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STUDIES ON TEXTILE DYE DECOLOURISATION BY DIFFERENT FUNGAL SPECIES

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ABSTRACT

Different fungal species, isolated in the laboratory, were tested for their dye degrading ability in still culture at various incubation periods. The study revealed the effective decolourisation of Orange-11 and some commercially used dyes like Dri green 2B1 and Dri brill red 4BL1. *Aspergillus niger* and *Rhizopus* sp. caused 100% and 92% degradation respectively in 10 days incubation in still culture containing Orange 11 dye. Dri green 2B1 was effectively decolourised by most of the fungal species causing more than 70% decolourisation in 10 days. Dye decolourisation, an ability of some fungal species, suggests that they were promising fungal strains for the treatment of textile industry waste waters.

INTRODUCTION

In textile industries 90% of reactive textile dyes entering activated sludge waste treatment plant will pass through unchanged and will be discharged in water bodies. These are toxic to living beings and may be responsible for many ailments in humans and animals.

Colour has been playing a dominant role in the life of each and every individual, no matter which part of the world they belong to. An in-depth analysis of our environment provides a good estimate of the variety of applications of synthetic dyes ranging from textile to modern laser disks. Estimation of pollutants largely depends on the physical appearance of colour, odour and turbidity conditions. Untreated effluents from dyestuff production and dyeing mills may be highly coloured and thus particularly objectionable if discharged into open waters. Even though the dye concentration may be below 1ppm i.e., lower than many other chemicals found in wastewaters, the dye will be visible (Zollinger 1987).

For the past few years there has been a great awareness about toxicity hazards associated with dyeing industries. At present, the far most important factor in consideration is the carcinogenic effects of the chemicals, which are used for manufacturing dyes and intermediates. These hazardous compounds, either directly or indirectly, are related to the acute or chronic toxicities, depend on the nature of the molecule. Some of the very serious diseases like cancer, tumour of the urinary bladder and certain skin diseases have got a connection with these chemicals.

Not all dyes currently used could be degraded or removed with physical and chemical processes, and sometimes the degradation products are more toxic. The traditional textile finishing industry consumes about 100 litres of water to process about 1kg of textile materials. Biological treatment methods are cheap and offer best alternative to traditional chemical methods. Biologically, decolourisation can be achieved by the use of a number of naturally occurring microorganisms such as bacteria and fungi. Fungi, especially *Phanerochaete chrysosporium*, are able to degrade a wide range of structurally diverse organic pollutants.

The treatment of wastewaters to remove both colour and synthetic dye compounds is clearly an important issue for manufacturers (Kulla et al. 1981). Colleen et al. (1990) reported that *Phaenerochaete chrysosporium* was able to decolourise the azo and heterocyclic dyes. Barvesgaard et al. (1992) reported that *A. oryzae* was able to decolourise various dyes used in textile industry.

The present study deals with the ability of microorganisms to decolourise artificial textile dyes in different environmental factors. Different types of fungal species are used as the test organisms to decolourise commercially used textile dyes. Commonly used dyes Dri brill red 4BL1, Brilliant blue, Dri green 2B1 and Orange 11 were used in the experiments.

MATERIALS AND METHODS

Organisms used: Different fungal species, isolated in the laboratory and screened for their ability to degrade textile dye, were used in the experiments.

Maintenance of culture: Isolates of fungal species were brought to pure culture on Potato Dextrose Agar (PDA) slants. Number of copies were prepared and maintained at 5°C.

Media used: Potato Dextrose Agar (PDA) and Czapek-dox Agar (CDA) were used for the assay.

Dyes used: Textile colouring dyes such as Brilliant blue, Orange 11, Dri brill red 4BL1 and Dri green 2B1 were used in the assay.

Sterilization: All the media and glassware used for the experiments were sterilized at 121°C for 15 minutes under 15 psi pressure in an autoclave.

Method of inoculation: The fungus was grown on PDA plates and from the margin of an actively growing colony; a plug of mycelium was transferred to the media. To ensure equal inoculum a sterile cork-borer (5mm) was used to cut the colony.

Incubation: PDA cultures of fungal species were incubated in the laboratory conditions (still culture), and necessary aeration was provided by placing the flasks in a shaker with a speed of 180-120 rpm (shake culture).

Dye decolourisation by fungi: The dyes Brilliant blue, Orange 11, Dri brill 4BL1, Dri green 2B1 were prepared to give a final concentration of 50ppm and sterilized. The dyes were added to conical flasks containing 100mL medium. Different fungal species were inoculated and incubated in still condition for 10 days. The decolourisation efficiency, exhibited by the test organism, was estimated. During the incubation period, sample was drawn at 72 hours interval for 10 days. They were then analysed for decolourisation of the dye by the fungi in a spectrophotometer (Spectronic 20) by scanning the optical density of culture supernatent. Sterile control was maintained throughout the incubation period and sterile distilled water served as blank.

RESULTS AND DISCUSSION

The results of the study indicating percent decrease of various dyes by different fungi on different days are given in Tables 1, 2, 3 and 4. Industrial wastes are usually discarded into water, with or without processing. When waste substances reach such a concentration that they exert measurable effects upon ecosystems, they are said to be pollutants. Physical and chemical methods, available to treat effluents, are expensive and do not provide satisfactory results. Biologically, decolourisation can be achieved by the use of naturally occurring microorganisms such as bacteria and fungi. In recent years attention has been directed towards fungal dye decolourisation system (Moreira et al. 2000). The present study is the preliminary report on dye decolourisation by different fungal species.

Table 1: Percentage of Orange 11 decolorization by different fungal species in still culture.

S.No.	Culture	Period of Incubation		
		3rd Day	7th Day	10th Day
1	A.niger	68	84	100
2	*A.fumigatus*	61	73	93
3	*A.flavus*	62	73	91
4	*Rhizopus spp.*	66	70	92
5	*Penicillium spp.*	52	61	70
6	*Curvularia spp.*	62	66	70

Table 2: Percentage of Brilliant blue decolourization by different fungal species in still culture.

S.No.	Culture	Period of Incubation		
		3rd Day	7th Day	10th Day
1	A.niger	76	83	96
2	*A.fumigatus*	56	65	88
3	*A.flavus*	62	73	91
4	*Rhizopus spp.*	66	74	92
5	*Penicillium spp.*	52	61	70
6	*Curvularia spp.*	62	66	70

Table 3: Percentage of Dri Green 2B1 decolourization by different fungal species in still culture.

S.No.	Culture	Period of Incubation		
		3rd Day	7th Day	10th Day
1	A.niger	60	80	98
2	*A.fumigatus*	48	78	90
3	*A.flavus*	62	71	91
4	*Rhizopus spp.*	68	73	95
5	*Penicillium spp.*	50	76	91
6	*Curvularia spp.*	62	66	70

Table 4: Percentage of Dri Brill red 4BL1 decolourization by different fungal species in still culture.

S.No.	Culture	Period of Incubation		
		3rd Day	7th Day	10th Day
1	A.niger	66	72	95
2	*A.fumigatus*	50	62	70
3	*A.flavus*	60	67	80
4	*Rhizopus spp.*	64	76	93
5	*Penicillium spp.*	55	62	95
6	*Curvularia spp.*	64	67	85

Orange 11 was effectively degraded by still culture. *A. niger* and *Rhizopus* sp. caused 68% and 66% decolourisation within 48 hours which reached 100% and 92% respectively in 10 days incubation. *A. fumigatus* also brings 93% decolourisation in 10 days of incubation. When compared to *A. niger* decolourisation efficiency were slower in *Penicillium* and *Curvularia*.

Zimmerman et al. (1982) worked on "properties of purified Orange 11 azo reductase, the enzyme initiating azo dye degradation, by *Pseudomonas* KF46" and reported that Orange 11 was effectively decolourised by it. Mielgo et al. (2001) worked on a packed-fungal bioreactor for the continuous decolorization of azo dyes (Orange 11), and reported that the fungi *Phanerochaete chrysosporium* was involved in complete decolourisation of Orange 11.

Dye decolourisation efficiency of *A. niger* caused extensive decolourisation of brilliant blue, resulting colour reduction of more than 76% in 48 hours and 83% decolourisation after 7 days in still culture. *Rhizopus* sp., however, did not cause more than 74% decolourisation in 7 days. When compared to *A. niger* the rate of dye decolourisation was slower in other fungal cultures. Lonergan et al. (1997) reported that the fungi *Pycnoporus cinnabarinus* involved in complete decolourisation of Remazol brilliant blue R. Moreira et al. (2001) worked on decolourisation of Remazol brilliant blue R by a novel *Bjerkandera* sp. strain and reported that *Bjerkandera* sp. (B33/3) was effective in decolourising Remazol brilliant blue.

Biodecolourisation of Dri green 2B1 and Dri brill red 4BL1 dyes by different fungal species showed that Dri green 2B1

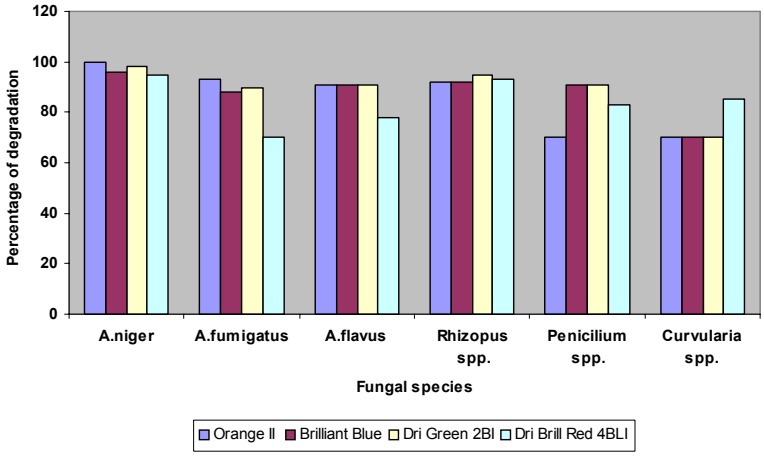

Fig. 1: Percentage of dye degradation by various species in still culture on 10th day of incubation.

was not effectively decolourised in 3 days, but on 10th day the percentage of decolorization was 98% and 95% by *A. niger* and *Rhizopus* sp. respectively. *A. fumigatus* gives a similar result in 10 days incubation. Dri green 2B1 was decolourised by most of the fungal species, causing more than 70% decolorization in 10 days.

Dri brill red 4BL1 was decolourised by *A. niger* and *Rhizopus* sp. caused 66% and 64% decolourisation in 3 days, which reached up to 95% and 93% in 10 days in still culture. *A. flavus* and *Penicillium* sp. cause 80% and 95% decolourisation in 10 days.

The dye decolourisation abilities of these fungal species suggests that they are promising fungal strains for the treatment of textile industry wastewaters. When compared to different fungal species, *A. niger* is found to be better strain for dye decolourisation followed by *Rhizopus* sp. These two organisms cause more than 80% of decolourisation in all the dyes tested (Fig.1). Further work is needed in this aspect to find out suitable conditions for dye decolourisation by other fungal strains, so as to augment ecofriendly biodegradation techniques to safeguard our green mother earth from pollution and to step in to a healthy world in the days to come.

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