Jr. of Industrial Pollution Control 23 (1)(2007) pp 145-150

ADSORPTION OF SYNTHETIC DYE AND DYES FROM A TEXTILE EFFLUENT BY DEAD MICROBIAL MASS

KRANTI ENGADE AND S.G. GUPTA*

Government Institute of Science, Department of Microbiology, Nipatniranjan nagar, Caves Road, Aurangabad 431 004, India.

Key words : Adsorption, Dead biomass, Textile effluent, Scarlet red dye.

ABSTRACT

Intensive research is in progress to utilize microorganisms for the ersxymatie degradation of toxic dyes present in industrial effluents. One of the most simple and efficient ways of removing dyes from industrial effluents by using the microbial biomass. In the present investigations, we have explored the possibility of utilizing dead yeast and fungal biomass to remove synthetic basic dye i.e. Rathilene scarlet red and dyes present in a local textile effluent. Colorimetric methods was standardized and performed to determine the percent dye adsorption. *Saccharomyces cerevisiae, Rhizopus oligosporus Aspergillus terreus* at 5% w/v showed 84%, 56.57% and 75.91 % dye adsorption from the textile effluent and at the same concentration the above dead microbial mass showed 6315 %, 56.84 and 68.31% adsorption of Rathilene Scarlet Red in 30 minutes contact time at ambient temperature.

INTRODUCTION

Textile industry is one of the important sources of contamination responsible for the continuous pollution of the environment. Several industries are discharging untreated effluents containing synthetic dyes into the environment. Dyes usually have a synthetic origin and complex aromatic molecular structures, which make them more stable and more difficult to be biodegraded (Fewson 1988 and Seshadri, *et al.* 1994).

The discharge of the colored effluents into water bodies is objectionable not only from aesthetic considerations but also due to the fact that it reduces penetration of sunlight through the water body thereby retarding biological activity. The presence of dyes and chemicals in waste effluents is harmful to both aquatic and terrestrial life even at very low concentration (Sarnaik and Kanekar, 1995).

Several methods such as ozonation, adsorption, chemical precipitation, flocculation, photolysis and ion pair extraction and biological prorocesse such as biodegradation are currently available to treat dye-containing effluents (Grant and Buchanan, 2000). These methods are very expensive and require considerable start-up costs and cannot meet increasingly stringent effluent color standards. Biodegradation process requires strict conditions to be maintained and sometimes become difficult to operate at large scale. (Bhole, *et al.* 2003).

Adsorption has been observed to be an effective process for color removal from dye wastewaters. Adsorption on activated carbon is an effective method for the removal of color, but it is too expensive. Many studies have been undertaken to find low-cost absorbents which include, peat, bentonite, steel-plant slag, fly ash, china clay, maize cob, wood shavings and silica for dyes (Ramakrishna and Viraraghavan, 1997; Gupta ,*et al.* 1992; El-Geundi, 1991; Abo-Elela and El-Dib, 1987; Ahmed and Ram, 1992). However, these low-cost adsorbents have generally low adsorption capacities, which mean that large amounts of adsorbents are needed. So, we still need to find new, economical, easily available and highly effective adsorbents for treating dye-containing effluents.

Increasing demands for effective and economical technologies for color removal have led to research into a biosorption-based process that exploits the sorption capacity of biological material for the removal of pollutants. Biosorption has been studied since I980's for removing heavy metals, dyes and other organicpollutants by various microorganisms from wastewaters. Basic dyes and metal ions are adsorbed on the negatively charged cell walls or micioorganisms and also by the negatively charged microbial metabolites and cell components. Metabolically active *Aspergillus* terreus culture was used for removal of basic synthetic dyes (Engade and Gupta, 2006), Dried, non living, pretreated biomass would be an attractive biosorbent for removing dyes from colored effluents. For dead cells the mechanism of biosorption involves physico-chemical interactions, such as adsorption, deposition, and ion exchange. It was also suggested that the integrity of the cell was important for the binding capacity and some dye was internalized. (Brahimi-Horn , *et al.* 1992). In the present study we explored the possibility of utilizing dead microbial mass for the removal of basic synthetic dye and dyes present in a textile effluent.

MATERIALS AND METHODS

Biomass for dye adsorption studies

1. Dead yeast biomass of *Saccharomyces cerevisiae* used for alcohol production was obtained from Shaw- Wallace distilleries, Aurangabad.

2. Dead fungal biomass of *Rhizopus oligosporus* used for lipase production was obtained from Chemical Technology Department of Dr.Babasaheb Ambedkar Marathwada University, Aurangabad
3. *Aspergillus terreus* isolated from an effluent of a dyestuff industry in our laboratory was grown in potato dextrose broth.

The above-mentioned yeast and fungal cell mass was washed with distilled water to remove color and impurties and dried in an oven. The powdered biomass obtained was used for bioremediation studies.

Effluent

The effluent used for bioremediatlon studies was obtained from a local textile mill. (pH- 10.5, colour - black, BOD - 38.6 mg/L, COD - 560 mg/L TDS - 6700 mg/L).) The basic pH of the effluent was mainly due to the presence of basic dyes and therefore suitable for microbial adsorption studies.

Synthetic dye

Synthetic dye used for bioadsorption experiments was procured from Rathi Dye Chem-industry, Raigad, Maharashtra. The pH of the dye was determined by dissolving 0.01g of Rathilene Scarlet red in 100 mL deionized water and was found to be 8.1. This confirmed that the synthetic dye is basic in nature and can be selected for adsorption by microbial mass.

Estimation method for Rathilene Scarlet Red

Absorption spectrum of Rathilene Scarlet Red dye (0.01% w/v) was obtained on a spectrophotometer and the A. max was found to be at 460nm. A standard graph for Rathilene Scarlet red was plotted by considering the concentrations of the dye on x axis and their Optical density values recorded at 460 nm on Y axis. The graph was referred to determine the concentration of residual dye concentration. The residual dye concentration was subtracted from the initial dye concentration to know the amount of dye adsorbed. Finally, % dye adsorption was calculated.

Estimation method for textile mill effluent

Absorption spectrum of effluent was obtained on a spectrophotometer and the λ, max was found to be at 650nm. The O.D of the effluent at 650 nm was considered as an index of colour content (Initial O.D). After dye adsorption studies, the O.D of the effluent was recorded again at 650 nm (Final O.D.). The % dye adsorption was calculated by using the formula mentioned below -

$$\%\ \text{Dye adsorption} = \frac{\text{initial O.D - Final O.D X 100}}{\text{Final O.D.}}$$

Biosorption studies

Flasks containing 100 mL of distilled with 0.01 g of Rathilene Scarlet red dye (in triplicate) was inoculated with varying concentrations (1 to 5%) of dead mass of cultures mentioned above. The flasks were kept on a rotary shaker (100 rpm) for 30 minutes and then the contents of the flaks were centrifuged (for yeast) or filtered (fungal) to remove dye-loaded biomass. The filtrate was collected

Table 1

Adsorption of synthetic dye Rathilene Scarlet red by dead biomass

% Biomass added	*S. cerevesiae* O.D at 460 nm	% ads	*R. oligosporus* O.D at 460 nm	% ads	*A. terreus* O.D at 460 nm	% ads
Control	0.950	0.00	0.950	0.00	0.950	0.00
1.	0.916	3.57	0.656	30.94	0.612	35.57
2.	0.713	24.94	0.570	40.00	0.531	44.10
3.	0.501	47.26	0.546	42.52	0.501	47.26
4.	0.412	56.63	0.457	51.89	0.413	56.52
5.	0.350	63.15	0.410	56.84	0.301	68.31

Average of 3 readings, Control - without biomass, ads- adsorption.

Table 2

Adsorption of dyes present in textile effluent by dead biomass

% Biomass added	*S. cerevesiae* O.D at 460 nm	% ads	*R. oligosporus* O.D at 460 nm	% ads	*A. terreus* O.D at 460 nm	% ads
Control	2.130	0.00	2.130	0.00	2.130	-
1.	1.801	15.44	1.533	28.02	1.620	23.94
2.	1.053	50.56	1.510	29.10	1.109	47.93
3.	0.547	74.31	1.373	35.53	0.991	53.47
4.	0.433	79.67	1.095	48.59	0.973	54.31
5.	0.339	84.00	0.925	56.57	0.513	75.91

Average of 3 readings, Control - without biomass, ads- adsorption.

and the amount of residual dye content was estimated colorimetrically and % dye adsorption was calculated by the method mentioned above and the results are depicted in Table 1. Textile mill effluent (100 mL) was distributed in 250 mL Erlenmeyer flasks (in triplicate). Different concentration of the powdered yeast and fungal biomass (1 - 5 %) was added to the flasks and contents were mixed on a rotary shaker (100 rpm) for 30 minutes. The contents of the flasks were centrifuged and filtered. The O.D of the untreated textile effluent (Initial) and the O.D of filtrate was determined on a Spectrophotometer at 650 nm (Final). Using the formula mentioned above the % dye adsorbed or removed from the effluent was determined and mentioned in Table 2.

RESULTS AND DISCUSSION

Results in Table 1 indicate that out of the dead cell mass of tried A. *terreus* showed a maximum of 68.31% adsorption of Rathilene Scarlet red dye followed by *S. cerevisiae* (63.15%) and a minimum of 56.84 % dye adsorption by *R. oligosporus* at 5% (w/v). Results also confirmed that the % dye adsorption increases with increase in the addition of powdered dead biomass from 1 to 5 % (w.v) of all the three cultures employed due to the availability of more negatively charged surface area for binding with positively charged Scarlet Red dye.

Biomass of *S. cerevisiae* was found to be more effective with 84% adsorption of mixed dyes present in the textile effluent followed by A. *terreus* (75.91%) and a minimum of 56.67 % by *R. oligosporus* at an inoculum level of 5% (w/v). Similarly, during colour removal from textile effluent, it was found that % dye adsorption increased with increase in the addition of dead biomass (1-5%w/v) again confirming that dye adsorption is adsorbent dependent.

After dye uptake from textile effluent by dead microbial mass the reduction in TDS was 41.7 %, BOD was 15.28 % and COD 23.21 %.

Therefore, it is concluded from the above experiments that in future dead biomass discarded in the fermentation industries can be effectively utilized as adsorbing material in raw or immobilized form for cleaning effluents containing dyes. The adsorbed dye(s) can be eluted by treating the dye loaded microbial mass with dilute HCI or 50% ethanol and the resulting biomass can be reutilized.

REFERENCES

Abo-Elela, S.I., El-Dib, M.A. 1987. Color removal via adsorption on wood shaving. The *Sci. Total Environ*. 66 : 267-273.

Ahmed, M.N. and Ram, R.N. 1992, Removal of basic dyes from wastewater using silica as adsorbent. *Environ. Poll*. 77 (1) : 79-86.

Banks, C.J. and Parinson, M.E.1992. The mechanism and applcation of fungal biosorption to color removal from raw waters. *Jr. Chern. Technol. Biotechnol*. 54 : 92- 196.

Bhoie, B.D., Ganguly, B., Madhuram, A., Deshpande, D. and Joshi, J .2003. Biosorption of methyl violet, basic fuchsin and their mixture using dead fungal biomass *Curr. Sci*. 86 (12) : 1641-1645.

Brahimi-Horn, M.C., Lim, Liany, S.L., Mou, D.G. 1992. Binding of textile azo dyes by

Mirothecium Verrucaria Orange II, lOB (Blue) and RS (red) azo dye uptake for textile wastewater decolorization. *Jr. Ind. Microbiol*. 10 : 245-261.

El-Geundi, M.S. 1991.Colour removal from textile effluents by adsorption techniques. *Water Res*. 25 : 271-273.

Engade, K.B. and Gupta S.G. 2006. Decolorization of few synthetic dyes by metabolically active culture of *Aspergillus terreus,* Accepted for publication in *the.* ISSIK. of June 2006 of Nail. *Jr. of Life Sciences*, Satna, M.P. India.

Fewson, C.A. 1988. Biadegradation of Xenobiotic and other persistent compounds : the causes of recalcitrance. *Trends Biotechnol*. 6 : 148-153,

Grant, J. and Buchanan, I. 2000. Colour removal from pulp mill effluent using immobilized horseradish peroxidase, SFM Network project report.

Gupta, G.S., Shukla, S.P., Prasad, G. and Singh, V.N. 1992. China clay as an adsorbent for dye house wastewater. *Environ. Technol*. 13 : 925-936.

Montgomery, D.C. 1976. *Design and Analysis of Experiments*. John Wiley, New York, 121-165.

Ramakrishna, K.R. and Viraraghvan, T. 1997. Dye removal using low cost adsorbents. *Water Sci. Tech*. 36 (2-3) : 189-196.

Sarnaik, S. and Kanekar, P. 1995. Bioremediation of colour of methyl violet and phenol from a dye-industry waste effluent using *Pseudomonas spp.* isolated from factory soil. *Jr. of Appl. Bacteriol*. 79 : 459-469.

Seshadri, S., Bishop, P.L. andAgha, A.M. 1994. Anaerobic/aerobic treatment of selected azo dyes in wastewater. *Waste Management.* 15 : 127-137

Zhou, J.L. and Banks, C.J. 1993. Mechanism of humic acid colour removal from natural waters by fungal biomass biosorption. *Chemosphere.* 27 (4) : 607-620.