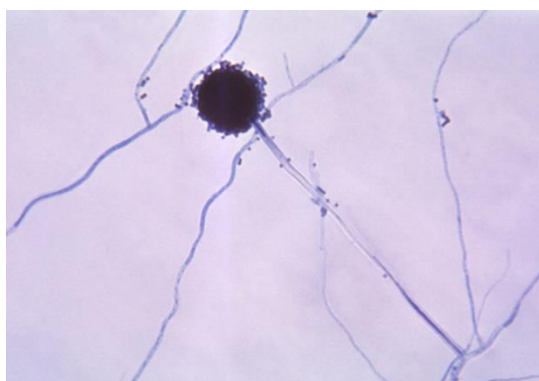


**Tumour induced by dye wastewater**

Textile wastewater constitutes a large number of chemicals like acids, bases, salts, dispersants, etc. and most importantly dyes that altogether are responsible for high biological oxygen demand (BOD), chemical oxygen demand (COD) and total organic carbon (TOC). Dyes therefore are one of the most important constituents of the textile industry and are major pollutants of water reservoirs.[5]

#### IV. DISCUSSION

Fungi can survive in a variety of habitats with complex soil matrix serving as the major location for fungal colonization along with freshwater as well as marine habitats which also show stable colonization of fungi. Fungi can largely thrive in the soils of different climatic conditions including the extreme ones and propagate through the dispersal of spores in the air and also help in maintaining the balance of ecosystem. They have also been reported to survive in effluent treatment plants (ETPs) treating various waste waters. The diversity of habitats and ability for secreting multitude of enzymes makes fungi potential candidates for bioremediation at various sites. Examples of fungi are *Aspergillus*, *Phanerochaete*, *Mucor*, *Rhizopus*, *Agaricus* etc. This is called Mycoremediation.[6]



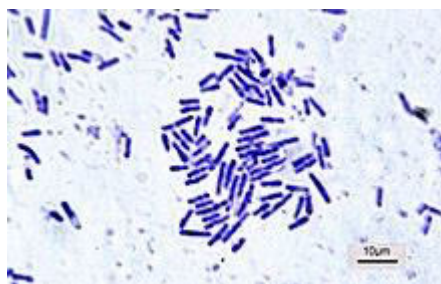
*Aspergillus niger*

Algae like *Chlorella*, *Spirulina* etc are commonly used in bioremediation technology. This is called Phycoremediation.



*Chlorella species*

Another strategy, bioaugmentation or bioaddition, is the addition of microbial populations to indigenous, alien or genetically modified organisms (GMO), in places where there is an insufficiency of indigenous microorganisms with ecophysiological characteristics compatible with the habitat conditions that are conducive to the promotion of bioremediation. Examples of bacteria in this regard are *Pseudomonas*, *Bacillus*, *Streptococcus* etc.[7]



*Bacillus species*

Currently, there is wide variety of microorganisms (bacteria, fungi, yeasts, algae) that are being studied for use in bioremediation processes. Even plants have the capability of absorbing dyes and heavy metals through roots and stem cellulose thus making their contribution in bioremediation technology. This is called phytoremediation. *Phragmites* species is a common example here.



*Phragmites species*

**IV. RESULTS**

*Pseudomonas* sp., *Citrobacter* sp., *Escherichia coli*, and *Micrococcus* sp. showed that plasmid was present in all isolates. *Micrococcus* sp. was reported to work well in an adapted environment, while *E. coli* showed the same decolorization potential in adapted and non-adapted environments. *Pseudomonas putida* and *Portulaca grandiflora* and reported complete degradation of a sulfonated diazo dye. Enzymes involved were reported as 2,6-dichlorophenol indophenol reductase, riboflavin reductase, lignin peroxidase, and tyrosinase in *P. grandiflora* and veratryl alcohol oxidase, laccase, and 2,6-dichlorophenol indophenol reductase in *P. putida*. [8]

**Table1: Degradation of Various Dyes using Bacteria**

#	Dye	Bacteria	Mechanism	Reference
1	Synazol Red 6HBN	<i>Alcaligenes aquatilis</i>	Mineral salt medium, 4 days, 37 °C, pH 7, static with yeast extract, and saw dust	Ajaz <i>et al.</i> 2019
2	Novacron Super Black G	<i>Bacillus cereus</i> AZ27, <i>Alcaligenes faecalis</i> AZ26, and <i>Bacillus</i> sp. AZ28	Nutrient broth medium, 4 days, 37 °C, pH 8, and at static condition	Hossen <i>et al.</i> 2019
3	Congo Red, Phenol Red, Direct Yellow, Direct Red, Acid Orange, Direct Violet, Direct Blue, Direct Pink	<i>Staphylococcus</i> sp., <i>Bacillus</i> sp., <i>Pseudomonas</i> sp., <i>Enterobacter</i> sp., <i>Micrococcus</i> sp., and <i>Klebsiella</i> sp.	Nutrient broth medium, 3 days	Islam <i>et al.</i> 2017
4	Methyl Orange and Congo Red	<i>Sphingomonas paucimobilis</i> , <i>Rhizobium radiobacter</i> , and <i>Bacillus subtilis</i> (Consortia)	Nutrient broth medium, 4 days, 37 °C, pH 7.5, shaken at 120 rpm (free cell vs. immobilized consortia)	Allam 2017
5	Red and Green dye	<i>Bacillus</i> sp., <i>Pseudomonas</i> sp., and <i>Aspergillus</i> sp.	Nutrient broth 1 day for bacteria and Sabouraud's Dextrose broth 3 days for fungi, 37 °C, occasional shaking	Fatima and Alamgir 2015
6	Reactive Blue 172	<i>Providencia rettgeri</i> strain HSL 1	Wheat bran medium, 20 h, 30±0.2°C, pH 7, shaken at 120 rpm, under microaerophilic conditions (correlated with NADH-DCIP reductase and azoreductase activity)	Lade <i>et al.</i> 2015
7	Textile effluent	<i>Enterobacter asburiae</i> and <i>Enterobacter cloacae</i> (consortium)	Nutrient broth, 10 min, 32 °C, pH 1.67, under aerobic conditions	Singh <i>et al.</i> 2017
8	Reactive Black 5	<i>Arthrobacter soli</i> BS5	Nutrient broth, 5 days, 37 °C, pH 5 to 9, static	Khan and Malik 2018
9	Direct Red 2B	<i>Klebsiella</i> sp. and <i>Staphylococcus</i> sp.	Bushnell Hass minimal salt medium, 5 days, 37°C, pH 7, rotary shaker at 100 rpm, supplementation 1% glucose	Desai 2017
10	Direct Blue 151 and Direct Red 31	<i>Bacillus flexus</i> strain NBN2, <i>Bacillus cereus</i> strain AGP-03, <i>Bacillus cytotoxicus</i> NVH 391-98, and <i>Bacillus</i> sp.L10	Mineral salt medium, 5 days, 36 °C, pH 9.5, on shaker, supplementation of sucrose and yeast extract	Lalnunhlimi and Krishnaswamy 2016

A. *flavus*, *A. niger*, *Fusarium oxysporium*, and *Penicillium notatum* and used them for the decolorization of azo textile dyes. The studies have reported that *A. niger* decolorized basic fuchsin (81.85%)>Nigrosin (77.47%)>Malachite green (72.77%) >dye mixture (33.08%), while *Phanerochaete chrysosporium* decolorized Nigrosin (90.15%)> basic fuchsin (89.8%)>Malachite green (83.25%)>mixture (78.4%) under shaking condition

Table 2: Degradation of Various Dyes using Fungi

#	Dye	Microbe	Mechanism	Reference
1	Reactive Black 5, Reactive Red 120, Reactive Blue 19, Acid Scarlet GR, and Azure B	<i>Sterigmatomyces halophilus</i>	Minimal Salt (MS) medium, 24 hours, 115 °C, pH 5, 50 mgL <sup>-1</sup> dye concentration, supplemented with carbon and energy sources, including glucose, ammonium sulfate, and yeast extract	Al-Tohamy et al. 2020
2	Congo Red	<i>Aspergillus niger</i>	Synthetic nutrient broth medium, 6 days, 28 °C, pH 5, shaken at 120 to 150 rpm (correlated with manganese peroxidase and lignin peroxidase)	Asses et al. 2018
3	Biebrich Scarlet, Direct Blue 71, Orange G, and Ponceau 2R	<i>Corioloopsis</i> sp. Strain arf5	Kirk's basal medium, 7 to 12 days, room temperature to 35 °C, pH 4.5 to 6, static under nitrogen-limiting conditions and an additional carbon source (glucose)	Cheng et al. 2016
4	Acid Blue 40, Acid Blue 193, Acid Blue 62, Acid Blue 113, Acid Red 73  Reactive Red 11, Reactive Blue 74	<i>Myrothecium verrucaria</i> , <i>Colletotrichum dematium</i> , <i>Corynespora cassicola</i> , <i>Dictyosporium zhejiangensis</i> , <i>Plectosporium tabacinum</i> , <i>Fusarium thapsinum</i> , <i>Alternaria alternata</i> , <i>Acrogenospora sphaerocephala</i> , and <i>Ceriporia lacerata</i>	Malt agar medium, 7 days, 25 °C	Yang et al. 2016
5	Procion Red MX-5B	<i>Aspergillus terreus</i> and <i>Aspergillus niger</i>	Aqueous solution, 3 h (biosorption), 1 day to 14 days (biodegradation), 30±1 °C, and pH 4	Almeida and Corso 2014
6	Reactive (Navy Blue M3R, Red M8B, Green HE4B, Orange M2R, RedM5B), Direct (Orange RS, Black BT, Blue GLL, Sky Blue FF)	<i>Aspergillus flavus</i> , <i>Aspergillus niger</i> , <i>Fusarium oxysporium</i> , and <i>Penicillium notatum</i>	Potato dextrose broth, 3 to 7 days, 30 °C, pH 5, in rotary shaker at 120 rpm, biotransformation enzymes (lignin peroxidase>laccase>manganese peroxidase>tyrosinase)	Laxmi and Nikam 2015
7	Malachite Green, Nigrosin Disodium, and Basic Fuchsin	<i>Aspergillus niger</i> , and <i>Phanerochaete chrysosporium</i>	Potato dextrose broth, 10 days, 25 °C, pH 7, rotary shaker at 100 rpm	Rani et al. 2014

*Elkatotrix viridis*, *Chlorella vulgaris*, *Nostoc linckia*, *Lyngbya lagerlerimi*, *Oscillatoria rubescens*, and *Volvox aureus* using methyl red, orange II, basic cationic, G-Red (FN-3G), and basic fuchsin and concluded that decolorizing using *C. vulgaris* or *N. Linckia* with G-Red or methyl red, respectively, induced the algal azo dye reductase enzyme by 72 and 71%.



Table 3: Degradation of Various Dyes using Algae

#	Dye	Microbe	Mechanism	Reference
1	Disperse Red 3B	<i>Chlorella sorokiniana</i> XJK and <i>Aspergillus</i> sp. XJ-2 (consortia)	BG 11 and Czapek's medium, respectively, 4 days, 30 °C, pH 7, and shaken at 170 rpm (due to lignin peroxidase and manganese peroxidase enzyme activities)	Tang <i>et al.</i> 2019
2	Congo red	<i>Chlorella vulgaris</i>	Bold's basal mineral medium, 25±3 °C, 3 days	Hernandez-Zamora <i>et al.</i> 2015
3	Malachite green	Xanthophyta alga, <i>Vaucheria</i> sp.	Dye solution, pH 1.5 – 8.5, temperature 5- 45 °C and initial dye concentration 2.5 – 17.5 mg L <sup>-1</sup>	Khataee <i>et al.</i> 2010
4	Methyl red, orange II, basic cationic, G-Red (FN-3G) and basic fuchsin	<i>Elkatotrix viridis</i> , <i>Chlorella vulgaris</i> , <i>Nostoc linckia</i> , <i>Lyngbya lagerlerimi</i> , <i>Oscillatoria rubescens</i> , and <i>Volvox aureus</i>	Bold's basal mineral medium, pH 7, 25±1 °C, continuous light intensity 5000 to 3000 lux on rotary shaker	El-Sheekh <i>et al.</i> 2009
5	Reactive Black 5, Direct Blue 71 and Disperse Red 1.	<i>Chlorella vulgaris</i>	Mineral salt media, 100 mg L <sup>-1</sup> dye, 12 days, 30 °C, dye concentration 100-500 mg L <sup>-1</sup> in static conditions	Ishchi and Sibi 2020

Nanoparticles, however, have gained attention due to their small size range (1 nm to 100 nm), large surface area, high adsorption properties, less resistance to diffusion and the fact that they show faster rates of equilibrium and increased chemical reactivity. Gold nanoparticles (AuNPs) synthesized using cell-free extract of *Bacillus marisflavi* showed outstanding catalytic activity in the decolorization of CR and methylene blue. Synthesis of AgNPs using *Bacillus pumilus* was verified that nano-based remediation was more efficient as compared to microbial remediation.[9]

Table 4: Degradation of Azo Dyes Using Microbe Nanoparticle Approach

S.No.	Nanoparticles	Dye	Microbes	Remarks	References
1.	Cobalt nanoparticles (CoNPs)	Remazol golden yellow RNL; textile effluent	-	CoNPs removed the RGY with high efficiency, reaching almost 100% removal in 30min; textile effluent resulted in 88% degradation of dyes and 32% reduction in CO	Cruz <i>et al.</i> 2019
2.	Bimetallic nanoparticles comprising of iron (Fe) and nickel (Ni)	Orange G	-	High efficacy at 1000 mg/L	Foster <i>et al.</i> 2019
3.	Silver nanoparticles	Methylene blue	Strain AN-1	Promising agents for treatment of synthetic dyes	Amabye and Hagos 2017
4.	Silver nanoparticles	Congo Red, Rhodamine B, and Orange G	<i>Pestalotiopsis versicolor</i>	Good azo dye-degrading potential	Rajput <i>et al.</i> 2017
5.	Silver nanoparticles	Methyl Orange and Congo Red	<i>Leuconostoc lactis</i>	Exopolysaccharide-stabilized (EPS) AgNPs efficient in degradation process of industrial textile dyes; the electron transfer takes place from reducing agent to dye molecule <i>via</i> nanoparticles, resulting in the destruction of the dye chromophore structure	Saravanan <i>et al.</i> 2017
6.	Silver nanoparticles	Methyl Orange	<i>Staphylococcus aureus</i>	62% of MO (2000µg/mL) degraded with 200µg/mL of AgNPs in 1 day	Ramalingam <i>et al.</i> 2017
7.	Gold nanoparticles	Congo Red and Methylene blue	<i>Bacillus marisflavi</i>	Outstanding catalytic activity, pseudo-first-order kinetics and reaction rate constant of 0.2192 and 0.2484 min <sup>-1</sup> , respectively	Nadaf and Kanase 2016
8.	Silver nanoparticles	Congo Red	<i>Bacillus pumillus</i>	Nano-based bioremediation was found 13% more efficient than the	Modi <i>et al.</i> 2015



## V. CONCLUSION

Bioremediation using nanoparticles represent a promising new technology for environmental clean-up technology, not only because of their high treatment efficiency, but also for their cost-effectiveness, as they have the flexibility for *in situ* and *ex situ* applications. Nanoparticles work by increasing the surface area of a heterogeneous catalyst (its active component), enhancing the contact between the catalytic site and its substrate moiety. Efficacy of microbe-associated nanoparticle in bioremediation and its translational effects are unexploited. Thus, recovery of environmentally relevant microorganisms in combination with the 'omics' concept would facilitate an improved understanding of the physiology of microorganisms together with their nanoparticle synthesis catalyzing environmental processes. This increased understanding will further help to design and operate relevant bioremediation strategies.

## REFERENCES

1. Fu Y, Viraraghavan T. Fungal decolorization of dye wastewaters: a review. *Bioresour Technol.* 2001;79:251–262. doi: 10.1016/S0960-8524(01)00028-1. [PubMed] [CrossRef] [Google Scholar]
2. Zheng Z, Levin RE, Pinkham JL, Shetty K. Decolorization of polymeric dyes by a novel *Penicillium* isolate. *Process Biochem.* 1999;34:31–37. doi: 10.1016/S0032-9592(98)00061-2. [CrossRef] [Google Scholar]
3. Hossain K, Ismail N. Bioremediation and Detoxification of Pulp and Paper Mill Effluent: A Review. *Res J Environ Toxicol.* 2015;9(3):113–134. doi: 10.3923/rjet.2015.113.134. [CrossRef] [Google Scholar]
4. Asgher M, Bhatti HN, Ashraf M, Legge RL. Recent developments in bioremediation of industrial pollutants by white rot fungi and their enzyme system. *Biodegradation.* 2008;19:771–783. doi: 10.1007/s10532-008-9185-3. [PubMed] [CrossRef] [Google Scholar]
5. Asgher Muhammad, Azim Naseema, Bhatti Haq Nawaz. Decolorization of practical textile industry effluents by white rot fungus *Coriolus versicolor* IBL-04. *Biochem Eng J.* 2009;47:61–65. doi: 10.1016/j.bej.2009.07.003. [CrossRef] [Google Scholar]
6. Palmieri G, Cennamo G, Sannia G. Remazol Brilliant Blue R decolourisation by the fungus *Pleurotus ostreatus* and its oxidative enzymatic system. *Enzyme Microb Technol.* 2005;36:17–24. doi: 10.1016/j.enzmictec.2004.03.026. [CrossRef] [Google Scholar]
7. Lopez MJ, Guisado G, Vargas Garcia MC, Estrella FS, Moreno J. Enzyme Microb Technol. 2006;40:42–45. doi: 10.1016/j.enzmictec.2005.10.035. [CrossRef] [Google Scholar]
8. Firmino PIM, Da Silva, MER MER, Cervantes FJ, Dos Santos AB. Colour removal of dyes from synthetic and real textile wastewaters in one and two-stage anaerobic systems. *Bioresour Technol.* 2010;101(20):7773–7779. doi: 10.1016/j.biortech.2010.05.050. [PubMed] [CrossRef] [Google Scholar]
9. Spagni A, Casu S, Grilli S. Decolourisation of textile wastewater in a submerged. *Bioresour Technol.* 2012;117:180–185. doi: 10.1016/j.biortech.2012.04.074. [PubMed] [CrossRef] [Google Scholar]
10. Punzi Marisa. Treatment of textile wastewater by combining biological processes and advanced oxidation. Ph.D. Thesis 2015; Printed in Sweden by Media-Tryck, Lund University Lund.



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