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Role of Micro-Organisms in Ecosystem Restoration - A Case Study

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ABSTRACT

Rapidity of industrialization and urbanization around the world has led to the recognition and understanding of relationship between environmental pollution and public health. Aiming the most concerned environmental pollution that are threatening our biodiversity, water pollution is the major one where effluents from dye-based industries serve as a principal source. Bio-remediation is a treatment that uses naturally occurring organisms to breakdown hazardous substances into less toxic or non-toxic substances.

Different fungi have the potential to decolourise complex organic compounds into simpler compounds. *Aspergillus fumigatus*, a fungi belonging to phylum Ascomycota, has capacity to degrade textile affluent dyes, like Turquoise blue and Reactive red. Turquoise blue and Reactive red belongs to an important group of synthetic dye used in textile industries.

In this works, a batch of experiments were conducted for the decolourisation of Turquoise blue and Reactive red, using *Aspergillus fumigatus*. At 0.2 mg/l Turquoise blue and Reactive red, 83% and 86% decolourisation was achieved with *Aspergillus fumigatus* in five days interval at static and shaken condition respectively. This study brings out the ability of *Aspergillus* species to degrade Turquoise blue and Reactive red. It has the capacity to degrade Reactive red faster than Turquoise blue.

KEYWORDS: *Aspergillus fumigatus*, decolourisation, Turquoise blue, Reactive red, industrial affluent, dyes.

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INTRODUCTION

Rapidity of industrialization and urbanization around the world has led to the recognition and understanding of relationship between environmental pollution and public health. Among the most concerned environmental pollutions that are threatening our biodiversity, water pollution is the major one where effluents from dye-based industries serves as the principal source. Industrialization of the textile industry and use of a very large variety of chemical treatments and dyes has resulted in causing severe threat to public health. The pollution potential of textile dyes and intermediates compounds was first raised due to its toxicity and carcinogenicity that can cause damage to human health and environment ¹.

Waste water from textile industries contain many pollutants including acids, dispersants, alkalis, dyes, heavy metals, organic-chlorines, PBDE, PFOA, phthalates pigments, salts and many more. The release of these hazardous materials into public drains alters the pH and increases BOD and COD levels. The industries have shown a significant increase in the use of synthetic complex organic dyes as their coloring material. Presence of dyes reduces light penetration and photosynthesis. The dyes used are mainly synthetic in nature that makes them more stable and more difficult to be biodegraded. This cannot be completely removed by conventional waste-water treatment systems. Before disposal and discharge of dye containing effluents, they are to be treated to reduce their levels of toxicity and thus to minimize their pollution impact.

Due to the toxicity, mutagen city and carcinogenicity of azo dyes and their break down products, their removal from industrial waste-waters has been an urgent challenge. It is very difficult to treat textile industrial effluents by commonly used physical and chemical method mainly because of their high biological oxygen demand, chemical oxygen demand, heat, colour, pH, presence of metal ions and also because of the involvement of high expense. Meanwhile, a broad validation and integration of different methods of treatment will be needed to make these technologies both efficient and economically viable ².

To overcome the difficulties posed by conventional waste-water treatment systems, bio-remediation has emerged as a promising technology in the past few years for treatment of industrial dye effluents and contaminated soil. In recent days technologies based on bio-remediation has got much attention for the treatment of textile dye effluent because of its simple structural setup, low cost, easy to operate, eco-friendly nature, low sledge volume, environmental benignity and wider application. Bio-remediation is a treatment that uses naturally occurring organisms to breakdown hazardous substances into less toxic or non-toxic substances.

The physio-chemical treatment does not remove the color and dye compound concentration. The decolorization of the dye takes place either by adsorption on the microbial bio-mass or bio-degradation by the cells. The anaerobic process converts dye in toxic amino compounds which on further treatment with aerobic reaction convert the intermediate into CO₂ biomass and inorganics³. High decolourization extent and facile conditions show the potential for the fungal strain to be used in the biological treatment of dyeing mill effluents⁴. Different fungi have the potential to decolourise complex and re-calcitrant organic compounds into simpler fragments⁵. Both *Aspergillus oryzae* and *Phanerochaete chrysosporium* have considerable potential regarding the bio-degradation of dyes in waste-water. These results may contribute towards improving effluent treatment systems in the textile industry⁶.

OBJECTIVES OF THE STUDY

- To investigate the role of individual fungal isolate – *Aspergillus fumigatus*, for the decolourization or degradation abilities of two dyes, Reactive red and Turquoise blue.
- To compare the decolourization of dye effluent from industries and artificially prepared medium, using fungal isolate.

MATERIALS AND METHODS

Textile dyes:

Textile dyes were collected from textile export division of M/s. Sagar dyes, Kannur. Two dyes used in this study are: Reactive Red and Turquoise Blue.

Fungal strains:

Aspergillus fumigatus is a fungi belongs to phylum: Ascomycota and class: Ascomycetes. *Aspergillus fumigates* colony has hyphae with columnar or radiate conidial heads with conidiophores and conidia. They are commonly seen in soil and decaying organic debris. Mostly not common in indoor environments. Important in clinical environment.

Pure culture of *Aspergillus fumigatus* were collected from Dept. of Biotechnology, Sir Syed Institute, Taliparamba, Kannur. It was sub-cultured in freshly prepared potato dextrose media and kept for incubation at 34^oc for 2-3 days.

Absorbance was detected using spectrophotometer with absorption maxima of 520 nm for Reactive Red and 340 nm for Turquoise blue.

Preparation of Aspergillus fumigatus subculture

Potato dextrose agar media (PDA) is used as the culture media for sub-culturing fungus. 36 gms of Potato dextrose agar is weighed, dissolved it in 250 ml of distilled water and autoclaved. Petridishes are also autoclaved. It is then transferred to laminar airflow. The autoclaved hot solution of agar is transferred to the petri dishes and allowed to cool and solidify. The inoculation loop has been sterilized. Then the agar media is inoculated with a loop full of *Aspergillus fumigates* by streak plate method. Then it is sealed with laboratory film and is placed in the incubator at 27°C for a week for incubation.

Preparation of nutrient broth

We prepared 1.5ltr of Potato dextrose broth by mixing 19.5gms of Potato dextrose with distilled water, in a beaker. Then 100 ml of this solution of nutrient broth is measured and poured into the 250ml conical flask and is then plugged with the cotton and covered with an aluminium foil. 12 nos, of such conical flasks are made. All are then shifted to the laminar airflow.

Dye decolourization assay

The dyes used for the study, Reactive Red and Turquoise Blue were frequently used in most of the textile industries in India. These dyes are chosen because of their ability to produce the greatest variety of colours and can withstand wide range of temperature, depending upon their chemical structures.

Reactive Red and Turquoise Blue, each with concentration 0.2mg, 0.4mg, 0.6mg, 0.8mg, and 1mg were weighed and put in formerly prepared nutrient medium. Another 0.1mg each of Reactive Red and Turquoise Blue were weighed and put in two separate nutrient medium and are used as standards.

These modified broths were inoculated with the sub-cultured *Aspergillus fumigatus*, individually and incubated at 27°C in a periodic shaking condition for 15 days.

We took 100ml of effluent in two conical flasks. One is taken as standard and in the other one; loop full of fungal culture is added. It is also incubated at 27°C in a periodic shaking condition for 15 days.

After the incubation period, decolourization of dyes by selected isolates were determined at their respective maximum wavelength in a culture supernatant using UV spectro-photometer. The percentage of dye decolorization by the cells was done using the modified method of Yatome et al.⁷. 1.5ml of broth from each conical flask was centrifuged at 5000rpm for 15 minutes. After centrifugation supernatants were subjected to UV spectro-photometer and absorbance were recorded. From this absorbance, percentage of decolourization can be calculated. The efficiency of colour

removal was expressed as the percentage ratio of the decolourised dye concentration to that of initial concentration, based on the following equation:

$$\% \text{ of decolourisation} = \frac{(\text{Initial dye concentration} - \text{residual dye concentration}) \times 100}{\text{Initial dye concentration}}$$

RESULTS AND DISCUSSION

The percentage of decolourisation of Reactive Red and Turquoise Blue, using *Aspergillus fumigatus* are as follows:

Table01: % of decolourization

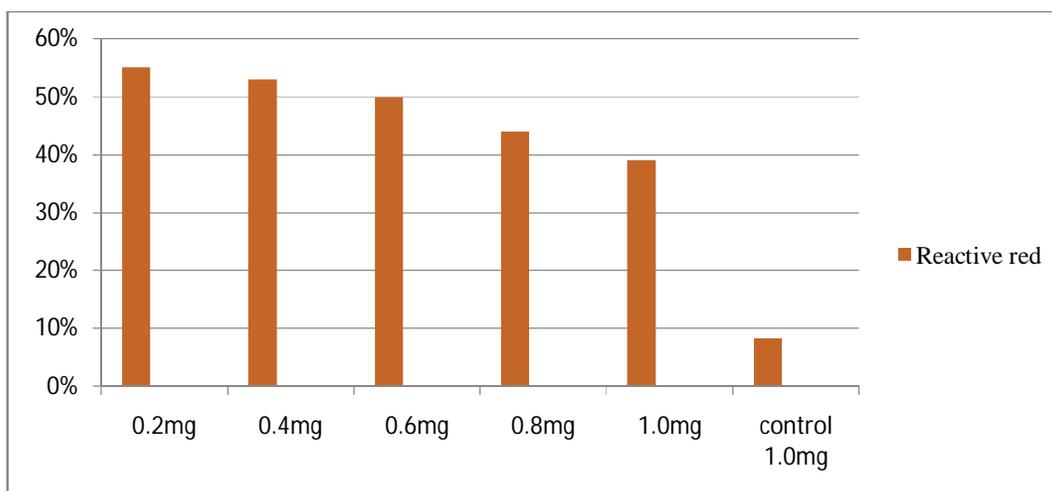
Reactive red			
Concentration	Absorbance (520nm)		% of Decolourization
	Initial	Final	
0.2mg	1.69	0.75	55%
0.4mg	1.84	0.86	53%
0.6mg	1.95	0.96	50%
0.8mg	2.02	1.12	44%
1.0mg	2.04	1.22	39%
Control(1.0mg)	2.16	1.98	8.3%

Table 2: % of decolourization

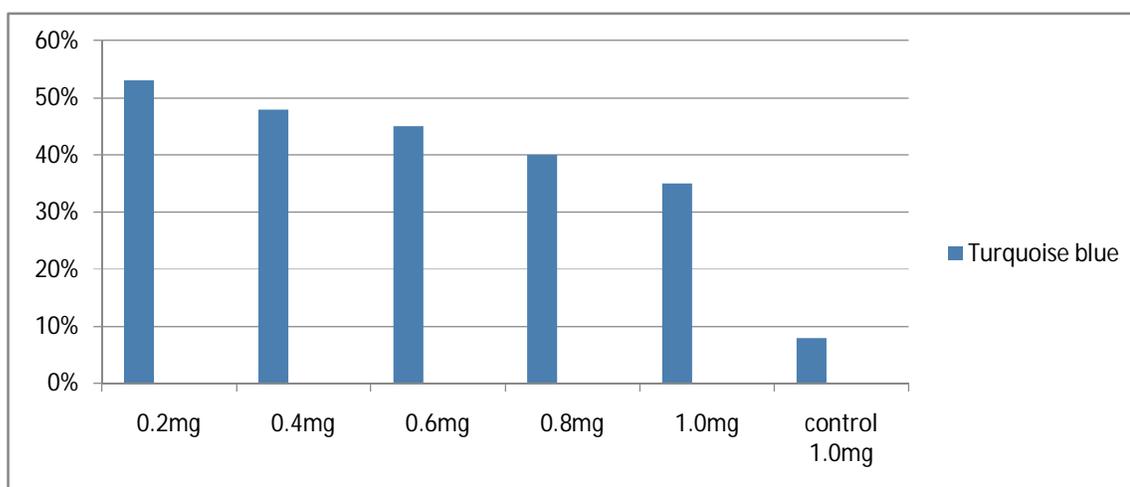
Turquoise blue			
Concentration	Absorbance (340nm)		% of Decolourization
	Initial	Final	
0.2mg	1.81	0.85	53%
0.4mg	1.95	0.98	48%
0.6mg	2.16	1.17	45%
0.8mg	2.33	1.39	40%
1.0mg	2.51	1.62	35%
Control(1.0mg)	2.49	2.27	8%

Table 3: % of decolourization

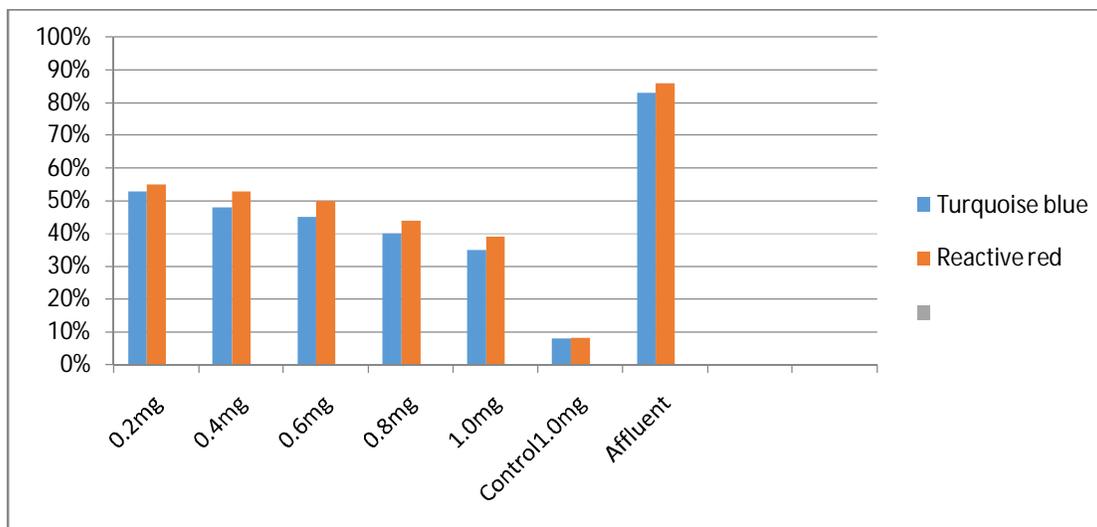
Textile affluent			
Dye	Absorbance (340nm)		% of Decolourization
	Initial	Final	
Reactive red	1.66	0.22	86%
	Absorbance (520nm)		
	Initial	Final	
Turquoise blue	1.43	0.24	83%



Graph 01: % of decolourization of Reactive red



Graph 02: % of decolourization of Turquoise blue



Graph 03: Comparative study

CONCLUSION

From our study we conclude that:

- Fungus, *Aspergillus fumigates* has the capacity to degrade the textile effluent dyes like Reactive Red and Turquoise Blue.
- *Aspergillus fumigates* has the capacity to degrade Reactive Red faster than Turquoise Blue.
- Dye degradation with *Aspergillus fumigates* in industrial effluent is more effective than in artificial culture media.

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