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Remediation of textile industry waste water using immobilized *Aspergillus terreus*

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ABSTRACT

Synthetic dyes are released into the environment from textile industrial effluents. It decreases photosynthetic activity and increases toxicity to the living beings. In present paper pollution level was monitored in terms of Biological oxygen demand (BOD) and Chemical oxygen demand (COD). The strain Aspergillus terreus was evaluated for its efficiency to decolorize and decrease BOD and COD values of the effluent. Various inexpensive matrices were used for immobilization of A. terreus viz. Bagasse, coconut coir, Loofa sponge and Gunny bag (Jute). A. terreus immobilized on Bagasse showed 62%, on coconut coir 58.6%, on Loofa sponge 71.7% and on Gunny bag (Jute) 82.66% reduction in BOD. In case of COD reduction, A. terreus immobilized on Bagasse showed 60.25%, on coconut coir 56.31%, on Loofa sponge 69.71% and on Gunny bag (Jute) 81.25%. Amongst all Gunny bag (Jute) was found most efficient immobilizing material for A. terreus to decrease the pollution level and remediation of the effluent.

Key words: Textile industry effluent, Gunny bag (Jute), decoloration, immobilization, *A. terreus.*

INTRODUCTION

In the India, the textile is one of the country's largest industries, earning large amount of foreign exchange and attracting public attention from the view point of pollution. Untreated effluent from dyestuff production and dyeing mills is highly colored and hence objectionable if discharged into open waters. Even though the dye concentration may be well below 1 ppm, i.e., lower than many other chemicals found in wastewater, the color is predominant and visible. Approximately 10,000 different dyes and pigments are used industrially [1]. It is estimated that 280,000 tons of the textile dyes are discharged in such industrial effluents every year worldwide [2]. Many synthetic dyes are toxic mutagenic and carcinogenic [3].

Biological approaches like activated sludge systems, give rise to the accumulation of concentrated sludge and emission of toxic substances, which still remains as a disposal problem during dye removal. In this context there is a need to improve those biological treatments systems that are effective in removing dyes from large volumes of effluents at a low cost [4]. Commonly, azo dyes are related to be resistant to biological treatment but, face to the combination of anaerobic and aerobic methods, bioremediation might occur [5]. Treatment of dye wastewater has become a matter of great concern, and several advanced treatment methods such as physical and chemical methods, have been suggested [6, 7, 8]. Compared to these methods, biological methods were environmental-friendly and cost

less [9]. Biological remediation is considered more efficient in terms of its long lasting benefits and for having almost no harmful effects on environment. In addition, it would be cheaper as compared to other different physico-chemical methods [10].Various fungal strains that have proved more efficient in decoloration of textile dyes mostly belong to the group of white-rot. Dyes are removed by fungi by biosorption[11, 12] and enzymatic mineralization (degradation) Lignin peroxidase (LpP), Manganese peroxidase (MnP), Manganese independent peroxidase (MIP), Laccases ($Lacc_s$) [13, 14, 15, 16, 17, 18, 19, 20, 21, 22]. However, one or more of these mechanisms could be involved in color removal, depending on the fungus used. Some studies on the treatment of black liquor showed that COD, BOD and color removal of black liquor was dependant on biomass concentration, initial BOD and COD [23].

Here, an attempt has been made to use various inexpensive matrices for the immobilization of *Aspergillus terreus*. We used different materials for immobilizing *Aspergillus terreus* and efficiency of immobilizing material is determined in terms of their ability in percent reduction of BOD and COD values of textile industry effluent. Physicochemical analysis of effluent before and after treatment with immobilized *Aspergillus terreus* was carried out for matrix showing highest reduction potential.

MATERIALS AND METHODS

Microorganisms:
The strain was isolated from the textile industry effluent and identified by morphological and microscopic characteristics. Isolation and preservation of the culture was done on potato dextrose agar.

Chemicals:
All BOD and COD reagents were prepared according to the standard methods of water analysis [24]. All the reagents used were of AR grade (Sigma Aldrich).

Immobilization of *A. terreus*:
Various inexpensive matrices such as Bagasse, coconut coir, loofa sponge and Gunny bag (Jute) used for fungal immobilization was prepared by cutting dry matrix into rectangular pieces, washed with distilled water to remove impurities and dried in oven at 105^0C. The dried matrices were then cut in small pieces of size (2X3 cm) weighing approximately, 0.1 gm matrix pieces were added in Potato dextrose broth and sterilized at 121^oC at 15 psi for 15 minutes. The medium was cooled and then incubated with 1 ml of suspension containing 10^6 spores of *A. terreus* and kept for incubation on shaker (100 rpm) at 30^0C. After 6 days of incubation, heavy fungal growth was found entrapped in the matrix. Immobilized material was removed from the flasks and tried for remediation studies.

BOD and COD Analysis:
BOD was determined as oxygen required by microorganisms while stabilizing biologically decomposable organic matter in a waste under aerobic conditions. COD was determined as the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant [24].

Physico-chemical analysis of effluent:
Effluent was collected from the effluent treatment plant of the textile industry Aurangabad, India. Physicochemical characters of the effluent were carried out. Following parameters were estimated pH, Color, Total solids, Total dissolved solids, Total suspended solids, Biological oxygen demand, Chemical oxygen demand, Total acidity, Total hardness, Magnesium, Sulphate, Chloride, Conductivity, Sodium, Potassium, Nitrate, Nitrite, Oil and Grease.

Remediation studies:
Inorganic nutrients such as phosphate buffer, $MgSO_4$, $CaCl_2$, $FeCl_3$ were added to effluent and pH was adjusted to 7. Two pieces of each matrix immobilized with *Aspergillus terreus* were inoculated into the 100ml textile industry effluent. Samples were withdrawn periodically and BOD, COD were determined. After 8 days of treatment with *A. terreus* immobilized on efficient matrix, physico-chemical parameters of such effluent was determined.

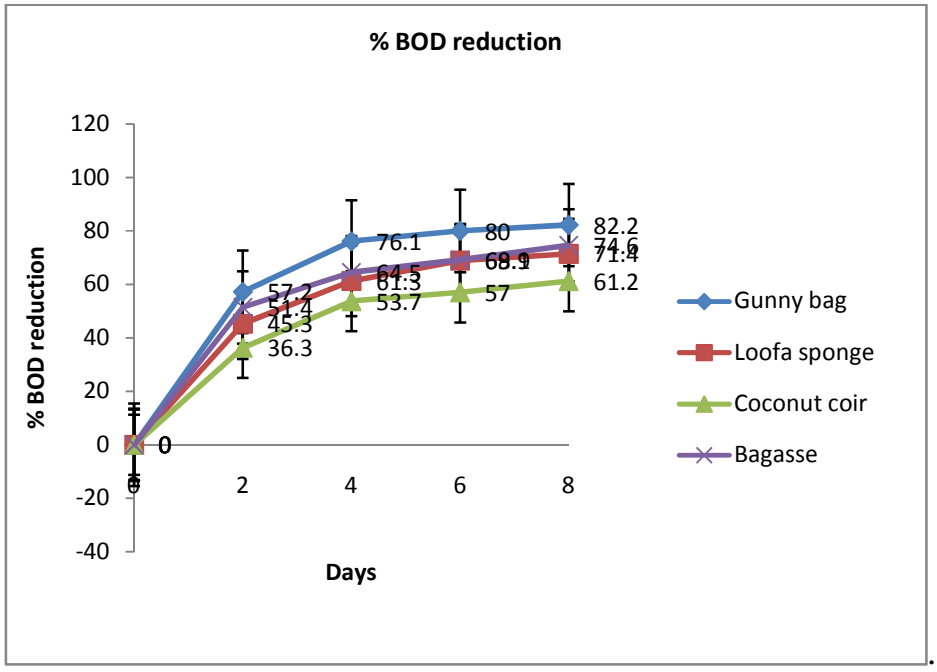
RESULTS AND DISCUSSION

The strain was isolated from the textile industry effluent and identified as *Aspergillus terreus* based on morphological and microscopic characteristics and maintained on potato dextrose agar. This was used for

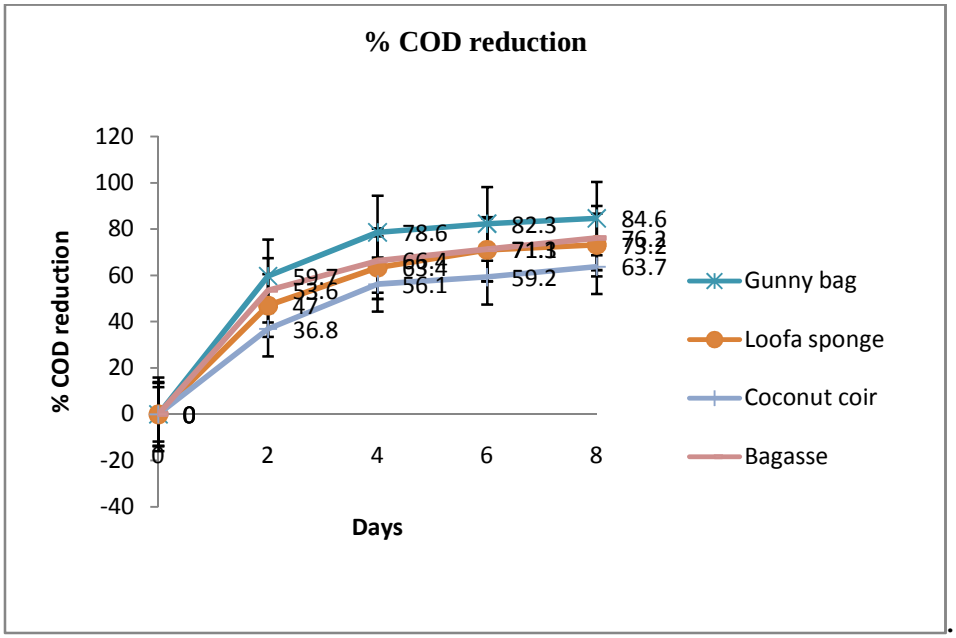
remediation of textile industry effluent immobilized with various matrices. Incubation of *A. terreus* with various matrices in PDB, immobilization sufficient was achieved on 6th day as shown in Fig.1.

Fig. 1. Gunny bag matrix immobilized with *A. terreus* and without immobilization.

This when added to textile industry effluent that was with BOD, COD values were 3000 and 16000 mg/Lit respectively, significant reduction in BOD and COD values i.e. 50% reduction obtained in 3rd and 4th day. This was obtained with all matrices used as shown in graph 1 and 2. Amongst all matrices used for immobilization of *A. terreus* Gunnybag showed highest i.e. 82.2% reduction in 8 days.



Graph 1: Percent BOD reduction (Initial BOD: 3000, Final BOD: 520)



Graph 2: Percent COD reduction. (Initial COD: 16000, Final BOD: 3000)

Similar result obtained for various physiochemical parameters as shown in table1. Treatment of *A. terreus* immobilized on Gunny bag showed significant reduction of TS, Alkalinity, EC, nitrate, nitrite, oil and greese. Result thus supporting potential of *A. terreus* immobilized on Gunny bag for remediation of pollutants from waste water.

Table1: Physicochemical parameters of effluent before & after treatment with *A. terreus* immobilized on Gunny bag.

Sr. no	Characteristics (Mg/L)	Before treatment	After treatment
1	Colour	Dark brown	Pale yellow
2	pH	8.7	
3	Total solids	6582	1570
4	Total dissolved solids.	6002	1564
5	Total suspended solids	580	27
6	EC	3500	1500
6	BOD	3000	520
7	COD	16000	3000
8	Total alkalinity	638	160
9	Total hardness	569	575
10	Magnesium	36	46
11	Sulphate	40	104
12	Chloride	73	2553
13	Conductivity	1.441	9.30
14	Sodium	143	622
15	Potassium	36	76
16	Nitrate	12	5
17	Nitrite	0.12	0.054
18	Oil & Grease	146	37

(All parameters except color & conductivity are given in mg/l, Conductivity was measured in µmhos/cm and data presented is average of three different readings.)

Result obtained also showed discoloration / removal of color of effluent, this is in similar to findings reported for *Asprgillus oryzae* [25]. Similar finding but for distillery effluent i.e. reduction in BOD and COD with decolorization have been reported [26].

Fig. 3. Showing decolonization of textile industry effluent after treatment with *A.terreus* immobilized with different matrices.

Effluent used in present work having dark blackish color suggesting presence of more than one dye (data unknown) along with other organic pollutants. Initial rapid decrease in the BOD and COD values of the effluent in this study might be because of quick (in 4 days) adsorption of dyes. Further steady reduction is suggestive of remediation of other organic components in the effluent.

Improvement in the removal of dyes by adsorption is depending on contact of effluent containing dyes with organism. For repeated use always immobilized growth is preferred. Matrices with better holding capacity are needed for this purpose. Various matrices used in the study are as Bagasse, coconut coir, Loofa sponge and Gunny bag (Jute). Among these Gunny bag was found most efficient for *A. terreus*. It is widely used by Indian farmers for bulk packaging of food grains, thus available in ample and chief. Obtained result highlighted potential use of *A. terreus* immobilized on gunny bag matrix for removal of dyes from the textile effluent.

A finding of this study focuses potential use of Gunny bag matrix which is having highest holding capacity for fungal mycelia suggesting its suitability for developing cost effective technology. A study of decoloration of carpet dye effluent also used Jute twine for immobilization of *T. versicolor* and reported significant decoloration without increasing toxicity [27]. But in her studies at the same time increase in the COD values reported. In our study along with decoloration the immobilized *A. terreus* showed significant decrease in the value of BOD and COD values, at the same time other physicochemical parameters also have shown significant decrease. This study focuses use of individual isolate at same time studies with consortium have also reported [28].

Thus this study indicates that the strain *A. terreus* not only useful for decoloration (dye adsorption) but also degradation of other organic wastes that are present in the effluent. This study highlighted efficient and cost-effective method for immobilization of *A. terreus* useful for remediation of textile industry effluent.

CONCLUSION

Present investigation put focus on use of *A. terreus* immobilized with Gunny bag (Jute) and shown highest reduction of BOD and also COD i.e. 82.66% and 81.25% reduction. This was also with significant decrease in other physicochemical parameters. Thus use of Gunny bag for immobilization of *A. terreus* and other organisms can serve as an efficient and cost effective way for treating textile and other effluents.

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