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Research Article

Agar-Plate Screening for Textile Wastewater Decolorization by Some White Rot Fungi

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Abstract

In this study, the ability to decolorize the textile wastewater by white rot fungi *Pleurotus eryngii*, *Pleurotus ostreatus* and *Phanerochaete chrysosporium* were evaluated on sabouraud dextrose agar medium. For all studied white rot fungi, growth and decolorization halos were determined on sabouraud dextrose agar plate mediums containing different diluted ratio of (1/5, 1/10 and 1/20 diluted with deionized water) textile waste water for 3 and 6 days. The all fungi showed certain decolorization capacities and were able to decolorize textile wastewater on the sabouraud dextrose agar plates, but not to the same extent. The presence of textile wastewater in the medium reduced the fungal growth in comparison with the control group growing in the medium without wastewater. It was found that a positive correlation between the fungal growth rate and the decolorization capacity.

Keywords: *White Rot Fungi; Textile Wastewater; Decolorization*

Introduction

Industrial pollution is a great concern for modern society and developing cyclic processes is one of the major challenges [1]. Wastewater is a major environmental problem for the growth of the textile industry besides the other issues like solid waste and hazardous waste management. Textile and dye industry uses many kinds of synthetic dyes and discharge large amounts of highly textile wastewater as the uptake of these dyes by industries is very poor. This highly colored textile wastewater severely affects receiving environments. This situation also has an impact on biological life due to low oxygen consumption and light penetration. It may also be dangerous to certain forms of aquatic life due to the occurrence of component metals and chlorine present in the synthetic dyes of textile wastewater [2].

The main harms caused by the textile industry to the receiving environment, however, are those resulting from the discharge of untreated waters into the receiving environments [3]. The greater emphasis should be attributed to the large amount of non-biodegradable organic compounds, especially textile dyes of industries [4]. The dyes come from textile wastewater are soluble organic pollutants [5], especially those classified as direct, basic and acids. They exhibit high solubility in water and so make it difficult to remove them by classical conventional methods [6]. One of its properties is the ability to impart color to a given substrate [7] because of the presence of chromophoric groups in its molecular structures. Micropollutants are a diverse group of compounds that are detected at trace concentrations and may have a negative effect on the environment and/or human health [8]. Low efficiency of textile wastewater removal by bacterial

consortia and high rates of decolorization by white-rot fungi offers a combination of both processes to be an option of treatment of textile wastewaters and high concentrations of organic pollutants [9].

It is widely found that white rot fungi are suitable for treating a large range of textile wastewater residuals because of their non-specific extracellular enzyme system [10]. Most preferred methods for treating pollutants with aerobic microorganisms like fungi, which utilize oxygen as the reducing equivalent acceptor during the respiration [11]. White-rot fungi's structural polymers found in woods and these are able to degrade lignin [12]. The white-rot fungi are most efficient in degrading synthetic wastewaters, with properties of their depolymerize and mineralize lignin activities. These white rot fungi can have an ability to the production of extracellular lignin-modifying enzymes with their substrate specificity, and also have an ability to degrade a wide range of xenobiotic pollutants [13].

In this study, the white rot fungi *P. eryngii, P. ostreatus and P. chrysosporium* were screened for textile wastewater decolorization capacities in sabouraud dextrose agar (SDA) mediums.

Purpose of the Study

The purpose of this study is to reveal the bioremediation ability of these white rot fungi.

Materials and Methods

Fungi

P. eryngii, *P. chrysosporium* and *P. ostreatus* were used for this study belong to the culture collection of Environmental Microbiology Research Laboratory, Munzur University, Tunceli, Turkey. The stock cultures were maintained on 2% (w/v) SDA at 4ºC. The mycelium from stock culture was transferred periodically to SDA plates and incubated at 27ºC for 6 days.

Textile wastewater samples

The textile wastewater samples were used in this study taken from a factory located within Gaziantep province of Turkey. The samples were brought to Munzur University, Environmental Microbiology Laboratories by means of cooler carrying bags.

Preparation of application mediums

The mycelial plugs (3 mm diameter) from peripheral region of actively growing stock culture for each three fungi were inoculated into the center of Petri dishes (90 mm diameter) on mediums containing textile wastewater at diluted ratios of 1/5 (X), 1/10 (Y) and 1/20 (Z) with deionized water. The plates were incubated at 27ºC in the dark for period of 6 days. The diameters (mm) of the decolorization and growth halos were measured in two perpendicular directions of the plate after 3 and 6 days of incubation. Plates containing the textile wastewater but not inoculated served as control. All statistical analyses were performed with SPSS program (SPSS Inc., Chicago, IL, USA). The data presented are the averages of the results of three replicates with a standard error.

Results and Discussion

P. eryngii, P. chrysosporium and *P. ostreatus* were tested for decolorization (Figure 1 and 2) and radial growth rate on agar plates. All three fungi were able to grow on solid media in the presence of the textile wastewater. Out of the tested fungi, it is found that the highest growth zone for textile wastewater; *P. chrysosporium* showed maximum growth zone as 57.33 mm diameter while as 30,33 mm decolorization zone on Z medium. Other decolorization zone by *P. chrysosporium* was on X medium was 22 mm, while growth zone was 40 mm at the end of the 3rd day (Figure 1). The other fungi *P. ostreatus* showed nearly 1 mm difference between decolorization and growth zone on Z medium. This fungi showed no decolorization and growth zone on X medium but showed 18,66 mm growth zone in Petri dish with

Y medium. *P. eryngii* showed max growth zone at Y media as 39 mm while 35,66 mm and 35,33 mm in media with Z and X respectively in three days. In same time period, the decolorization zone for this fungi was seen on a maximum level as 32,33 mm in media with Y medium while 26,66 and 27,66 mm in Z and X mediums respectively (Figure 1).

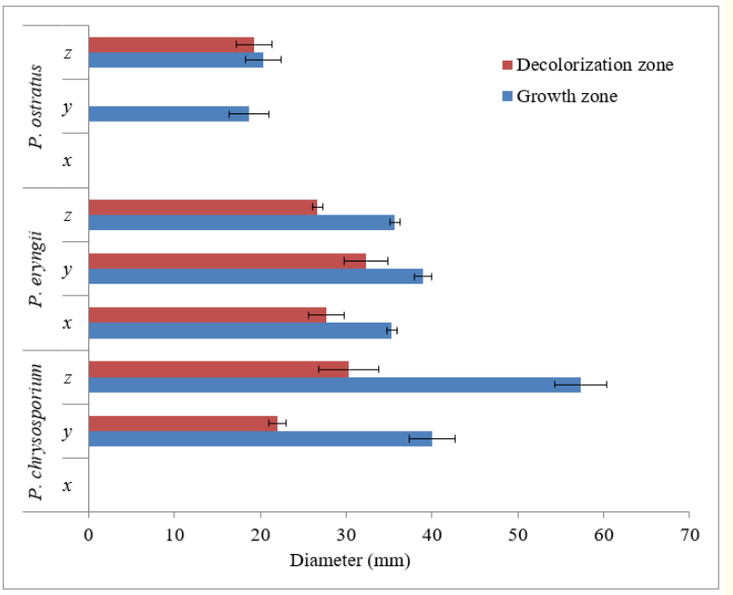

Figure 1: *After 3 days of incubation, growth and decolorization zones of fungi in petri dish on SDA mediums containing textile wastewater at diluted ratios of 1/5 (X), 1/10 (Y) and 1/20 (Z) with deionized water. Means ± SE with for three replicates. Growth zone as a diameter of mycelial colony on SDA medium. Decolorization zone measured as a diameter of decolorized zone on a Petri dish on SDA medium.*

After the 6 days of incubation, the max growth zone seen in *P. eryngii* in media with Z medium and *P. chrysosporium* in Y and Z mediums as 90 mm diameter. The decolorization diameter for these fungi was 58 and 51 mm in Z and Y mediums respectively. There is no growth and decolorization zone in X medium for these fungi at the end of this time period. The second high growth rate seen on *P. eryngii* in Y medium was 75,66 mm diameter. The worst growth zone seen in *P. ostreatus* was 32,33 and 29,66 mm diameter in Z and Y mediums respectively while decolorization zone was seen nearly 22 mm in both media. It was also observed that different fungi types revealed statistically ($p < 0.05$) different results in decolorization and growth zone ability (Figure 2).

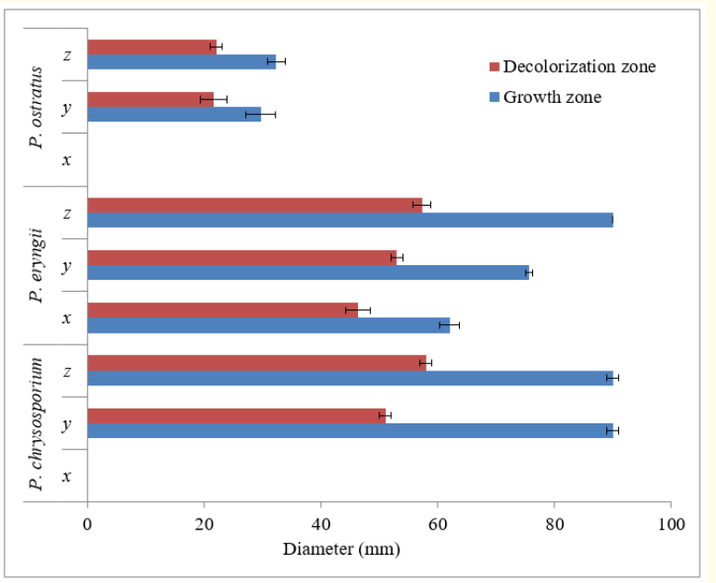

Figure 2: *After 6 days of incubation, growth and decolorization zones of fungi in petri dish on SDA mediums containing textile wastewater at diluted ratios of 1/5 (X), 1/10 (Y), and 1/20 (Z) with deionized water. Means ± SE with for three replicates. Growth zone as a diameter of mycelial colony on SDA medium. Decolorization zone measured as a diameter of decolorized zone on a Petri dish on SDA medium.*

In order to develop more efficient and more cost-effective treatment methods for degrading textile wastewater, the capability of the white-rot fungus *Ganoderma sp*. En3 isolated by [14]. They decolorize and detoxify Reactive Orange 16 with *Ganoderma sp*. En3 and they found this microorganism had a strong ability to decolorize high concentrations of Reactive Orange 16 in submerged cultures.

Restrepo., *et al*. (2020) investigated the capability of eight white-rot fungi on decolorization the dye mixture of brilliant blue FCF and allura red AC adsorbed onto corncob. They reached decolorizations between 11.47% and 87.64%. Then, *I. lacteus, B. adusta* and *T. versicolor*, based on the decolorization yield, were selected to evaluate inoculum quantity on the decolorization percentage [1].

According to Holkar., *et al*. (2016) the decolorization potential of a local white rot fungus, *Coriolus versicolor* IBL-04 can have an ability for decolorization of a textile wastewater for practical industrial effluents collected from five different textile industries of Faisalabad, Pakistan. According to their study, *C. versicolor* IBL-04 on five effluents showed best decolorization results (36.3%) for Arzoo Textile Industry effluent in nearly one week followed by Crescent Textile Industry (CRT), Itmad Textile Industry Megna, Textile Industry and Ayesha Textile Industry effluents [2]. Toh., *et al*. (2013) investigated three strains of white-rot fungi isolated in Singapore were screened for their ability to decolorize three azo dyes relative to the studied species, *Phanerochaete chrysosporium*. The local isolate *Trametes versicolor* CNPR 8107 exhibited the greatest potential in treating dye effluents and its capabilities were investigated in detail. Dye decolorisation by CNPR 8107 was more favorable at 30° than at 37°C and compared favourably with *P. chrysosporium* as well as a reference commercial strain *T. versicolor* ATCC 20869. However, CNPR 8107 exhibited an initial lag in its dye decolorization rate due to lower laccase production than ATCC 20869. A significant increase in decolorization rate by CNPR 8107 was observed at the end of 5th day, following higher manganese-dependent peroxidase production. It is found that, CNPR 8107 did not require strict secondary metabolism for ligninolytic enzymes production [10].

Decolorization of indigo dye in liquid medium was monitored with ligninolytic basidiomycete fungi from Brazil. Decolorization started in a few hours and at the end of the 4th day. The removal of dye by *Phellinus gilvus* was full. *Pleurotus sajor-caju, Pycnoporus sanguineus* and *Phanerochaete chrysosporium* showed 94%, 91% and 75% respectively. No color decrease was seen in a sterile control [15].

For screening of fungi types for decolorization, the majority of researchers used textile wastewater in different concentrations. Recently study results showed a positive correlation between the mycelial growth rate and the decolorization ability measured as the diameter of the decolorized zone. The radial growth diameter mostly exceeded the diameter of the decolorized zone. It seems likely that the strong growth reduction in the presence of both dyes caused their poor decolorization.

Conclusion

The ability of white rot fungi to degrade a wide variety of textile wastewaters indicates their potential use in antipollution treatments. There is a need to develop fungi types which are capable of decolorizing textile wastewater. Present results indicate that some white rot fungi could be used in bioprocesses to remove color from textile wastewater effluents from colored solid substances. It was found that these fungi were able to decolorize textile wastewater. Studies from recent years can be helpful literature for the development of an economical as well as simplified biological treatment method for treating toxic dyes by using white rot fungi. The results indicate that *P. ostreatus, P. eryngii* and *P. chrysosporium* can easily decolorize some synthetic dyes, which could be promising for biological purposes.

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