

Decolorization of Textile Effluent by Immobilized *Aspergillus terreus*

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Abstract

The present investigation envelopes the uptake of dyes from textile effluent by a fungal culture *Aspergillus terreus* immobilized in various matrices.

Results confirmed that the percent adsorption of dyes from textile effluent (1:4) diluted, by *Aspergillus terreus* immobilized in Loofa sponge after 48 hours was 91.1% with 8 loofa pieces.

The percent adsorption of dyes from undiluted textile effluent by 8 pieces of loofa sponge immobilized with *A. terreus* was 50.5% in 48 hours. When pH of diluted effluent was adjusted to 7.0 percent adsorption of dyes by 8 pieces of loofa sponge immobilized with *A. terreus* was 98.7%. Percent uptake of dyes at pH 7 by coconut fibre and groundnut shell matrix immobilized with *A. terreus* in 48 hrs was 31.2% and 55% respectively and at pH 10 it was 27.4% and 37.8%.

Keywords: Textile effluent; adsorption; Loofa sponge; Immobilized

Introduction

Synthetic dyes are widely used in a number of industrial processes, such as textile industries, paper printing, and photography [1]. Dyes usually have synthetic origins and complex aromatic molecular structures [2]. Dye wastewaters discharged from textile dyestuff industries have to be treated due to their impact on water bodies, and growing public concern over their toxicity and carcinogenicity in particular.

Several strategies are currently available to remove color from the industrial effluent. These include physical processes such as membrane technologies, chemical processes such as ozonation, physico-chemical methods, adsorption, chemical precipitation, flocculation, photolysis, and ion pair extraction and biological processes such as biodegradation and bioadsorption [3]. The available methods require considerable start-up costs and cannot meet increasingly stringent effluent colour standards. Many different and complicated molecular structures of dyes make dye wastewaters difficult to be treated by conventional biological and physico-chemical processes. Therefore, innovative treatment methods need to be investigated [4].

Use of immobilized microbial cells in the field of wastewater treatment has been found to be useful because of the advantages which include long retention time of biomass in the system, ease of use in a continuous reactor and their ability for scale up. Search for alternative carrier for immobilization had shown the loofa sponge (*Luffa cylindrica*) as a suitable matrix for immobilization of various microorganisms like *Candida brassica*, *Aspergillus niger* and *Lactococcus lactis* [5-9].

In the present investigations textile effluent from a local silk mill was obtained and its decolorization studied using immobilized *Aspergillus terreus*. Three different matrices for immobilization of *Aspergillus terreus* were tried namely, loofa sponge (*Luffa cylindrica*), coconut fibre and groundnut shells.

Aurangabad is a historical city famous for its Himroo textile. There are many textile mills at the outskirts of the city. The aim of this study was to design an effluent treatment technology which will be economically feasible for these small scale industries.

Materials and Methods

Fungal culture

Aspergillus terreus, isolated on Czapek dox agar plates from textile effluent and maintained on Potato Dextrose Agar slants.

Textile Effluent: Local textile effluent (λ max 650nm).

Matrix for immobilization

Loofa sponge, groundnut shell and coconut fibre Loofa sponge matrix for fungal immobilization was prepared by cutting dry loofa sponge into circular pieces, washed with distilled water to remove impurities and dried in oven at 105°C. The dried matrices were then cut in small pieces of size (1.5x2cm) weighing approximately 0.1gm. Loofa sponge pieces were placed in Potato Dextrose broth and sterilized at 121°C at 15psi for 15 minutes. The medium was cooled and then inoculated with 1 ml of suspension containing 10⁶ spores of *Aspergillus terreus* and kept for incubation on shaker (100 rpm) at 30°C for 6 days during which heavy fungal growth was found entrapped in the loofa matrix. Immobilized material was removed from the flasks and tried for dye adsorption studies.

Groundnut shell and coconut fibre were cut into small pieces of about 0.2mm and were washed with distilled water in order to remove impurities and dried in an oven. These materials were then added to potato dextrose broth and autoclaved at 121°C for 15 min. After sterilization flasks were cooled and were inoculated with 1 ml of suspension containing 10⁶ spores of *Aspergillus terreus* and kept

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No. of loofa	Textile effluent(1:4)diluted (pH 8.5)			
	OD after 24hrs (650nm)	% Ads.	OD after 48 hrs (650nm)	% Ads.
Control	0.406	00	0.406	00
2	0.396	2.46	0.209	48.5
3	0.351	13.5	0.203	50.0
4	0.308	24.1	0.141	65.2
5	0.271	33.2	0.117	71.1
6	0.065	83.9	0.051	87.4
8	0.056	86.2	0.036	91.1

Average of 3 readings

Table 1: Adsorption of dyes from diluted (1:4) textile effluent by *Aspergillus terreus* immobilized in Loofa sponge.

No. of loofa	Textile mill effluent (pH 10.5)			
	OD after 24hrs (650nm)	% Ads.	OD after 48 hrs (650nm)	% Ads.
Control	2.076	00	2.076	00
2	1.927	7.1	1.885	9.2
3	1.819	12.3	1.741	16.1
4	1.801	13.2	1.713	17.4
5	1.779	14.3	1.282	38.2
6	1.286	38.0	1.094	47.3
8	1.196	42.3	1.041	50.5

Average of 3 readings

Table 2: Adsorption of dyes from original textile effluent by *Aspergillus terreus* immobilized in Loofa sponge.

No. of unimmobilized loofa	Textile mill effluent (pH 10.5)			
	OD after 24hrs (650nm)	% Ads.	OD after 48 hrs (650nm)	% Ads.
Control	2.076	00	2.076	00
2	2.053	1.10	2.049	1.3
3	2.045	1.49	2.039	1.78
4	2.012	3.08	1.993	3.99
5	1.967	5.25	1.955	5.82
6	1.935	6.79	1.920	7.51
8	1.886	9.15	1.863	10.26

Table 3: Adsorption of dyes from original textile effluent by Unimmobilized Loofa sponge.

for incubation on shaker. In 6 days sufficient amount of the fungal growth was found trapped in the matrix of groundnut shells and coconut fibre. Immobilized material was filtered through Whatman filter paper and used for dye adsorption studies.

Decolorization process

Flasks containing 100 ml of diluted (1:4) textile effluent (pH 8.5) and flasks containing undiluted textile effluent (pH10.5) were inoculated with increase in the number of *A.terreus* immobilized loofa sponge pieces according to (Table 1 and Table 2) and 2.5g each of *A.terreus* immobilized ground nut shell and coconut fibre. Uninoculated flask served as a control which gives the initial optical density of diluted and undiluted effluent. The flasks were kept on a shaker (100rpm). After 24 hrs and 48 hrs retention time the

immobilized material was separated by filtration and the optical density values of the filtrates were determined at 650nm on a UV-Visible Spectrophotometer. Percent dye adsorption was determined after 24 and 48 hrs by using the formula mentioned above. Flasks containing effluent and only the matrices without immobilized fungi were also kept and dye adsorption only by the matrices was also recorded. The results are computed in (Table 1, Table 2, Table 3, Table 4 and Table 5).

Results and Discussion

As seen from the (Table 1) the percent adsorption of dyes from textile effluent (1:4) diluted, by *Aspergillus terreus* immobilized in Loofa sponge after 24 hours increased from 2.46 % with 2 loofa pieces to 86.2% with 8 loofa pieces. And after 48 hours, the percent adsorption was 48.5% with 2 loofa pieces to 91.1% with 8 loofa pieces.

The percent adsorption of dyes from undiluted textile effluent by 8 pieces of loofa sponge immobilized with *A.terreus*. In 24 hrs, it was 42.3% and 50.5% in 48 hours (Table 2).

Percent adsorption of dye by *Aspergillus terreus* biomass immobilized in loofa sponge from diluted textile effluent was approximately 44% more as compared to that of original textile effluent. This could be the effect of pH of diluted and undiluted textile effluent and the concentration of dyes.

Data shown in Table 3 confirmed that if the pH of the diluted effluent is adjusted to pH 7.0 the percent adsorption of dye by 8 pieces of loofa sponge immobilized with *A.terreus* was 98.7%

Textile effluent(pH 7)		OD after 24hrs	% ads.	OD after 48hrs	% ads.
Control					
(1:4)diluted	0.406	0.005	98.7	0.005	98.7
Original	2.076	0.657	68.3	0.657	68.3

Average of 3 readings

Table 4: Adsorption of dyes from diluted effluent (pH7) by *Aspergillus terreus* immobilized in Loofa sponge (using 8 pieces).

Time (Hrs)	Textile effluent(1:4) diluted							
	pH 7				pH 8.5			
	Coconut fibre		Groundnut shell		Coconut fibre		Groundnut shell	
	OD	% Ads.	OD	% Ads.	OD	% Ads.	OD	% Ads.
Control	0.425	00	0.425	00	0.431	00	0.431	00
24	0.301	29.1	0.130	69.4	0.415	3.7	0.190	55.9
48	0.215	49.4	0.110	74.1	0.359	16.7	0.185	57.0

pH 8.5 was the pH of the diluted effluent (1:4) and pH 7 was adjusted using acid

Table 5: Adsorption of dyes from (1:4) diluted textile effluent #3 by *Aspergillus terreus* immobilized in coconut fibre and groundnut shell.

Time (Hrs)	Original Textile effluent							
	pH 7				pH 10.5			
	Coconut fibre		Groundnut shell		Coconut fibre		Groundnut shell	
	OD	% Ads.	OD	% Ads.	OD	% Ads.	OD	% Ads.
C	2.081	00	2.081	00	2.075	00	2.075	00
24	1.510	27.4	1.390	33.2	1.880	9.3	1.38	33.4
48	1.430	31.2	0.935	55.0	1.520	27.4	1.29	37.8

Average of 3 readings, C= control

Table 6: Adsorption of dyes from original textile effluent by *Aspergillus terreus* immobilized in coconut fibre and groundnut shell.

showing an increase of 7 to 12% more dye adsorption as compared to undiluted textile effluent with pH 8.5. This experiment confirmed once again that at neutral pH dye adsorption is more either by dead biomass or immobilized biomass.

Maximum percent adsorption of dyes was obtained when 1:4 diluted textile effluent of pH 7 was used. The neutral pH facilitated maximum adsorption (98.7%) of the dyes from the textile effluent. Whereas, undiluted textile effluent with pH 7 showed 68.3% adsorption (Table 3). Result confirmed that as compared to pH 8.5 and pH 10.5 (original effluent), pH 7 was optimum for decolorization of dye from textile effluent.

Out of these two matrices used for immobilization and decolorization groundnut shell immobilized *A.terreus* was found more efficient as compared to coconut fibre matrix. (Table 4)

Results confirmed that the pH of the effluent played a crucial role in deciding the uptake of dyes. Percent uptake of dyes at pH 7 by coconut fibre and groundnut shell matrix immobilized with *A.terreus* in 48 hrs was 31.2% and 55% respectively and at pH 10 it was 27.4% and 37.8%. Percent increase of dye adsorption by immobilized material at pH 7.0 was between 4 to 18% as compared to pH 10.5 of the original textile effluent.

Similarly, percent adsorption of dyes from undiluted (original) textile effluent by *Aspergillus terreus* immobilized on coconut fibre and groundnut shell was found to be comparatively less than that of diluted textile effluent. The values of percent adsorption for pH 7 are higher, as compared to pH 10.5 (original). Results are as tabulated in (Table 5).

In this experiment, Loofa sponge was found to be an effective matrix for immobilizing *Aspergillus terreus*, rendering almost a clear solution. As per the results depicted in (Table 3), it was found that the loofa without the immobilized fungus adsorbed a very meagre amount of dye on its surface, and it was because of the fungus that the maximum amount of dyes were adsorbed from the textile effluent.

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