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Reduction of environmental pollution load by treatment of paper industry effluent using white rot fungi

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ABSTRACT

The work was undertaken to reduce environmental pollution load by treating the effluent from paper industry with white rot fungi. The white rot fungi (*Sporotrichum pulverulentum* and isolated strain) have been found to utilize the paper industry effluent and degrade environmental pollutants into simpler substances. The bioprocessing of effluent was done under different atmospheric conditions i.e. active aeration, passive aeration, sterilization, no sterilization and at different pH. This has given an idea of comparative study. The paper industry effluent mainly comes from the bleaching stages of pulp and after chemical bleaching contains various toxic and mutagenic environmental pollutants. In this research work such polluted effluents were treated before releasing it to environment by white rot fungi which have ability to degrade the toxic and pollutant chemicals present in effluent. Finally there was significant reduction in TDS, BOD and COD than initial values.

KEYWORDS

Paper industry effluent;
Chemical oxygen demand;
Biological oxygen demand;
White rot fungi.

INTRODUCTION

The effluents produced during chemical bleaching of Kraft pulp in paper industry are the major contributors to waste water pollution and must be treated before discharge, they are increasing concern[1]. Obviously therefore, further research with white rot fungi is warranted. Bleaching effluents from paper mills are potentially hazardous to due to there high content of toxic chlorinated organic compounds[2] The C- stage effluent particularly exhibit mutagenic effects[3]. White rot fungi so for found no technical use for degradation of chlorinated aromatic compounds in bleaching effluents. However, it has been demonstrated in laboratory studies that the white rot fungus *Sporotrichum pulverulentum* can decomposes the low molecular weight chlorinated aromatics found in Kraft bleach plant effluents, the compound decomposed include 2,4.6 trichlorophenol, 6 chlorovanilin, tri and tetra chloroguaicols[4]. Some at chlorinated guicol compounds are transformed by fungus to veratyl compounds (i.e. they are -o-methylated), which might be a disadvantage because of the greater lipophilicity of such compound. According to[5] white rot fungi have been shown to reduce quinines to their

TABLE 1 : Primary media nutrient concentrations

Nutrients	Conc. In solution
KH_2PO_4	14.7 mM
$MgSO_4$	2.0 mM
$Cacl_2$	0.9 mM
NH_4Cl	2.2 mM
Thiamine HCl	1.0 mg/lit.
Glucose	1 %
pH	4.5

corresponding phenols leading to bleaching in part action by enzyme cellobiose, quinine oxidoreductase and NAD(P)H quinone oxide reductase[4,5]. The biological treatment for paper industry effluent has been found to remove BOD, COD, toxicity, mutagenicity and organic carbon.

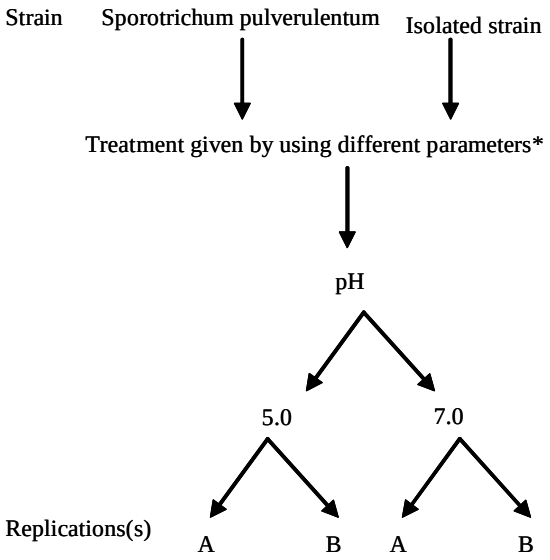
Since white rot fungi (*Sporotrichum pulverulentum*) are most attractive organism for removal of chemical pollutants by process of bioleaching. The purpose of this research work was to develop and evaluate an effective treatment process (aerated reactor) that could possibly provide a higher reduction of pollution load in terms of biological oxygen demand (BOD) and chemical oxygen demand (COD). Specific objectives were to establish cultural conditions, to optimize parameters and to evaluate treatment process for reduction of pollutants from paper industry effluent.

MATERIALS AND METHOD

The culture used (A) *Sporotrichum pulverulentum* used and maintained low temperature before being utilized. (B) Screening of strain : Another strain was used in this study was isolated from waste water disposal site of Shri. Vndhya Paper Mill, Duskheda, Bhusawal (M.S., India) using primary media (TABLE 1). The screening of fungi was done using agar plates containing cellulose and pulp as sole carbon source and tested for cellulosic degradation. The microscopic observations for the isolated strain were also conducted.

Maintenance of culture

The fungal culture were maintained on potato dextrose agar at 25°C and preserved in refrigerator. The culture were sub cultured at an interval of 30 days before being utilized as an inoculum.



Control = without inoculation, *Parameters = Sterilized and Aerated, Nonsterilized and Aerated, Sterilized and Nonaerated, Nonsterilized and Nonaerated

Flow chart

Effluent for treatment

The paper industry effluent waste commonly called black liquor collected from Shri. Vndhya Paper Mill, Duskheda, Bhusawal (M.S., India) and stored at low temperature before being used (within 15 days) for research work.

Analytical methods

The standard methods utilized for total dissolved solids (TDS), biological oxygen demand (BOD) and chemical oxygen demand (COD) values calculated before and after biological treatment of effluent.

Biological treatment of effluent using white rot fungi

The bioprocessing of effluent from paper industry was done by using the laboratory scale preliminary method involving various parameters using white rot fungi viz. *Sporotrichum pulverulentum* and isolated strain as an inoculum. The bioprocessing of effluent done at acidic pH (pH-5) because its favors growth of fungus. The set of 24 bottles was prepared and inoculated with spores of *Sporotrichum pulverulentum* and isolated strain and was incubated at ambient temperature under varying environmental conditions (Flow chart) for a period of 20 days. The control was also kept for different treatments and conditions. The pH of effluent

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TABLE 2 : Bioprocessing of paper industry effluent by *Sporotrichum pulverulentum* under following conditions at ph -5

Treatments(s)	pH		TDS (%)		D.O.(ppm)		BOD(ppm)		COD(ppm)	
	F	I	F	I	F	I	F	I	F	
Sterilized and In aerated UIn	6.0	5.13	1.36	1200	480	560	400	800	300	
	7.0	5.13	2.64	1200	600	560	440	800	760	
Sterilized and In nonaerated UIn	5.5	5.13	1.60	1200	240	560	40	800	540	
	6.5	5.13	2.24	1200	260	560	140	800	760	
Nonsterilized In and aerated UIn	6.5	5.13	2.40	1200	280	560	40	800	600	
	6.0	5.13	2.58	1200	360	560	80	800	780	
Nonsterilized In and nonaerated UIn	6.5	5.13	2.24	1200	240	560	120	800	360	
	6.5	5.13	2.80	1200	320	560	160	800	780	

I = Initial Readings, F = Final readings, In = Inoculated, UnI = Uninoculated

TABLE 3 : Bioprocessing of paper industry effluent by isolated strain under following conditions at ph -5

Treatments(s)	pH		TDS (%)		D.O.(ppm)		BOD(ppm)		COD(ppm)	
	F	I	F	I	F	I	F	I	F	
Sterilized and In Aerated UIn	6.5	5.13	1.48	1200	200	560	200	800	375	
	7.0	5.13	1.60	1200	240	560	240	800	760	
Sterilized and In Nonaerated UIn	6.5	5.13	2.28	1200	280	560	40	800	350	
	6.5	5.13	2.88	1200	520	560	240	800	750	
Nonsterilized In and Aerated UIn	6.0	5.13	2.32	1200	260	560	40	800	600	
	6.0	5.13	2.64	1200	480	560	120	800	780	
Nonsterilized In and Nonaerated UIn	6.0	5.13	2.32	1200	200	560	40	800	440	
	6.5	5.13	2.88	1200	280	560	160	800	770	

I = Initial Readings, F = Final Readings, In = Inoculated, UnI = Uninoculated

was adjusted at 5.0 then nutrient media added where the nitrogen and carbon source is depleted for lignolytic fungi[6].

The different treatment given as as shown in flow chart.

RESULT AND DISCUSSION

The major constituents of paper industry bleach effluent are chlorinated phenols, resins, fatty acids, hydrocarbons, hypochlorites which are toxic pollutants. At extraction stage effluents are composed by chlorinated and oxidized kraft lignin, hemi cellulose and their degradation products which are mostly polymeric, high color, high BOD and COD. The present study was mainly focused on the reduction of total dissolved solids, BOD and COD. The white rot fungi have ability to degrade various constituents from paper industry effluent, helping in reduction of pollution load in environment. The high rate of reduction in COD observed by *Sporotrichum pulverulentum* under sterilized and aerated condition. Similarly the reduction of COD, BOD and dissolved solids by isolated strain has been noted. Remarkly reduction of BOD up to 40 ppm than that of initial 560 ppm and TDS 2.4% than that of initial 5.13% at non sterilized and aerated condition by *Sporotrichum pulverulentum* was observed, it can be directed to large scale utilization. The detail results are summarized in TABLE 2 & 3.

The white rot fungus decomposes the components of effluent to various non pollutant compounds[4] some of chlorinated guicol components are transformed by fungus to veratryl compounds. The mutagenic substances can be eliminated from effluent by treatment of white rot fungus[7]. It can be stated that we have been able to reduce BOD, COD and TDS of paper industry effluent from Shri Vndhya Paper Mill, Duskheda, Bhusawal (M.S., India). This study proved significance of biological treatment of effluent in reduction of environmental pollution load and also directed to evaluate the detail biochemistry of degradation of various environmental pollutants by bioprocessing of effluents from various industries using white rot fungi.

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