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DECOLORIZATION STUDY OF SYNTHETIC OPTILAN RED DYE BY *Aspergillus niger*

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ABSTRACT

The decolorization of textile dye from wastewater is a major environmental crisis which threatens the aquatic life. The decolorization of such harmful products is the major field of interest in research. In this investigation, the most common fungi, *Aspergillus niger* is used for the decolorization of the dye optilan red. Two types of PDA media are prepared. The fungus is inoculated in two forms of media the modified PDA and optimized PDA containing the dye. In modified PDA the dye decolorization of dye is visualized after 10-11 days. Optimization to analyze the dye decolorization enhancement when sucrose and peptone are added as additives (C source and N source) to the modified PDA. The decolorization is achieved by 5 days in the study of optimized PDA media. Thus showing that the fungi *Aspergillus niger* is potentially capable of decolorizing the dye and consequently its decolorization rate is enhanced by optimizing the media. The main objective of optimizing the media is that the absorbing dye capability of the fungus is enhanced, (due to the presence of sucrose and peptone –growth is increased) leading to prior decolorization of the dye compared to that of the modified PDA media.

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INTRODUCTION

Dyes are colored substance that are used in several substrates such as paper, fabrics, cosmetics etc. They are potentially capable of retaining in the substrates by means of physical absorption and also by making covalent bonding with the metals and salts. Dyes are majorly used in textile and in the printing industries. The paper and textiles are washed for removing the excess of dye present in the material and the water is ultimately released into the water bodies which turns out to be hazardous to the water-thriving creatures thus leading to their extinction. This has become a major environmental pollution. It has been estimated that about 25% dyes from these industries are being released and this affects the processing of water for drinking purposes [14]. Dyes are of different classes based on the presence of unsaturated groups present; primarily these are the color producing agents namely the chromophores. The functional groups present are those that are responsible for the adhering to the fabrics or the paper thus giving it a desired color [12]. The dyes are considered to harmful as they will reduce the penetration capacity and also due to the presence of heavy metals and other toxins [4]. This method of decolorizing dye is preferable as the physico-chemical methods are expensive and release by-products. Bacterial degradation has some limitations that restricts their usage.

Other fungal species such as the white rot fungi are also found to decolorize the dye, *Phanerocheate chrysosporium* and *Trichoderma hazarium*. They are reported to degrade by

involving the enzymes as lignin peroxidase (LiP). In this investigation, the organism employed for degradation of dye is *Aspergillus niger*. Dyestuffs can be classified according to origin, chemical and/or physical properties and characteristics related to the application process. A division into native and synthetic dyes is inadequate, since nowadays the synthesis of many natural substances is possible. A classification into textile, leather, paper or food dyes gives only a clue to the characteristics of the colorant. A more suitable categorization for the applications sector should be based upon the modern dyeing technologies (e.g., inks, disperse dyes, pigments or vat dyes). All dyes used in the textile industry are designed to resist fading upon exposure to sweat, light, water, many chemicals including oxidizing agents, and microbial attack. During processing, up to 15% of the used dyestuffs are released into the process water [19].

Dye-containing effluents are hardly decolorized by conventional biological wastewater treatments [15]. Dye-containing effluents are hardly decolorized by conventional biological wastewater treatments. In addition to their visual effect and their adverse impact in terms of chemical oxygen demand, many synthetic dyes are toxic, mutagenic and carcinogenic [11]. *Aspergillus niger*, are considered because their biomass can be used as an adsorbent [5] and serve as part of a technical solution in water pollution control. The biodegradation of dyes was first reported in Whiterot [7] and since then many scientists have focused their efforts in exploring the bio-mineralization properties of different fungi. Virtually, dyes from all chemically distinct groups have been

found prone to fungal oxidation due to their lignin modifying systems[1] [6]. *Aspergillus niger* plays a significant role in the global carbon cycle. This organism is a soil saprobe with a wide array of hydrolytic and oxidative enzymes involved in the breakdown of plant ligno cellulose . A variety of these enzymes from *Aspergillus niger* are important in the biotechnology industry. *Aspergillus niger* is also an important model organism for several important research areas including the study of eukaryotic protein secretion in general, the effects of various environmental factors on suppressing or triggering the export of various biomass degrading enzymes, molecular mechanisms critical to fermentation process development, and mechanisms involved in the control of fungal morphology.

MATERIALS AND METHODS

Microorganism

The culture type of *Aspergillus niger*, brown rot fungi was obtained from the PRIST University, East campus, Thanjavur. Stock cultures were maintained on PDA (potato-dextrose-agar) medium. The cultures were preserved at 4 °C renewed once a month.

Preparation of modified PDA media

To prepare 100ml of PDA media, 0.026 gm of powdered dye is added to and is autoclaved. Modified PDA media indicates the presence of dye in the usual PDA medium composition.

Plating the modified PDA

The autoclaved PDA is then poured immediately into the sterile Petri plate under laminar flow hood while holding the top carefully in order to avoid contamination. Then it is allowed to solidify for about 30 min .Two Petri plates of modified PDA and modified PDA control were prepared .Then the modified PDA Petri plate is inoculated with fungus *Aspergillus niger* for assessing the decolorization of dye[8].

Optimization of modified PDA

For optimizing the modified PDA, 0.2gms of sucrose and peptone are added along with dye and is autoclaved. Two plates viz. One is prepared as control containing the optimized PDA and other is prepared containing optimized PDA containing the inoculums *Aspergillus niger*.

Inoculation of the fungi

Inoculation of stored pure fungal culture *Aspergillus niger* was carried out in the modified media (PDA+dye) and optimized media (PDA+dye+sucrose+peptone). The fungus is inoculated by radiant streaking method [8] under the laminar flow conditions. The two controls, modified PDA and optimized PDA were un-inoculated with the fungus *Aspergillus niger*

Monitoring for decolorization

Decolorization is observed by visualizing the color change of the dye as red in the controls and gradual disappearance of red dye. The duration is recorded by observing the change in the color of the dye. Both the modified and the optimized plates are compared with their respective controls.

RESULTS AND DISCUSSION

In this study, optilan red dye degradation has shown positive results for the fungi *Aspergillus niger* wherein the organism has the biosorbing capacity to utilize the media and degrade the dye to less complex compound and accumulate the same. The evaluation is done by disappearance of red colored dye to its pale color by the growth of its mycelium. These observations are possible by comparison with the control plates.

DISCUSSION

The process of degradation of these types of harmful dyes is now-a-days done by employing fungi are also carried out to reduce their ill effects. The degradation is supplying a single fungal organism and the experiment is carried out by using optilan red as the testing dye that promisingly showed positive results. The organism showed the initiation of decolorization process by gradual color change and is predominant after 5days whereas after the optimization of the media marked a rapid decolorization than the former by 6days.This is possible when sucrose and peptone are added to the modified PDA along with the dye. The controls in either case showed nil decolorization as there is a lack of the inoculums.

Table 1: Visual decolorization study of optilan red by *Aspergillus niger* in modified PDA and optimised PDA containing sucrose and peptone

S.No	Particulars	Time taken for decolorization of dye in the modified PDA	Time taken for decolorization of the dye in optimized PDA
1	Days	11	5
2.	Hours	264	120

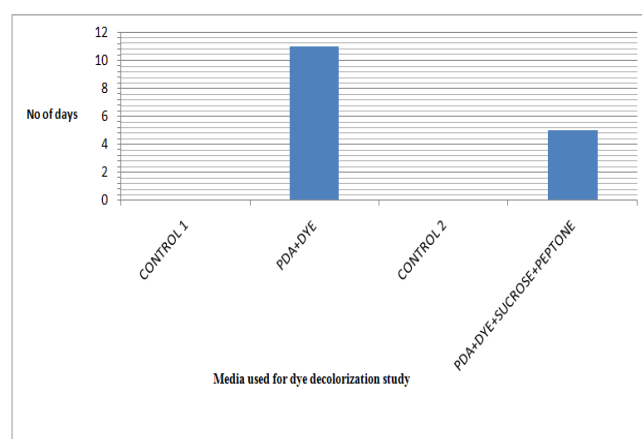


Figure1. Decolorization duration of optilan red dye by *aspergillus niger* in the modified and optimized pda media

Microbial degradation [16] are carried out in case of hazardous dyes such as Congo red, Bromophenol and other acid dyes namely the Lanasyms yellow dye etc., by supplying *Trichoderma hazaianum* ,[17] *Pleurotus ostreatus*, *Mucor mucedo* and biodegradation of plant waste materials are also being investigated [16]. Dyes are now –a -days decolorized by extracellular enzymes and also by the absorption of dyes by the growth of mycelium [3]. The absorption is a result of primary metabolism of the decolorization [9].

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