Biotreatment of coloured textile effluents by *Phanerochaete chrysosporium*

P. Jeevana Lakshmi, D.Hymavathi, d Y.Ambethkar

***Abstract*— Industrial effluents containing dyes pose a threat to human health as they are released into the environment without processing. In the current paper the potential of *Phanerochaete chrysosporium*, a white rot fungus, is investigated for its biological treatment of textile effluents containing three types dyes –Tri phenyl methane, Malachite Green & Reactive Blue. The decrease in optical density values corresponded with decolourization. The effect of pH, temperature, concentrations of cation and anion revealed that the dye decolorization was maximum at pH 6, 28 °C and 0.02 g/Kg concentrations of magnesium sulphate and potassium nitrate.**

Index Terms*— Decolorization, Dye degradation, Optimization, *Phanerochaete chrysosporium

I. INTRODUCTION

The usage of dyes has been increased day by day because of increased industrialization and mans' urge for use of various types of colours. Among the 40,000 dyes used in textile industries around 20,000 are accounted to be azo dyes and annual production of these dyes exceeds 7x 10^5 tonns worldwide. Of the total dyes used in the textile industry, 25-50% is lost in the effluents. Presence of dyes in the effluents poses a serious threat to environmental and human health as they are mutagenic and carcinogenic agents. They cannot be completely removed by conventional treatment methods.

However, they can be removed by filtration, coagulation, carbon activated and chemical flocculation methods that generate sludge with secondary disposal problem. Now-a-days, environmental friendly biological processes such as biodegradation, bioaccumulation and bio-sorption for effluent treatment of dyes is receiving increasing interest due to cost effectiveness and ability to produce less sludge. These processes include use of biological material and microorganisms for treatment of dye containing effluents. Bacteria are the widely studied organisms in the microbial degradation of the dyes in the effluents [1]. *Bacillus subtilis* [2] degradation was followed by numerous bacteria such as *Aeromonas hydrophilia* [3], *Bacillus cereus* [4], *Pseudomonas sp*. [5], *E. Coli* [6] *etc*. However, because of the production of toxic aromatic amines in the anerobic treatment and dye specific degradation involved aerobic treatment made bacteria less interesting.

This has opened up new arena in search of the other groups of microorganisms involved in dye degradation. In this scenario different groups of fungi have been studied in this decade for their capability of decolourization of dyes from textile effluents. Fungi like *Trametes versicolor* [7], *Trametes hirsute* [8], *Phanerochaete chrysospori* [9], *Schizophyllum commune* and *Lenzites eximia* [10], *Coriolus versicolor* [11], *Tramates versicolor* [12, 13], *Funalia trogii* [14], *Umbelopsis isabellina* and *Penicillium geastrivous* [15], *Aspergillus foetidus*, *Rhizopus oryzae* [16] were identified to decolourise polymeric synthetic dyes.

Widely used dyes - Malachite green (MG), reactive blue (RB) and triphenyl methane (TPM) have been studied and their decolorization from the effluents using fungus-*Phanerochaete chrysosporium* has been investigated in the present work. Owing to importance of fungi in decolourization of dye containing effluents, *Phenerochete sps*. isolated from Tirumala Hills, has been studied for the decolourization of the three dye containing effluents-Malachite green, Reactive Blue and Triphenyl methane.

II. MATERIALS AND METHODS

A. *Dye decolourization:*

Qualitative test of the dye decolourization was done by studying the effect of growth of *Phanerochaete sps.* in the dye incorporated Highley's basal salt medium [17]. 0.5ml of the 48-72 hour old culture isolated on malt yeast extract broth medium was inoculated into the basal media and incubated at 28^0C for 8 days in an orbital environmental shaker at 150rpm. The ability of the white rot fungus to decolorize the three types of dyes was visibly recorded.

The flasks were also prepared in a similar way for quantitative measurement of the dye decolourization with all the three types of dyes. After inoculation the flasks were incubated and the samples were read at 600nm foe malachite green and at 620nm for reactive blue and triphenyl methane in UV visible spectrophotometer every 48hrs.

B. *Optimization of the conditions of decolourization:*

Decolorization of textile effluents is effected by various environmental factors like pH, temperature, conc. of cation and anions. To study the effect of pH on the decolorization of the three dyes, each of the effluent flasks were prepared in range of pH 4-9. The flasks are incubated at 28^0C in orbital shaking incubator and the readings are taken every 48hrs. Percentage of degradation was calculated as

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$$\text{Decolourization\%} = \frac{(Co-Ce)}{Co} X100$$

Where, C_o is initial concentration of dye (mg/l) and Ce is residual dye concentration (mg/l) at different time intervals. To study the effect of temperature on decolorization, each of the effluent flasks were incubated in the temperatures between 25^0C and 32^0C. The samples were read every 48hrs. To determine the effect of cations and anions, the concentrations of potassium nitrate and magnesium sulphate were adjusted in the range of 0.01 and 0.1 $g100ml^{-1}$ for the three dye containing textile effluents. The flasks were incubated and the samples were read at 600nm for malachite green and 620nm for reactive blue and triphenyl methane every 48hrs. Percentage decolourization was calculated as given in the earlier section.

III. RESULTS AND DISCUSSION

Phanerochaete sps., white rot fungus, isolated from Tirumala Hills was grown on the three types of dye containing effluents- Malachite green, reactive blue and triphenyl methane. Visible decolourization started from day6 in all the dye containing effluents. Quantitative estimation revealed that optical density decreased (Fig. 1) and percentage of degradation (Fig.2) increased gradually and reached maximum corresponding with observed visual decolourization. Similar decolorization was also seen with the other fungi degrading dyes [18, 19].

Optimization of the conditions of decolourization:

Influence of various environmental factors like pH, temperature, conc. of cations on decolourization of the three dyes by white rot fungus was studied. Effect of pH revealed that the degradation % was optimum at pH 6 and comparatively high degradation is observed at neutral pH (Fig.3). Decolorization of the dye was favoured by slightly acidic pH exhibiting that dye degradation corresponded with nature of the dyes- malachite green, reactive blue and triphenyl methane. Similar degradation pattern was found with the degradation of dyes in acidic pH by other fungal species [20, 21]. The isolate was grown in effluent containing media at different temperatures in the range of 25^oC- 35^oC. Optimum decolorization was observed at 28 ^oC that corresponded with growth of the isolate inferring that dye decolourization is directly affected by the growth and metabolism of the white rot fungus (Fig.4). The effect of concentration of cations and anions on dye decolorization was performed with amendments of concentrations of potassium nitrate and magnesium sulphate in the range of 0.01 to 0.1 g per 100ml in the basal salt medium. It was observed that optimum decolorization was observed with 0.02 concentrations of both the compounds. Any further increase or decrease in the composition of the cations and anions decreased the percentage of decolorization as shown in the Fig.5 and Fig6.

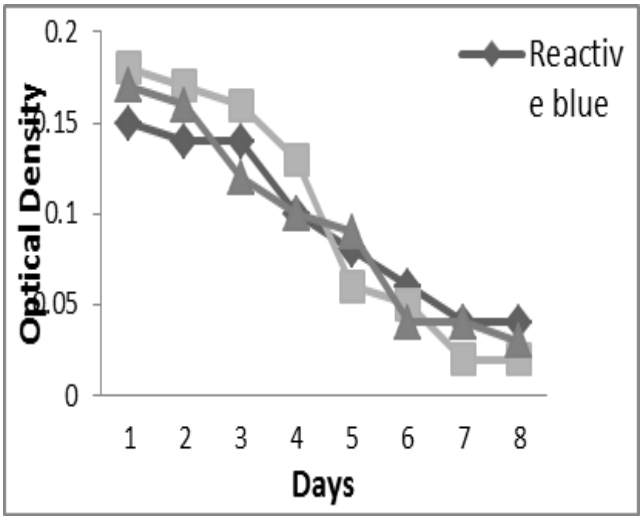

Fig. 1-Optical density values of the dye containing basal media recorded every 24 hour time

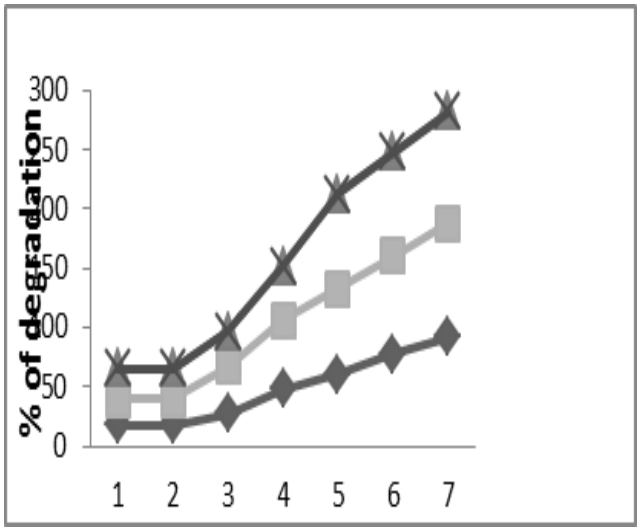

Fig.2. % of degradation of the dye decolorization of the three dyes by the *Phenerochaete sps*.

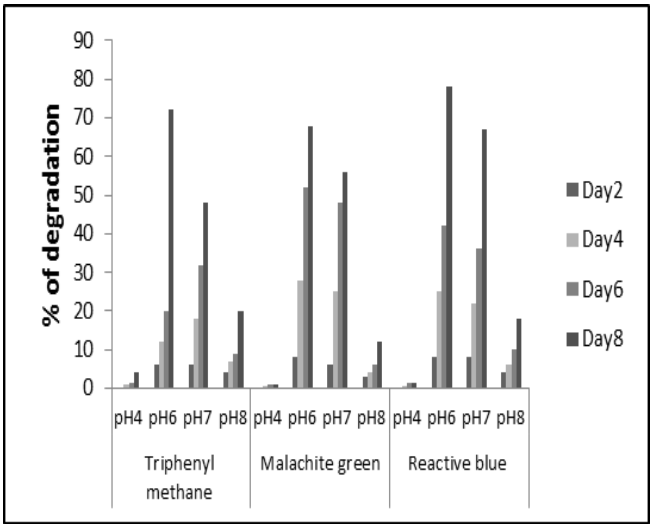

Fig.3. Effect of pH on the decolorization of the three dyes by the *Phenerochaete sps*.

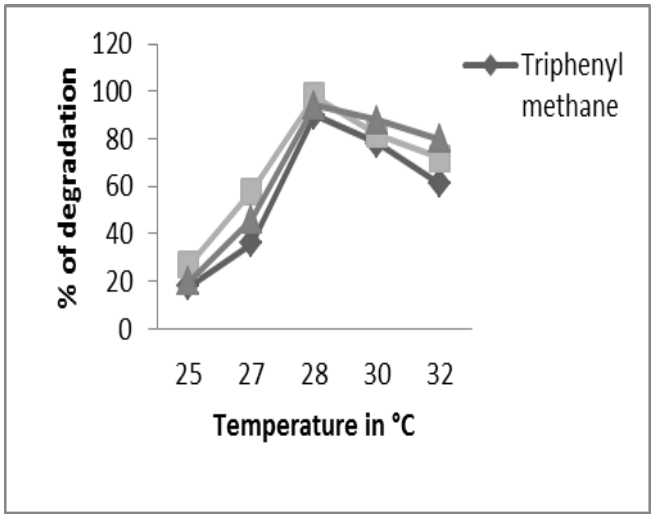

Fig.4. Effect of temperature on the dye decolorization of the three dyes by the *Phenerochaete sps*.

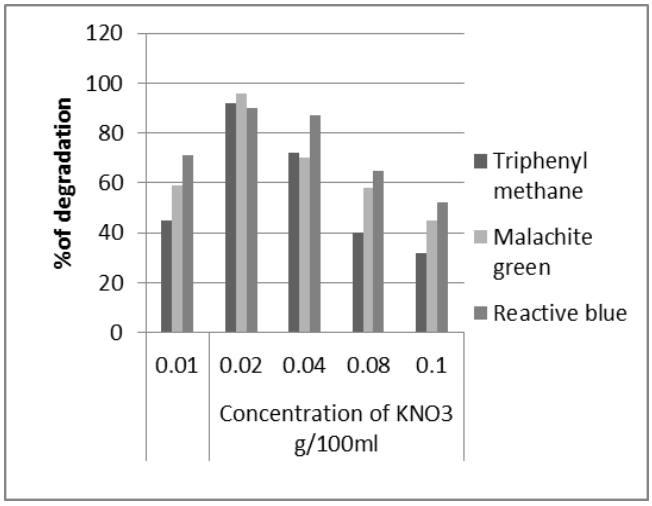

Fig.5. Effect of concentration of KNO_3 on the dye decolorization of the three dyes by the *Phenerochaete sps*.

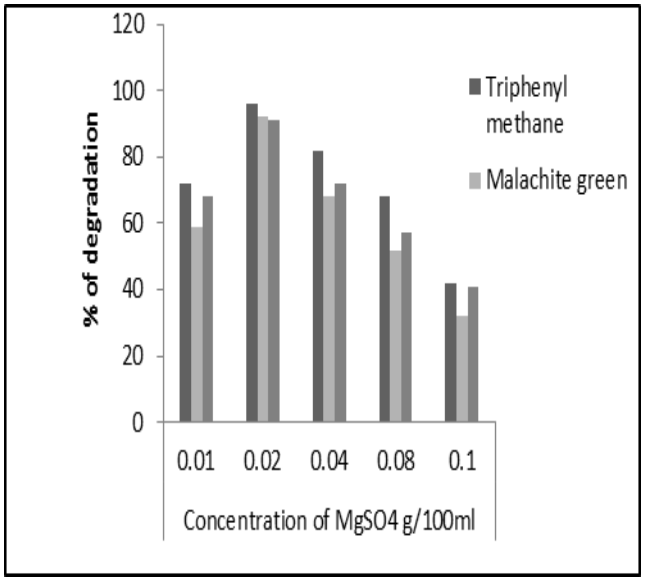

Fig.6. Effect of concentration of $MgSO_4$on the dye decolorization of the three dyes by the *Phenerochaete sps*.

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