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Recent Myco-Dye Decolorization Studies (Mini-review)

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ABSTRACT

Dyes are colored materials being extensively used in coloring the varieties of substances or substrates. They may be natural or synthetic depending upon their utilities. Worldwide extensive uses of the synthetic dyes are a matter of serious concern. Their uses by paper industries, cloth's industries, textile industries, chemical industries, pharmaceutical industries, food industries and other types of industries release the significant quantities as effluent and seriously polluted the ground water causing undesirable death and decay of water dependent lives. From the environmental point, it is very necessary to develop the methodologies for the destruction and remediation of these serious pollutants. Uses of fungi in decolorization or detoxification of synthetic dyes may be a green and useful route for this purpose. Several research works have been done in this area and many are going on by researchers to find out the efficient way for such bioremediation. This review concisely describes about the recent dye decolorization studies of past year (2019) performed by scientists/researchers using fungi or fungal based enzymes.

Keywords: *Fungus, dyes, myco-dye decolorization, decolorization, remedtaion, pollution*

INTRODUCTION

In the present time, dyes are the extremely used colored substances worldwide because they are used probably in all sectors using colored materials. They may be natural or synthetic. Natural dyes are obtained from plants and other natural resources while synthetic dyes are prepared in lab for commercial uses. Root, barks, berries, leaves, wood, fungi, lichens etc are the important sources for the natural dyes [1-2].Dyes can be used in aqueous solutions to color the substrates having selective affinity for the selected dyes. Generally, mordant is used to increase the fastness of dyes on substrates [3]. Based on their physical and chemical properties, dyes may be divided in to different types like acid and basic dyes, vat dyes, and direct dyes, mordant dyes, azo dyes, reactive dyes, disperse dyes and sulphure dyes and many other [1].

There is significant dispersal of pollution via the use of synthetic dyes from industries. Their uses cannot be checked, but precautions as well as pollution controlling measurements can be applied. In the present time, several types of research works are running all over the world to eliminate or detoxify the pollutants created by extensive uses of dyes out of which main focuses are to develop the green methodologies for the remediation or detoxification of various dyes being used in several types of industries. Fungi and their associated enzymes may play a significant role in decolorization or detoxification of different types of toxic dyes. In this direction, a large works is being performed by researcher worldwide every year [4-20]. The main purpose of this short review is to discuss about the studies already done on myco-remediation (i.e. fungal based bioremediation) in past one year 2019.

MYCO-DYE DECOLORIZATION

Decolorization done by fungi is known as myco-decolorization. Fungal based decolorization may be performed in two ways. In first way, a fungi or group of fungi may be applied directly for the decolorization of dyes and second way, there enzymatic liquid culture medium may also applied to dyes. There are significant numbers of researches being performed per year all over the world. Here authors have discussed only the selected recent year (year 2019) researches in this field (**Table 1**) [9-20].

Tang *et. al*. (2019) [9] performed studies on decolorization of disperse red 3B dyes. They used a consortium of fungus and microalgae. Fungus used was *Aspergillus sp.* XJ-2 and micro

algaeused was *Chlorella sorokiniana* XJK. It was clear from their experiment that consortium of fungus and algae showed better result for decolorization. Their experiment showed 98.09% decolorization under optimized conditions for the use of consortium of fungus and algae [9].

Jasińska *et. al.* (2019) [10] studied on decolorization of different dyes using secretome of *Myrothecium roridum* IM6482, an ascomycetous fungus. They used bottom up proteomic approach for their studies. They found the most suitable protein for decolorization as laccase, decolorized the different dyes like Acid Blue 113, Acid Red 27, Direct Blue 14 and Acid Orange 7 at level of 66, 91, 79, and 80%, respectively [10].

Table1. *Fungi/fungal enzyme based dye decolorization*

S.N.	Fungi/Fungal enzymes	Dyes as substrate for decolorization	% decolorization	Ref.
1	*Aspergillus sp.* XJ-2 (with microalgae Chlorella sorokiniana XJK	Disperse Red 3B	98.09	9
2	Secretome of *Myrothecium roridum* IM6482	Acid Blue 113, Acid Red 27, Direct Blue 14, and Acid Orange 7	66, 91, 79, and 80%	10
3	Extracts of *C. versicolor* and *P. ostreatus*	Remazol brilliant blue royal	80.42% and 70.42%	11
4	*Aspergillus niger* D2-1	Reactive yellow and reactive red dyes (Azo dyes)	98.62 % and 92.42 %	12
5	*Aspergillus niger* LAG	Thiazole yellow G	98%	13
6	Mutant PIE_5 (laccase from *Coprinopsis cinerea)*	Indigo dye	87.1-90.9%	14
7	Crude laccase from *Ganoderma lucidum*	Remazol Brilliant Blue R dye	50.3%	15
8	Laccase from *Trametes hirsuta* EDN084	Remazol brilliant blue R, reactive blue 4, acid blue 129, direct blue 71	50%, 47%, 51%, 85%	16
9	Isolated *Pleurotus ostreatus*	Congo red, Brilliant green	98.82%, 95.74 %	17
10	Recombinant TaDyP (from *Pleurotus ostreatus*)	Acid blue 129, Acetyl Yellow G	77 and 34% , respectively	18
11	*Aspergillus niger*	Textile effluents containing direct red dye	Above 97%	19
12	Selected fungal isolates	Bromophenyl blue, Bromothymol blue, and Remazol brilliant blue R	100%	20

A study was performed by Afiya *et. al.* (2019) [11] on decolorization of a textile dyes, namely, Remazol Brilliant Blue Royal. They used two white rot fungi for this purpose like *Coriolus versicolor* and *Pleurotus ostreatus*. They optimized the reaction conditions for the decolorization and used enzymatic extract from aforementioned white rotfungi. They found the decolorization of remazol brilliant blue royal as 80.42% and 70.42% for fungi *Coriolus versicolor* and *Pleurotus ostreatus*, respectively at optimized level [11].

Salem *et. al.* (2019) [12] performed a decolorization study on azo dye degradation by isolate *Aspergillus niger* D2-1. Results of maximum decolorization by *Aspergillus niger* D2-1 using 100 ppm concentrations of two azo dyes, namely, reactive yellow and reactive red for decolorization in the presence of glucose (as carbon source) and yeast extract (as nitrogen source) in seven days at pH 9.0 were 98.62 % and 92.42 %, respectively. They found that fungus decolorized textile wastewater effluent in promising way up to 59% [12].

A study on demethylation and desulphonation of thiazole yellow G was performed [13]. This dye is a textile industrial dye. Banokele *et. al.* (2019) reported the complete mineralization of this dye using filamentous fungus *Aspergillus niger* LAG. This fungus decolorized thiazole yellow G in five days. They achieved maximum level of decolorization (98%) at 10 mg L^{-1} , 35 °C and pH 6 (concentration, temperature and pH, respectively). According to them, two degradation products of this dye obtained were sodium 6-methyl-2-phenyl-1,3-benzothiazole-7-sulfonate and 2-phenyl-4,5-dihydro-1,3-thiazole characterized by GCMS. They had also proposed a metabolic pathway for *Aspergillus niger* LAG based degradation of thiazole yellow G [13].

Yin *et. al.* (2019)[14] worked on dye decolorization using fungal laccase. They

obtained a mutant library using error-prone PCR of *Coprinopsis cinerea*, a basidiomycete fungus, based laccase Lcc9. They selected a mutant PIE5 after different rounds of functional screening. This mutant showed the basic pH optimum for substrates like guaiacol and 2,6-DMP. They used it into indigo dye decolorization very effectively and decolorized the indigo dye as 87.1 ± 1.1% and 90.9 ± 0.3% in optimum conditions (pH 7.0–7.5 and temperature 60 °C) using mediators namely, 3,5-dimethoxy-4-hydroxybenzoate or 2,2′-azino-bis(3-ethylbenzothazoline-6-sulfonate). His results showed that this fungal laccase may be very useful for its use in dye decolorization in specific applications of industries [14].

Qin *et. al.* (2019) [15] performed their studies on decolorization of Remazol Brilliant Blue R dye using crude laccase which was obtained from white rot fungus *Ganoderma lucidum*. They studied the influence of different factors like reaction time, pH, temperature, metal ions, dye concentration and mediators on decolorization of this laccase. They achieved about 50.3%decolorization at temperature and pH 35 °C, 4.0, respectively and dye concentration 200 ppm in 30 min. They also performed comparative studies on dye decolorization based on the use of mediators like syringaldehyde, 1-hydroxybenzotriazole, and vanillin and found that decolorization has reached a level of 98.7% with 0.1 mM concentration of vanillin [15].

Yanto *et. al.* (2019) [16] decolorization studies was based the use of newly isolated fungus *Trametes hirsuta* EDN084 and mediator violuric acid. They found that laccase could decolorize remazol brilliant blue R, reactive blue 4, acid blue 129, acid blue 25, acid blue 113, acid orange 7, reactive black 5, reactive red 120, direct blue 71 in 50%, 47%, 51% , 21%, 40%, 11%, 2%, 2%, and 85%, respectively when performed for 4hrs. They also performed studies individually, using different mediators like violuric acid, 2,2,6,6- tetramethylpiperidine-1-oxyl, and 1-hydroxybenzotriazole and they found that the addition of 1.0 mM of violuric acid was sufficient to improve the decolorization up to 2-30 fold [16].

Vantamuri*et. al.* (2019) [17] performed a study on dye decolorization using liquid culture medium of *Pleurotus ostreatus*. They used different dyes like congo red, brilliant green, methyl orange and aniline blue for their decolorization studies. They performed study for 24 as well as for 48 hrs and observed good results for all the dyes. Decolorization was in the range of 86-98% [17].

Study of Cuamatzi-Flores *et. al.* (2019) [18] deals the effects of dyes on basidiomycete *Pleurotus ostreatus*, *dye decolorizing peroxidase enzyme and expression of four Pleos-dyp*genes. Dye used for studies were Acetyl Yellow G, Remazol Brilliant Blue R or Acid Blue 129. They found that recombinant TaDyP strains were able to decolorize Acid Blue 129 and Acetyl Yellow G up to 77 and 34%, respectively [18].

Verma *et. al.* (2019) [19] used saprophytic fungus namely, *Aspergillus niger* for the removal of textile effluent containing direct dye. They optimized the different conditions pH, temperature, dye concentration etc in order to get the maximum rate of decolorization of this dye. They achieved approximately 97% decolorization in three daysat pH 5, 200 mg/L (concentration of dye), 25°C (temperature). His study showed that *Aspergillus niger* has good ability to degrade the textile dyes [19].

Rao *et. al.* (2019) [20] studied on different isolates (about 30 wild isolates) in order to find out the activity of manganese peroxidase and its potential in degradation of different types of dyes like sulfonephthalein dyes, azo dye and kraft lignin. They found 18 isolates active for lignin modifying enzymes after total 30 isolate's screening. They found 13 isolates positive for laccases as well for peroxidase enzymes while four isolates only produced laccase and one isolate alone produced lignin peroxidase enzyme. A few of them were found to decolorize the different types of dyes like bromothymol blue, bromophenyl blue and remazol brilliant blue R while some of them were able to decolorize all types of tested dyes [20].

CONCLUSIONS

It is clear from the above discussions that there are significant amount of researches on green decolorization of different types of dyes polluting our water systems and causing different types of problems and diseases along with being a reason of death of the various types of living organism of aquatic systems. Authors have discussed here, in a very brief, about the different selected researches in the field of bioremediation by fungi worked by various researchers and scientists. Dye pollution is a major problem in the present time and aforementioned studies as well as several other

research studies in this field may be studied at industrial level for their utilization in dye decolorization in several types of industries using industrial dyes for their productions.

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