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REDUCTION OF CHEMICAL OXYGEN DEMAND IN TEXTILE INDUSTRY EFFLUENT USING *ASPERGILLUS NIGER*

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ABSTRACT

Textile industry effluents are among the most difficult to treat, due to the considerable amount of recalcitrant and toxic substances. Fungal biosorption is viewed as a valuable additional treatment for removing pollutants from textile industry wastewaters. In the present study the efficiency of *Aspergillus niger* for chemical oxygen demand (COD) reduction was tested against textile effluents having three dilutions i.e., 25%, 50%, 75% and raw effluent. The result showed that the fungal strain is a promising candidate for the reduction of COD in effluent and can be a cost effective solution to treat the textile industry effluents.

KEY WORDS: Textile industry effluent, Pollutants, Fungi, *Aspergillus niger*, Chemical Oxygen Demand (COD)

INTRODUCTION

Water pollution and its impact on the environment is a serious concern in the present world. To control the water pollution and improve the water quality, advanced wastewater treatment technologies are in practice (Jayapriya and Kavitha, 2017). These technologies are implemented by removing physical, chemical and biological contaminates from wastewater and producing an environmentally safe fluid waste stream (treated effluent) and solid waste (treated sludge). Textile industry is one of the leading consumers of water. It consumes about 3.2% of total consumption of water for various processes such as sizing, scouring, bleaching, dyeing, printing and other finishing processes. Waste water contains several organic, inorganic as well as heavy metals (Joshi and Saxena, 2018).

The used water containing various constituents such as dyes and chemicals is directly released into the sources of water which gets contaminated and thus results into water pollution (Alaguprathana and Poonkothai, 2017). The seriousness of water pollution depends upon how effectively the above processes are carried out and also the quantity of water as well as the substrate or the chemicals used in the processes. The polluted water is very harmful for human life as well as for various living organisms due to its odors, colors, turbidity and toxic chemicals present in it (Henagamage, 2019). Therefore these waste streams from different processing operation causing the pollution will have to be isolated and treated by either physical, chemical or biological methods or by combination of these methods in order to control water pollution. Various methods have been used for the removal of these constituents from the wastewater (Saranraj *et al.,* 2010). Physical and chemical methods have inherent drawbacks of being economically unfeasible (require more energy and chemical), unable to remove some of the recalcitrant dyes and production of large amount of sludge which if not properly treated, can cause secondary pollution (Ademakinwa and Agboola, 2015). The available chemical methods for treatment are found to be inefficient besides being extremely costly and are not always environmental friendly too (Shinkafi *et al.,* 2015).

Treatment of this high potent wastewater becomes crucial because textile wastewater contains substantial pollution loads in terms of chemical oxygen demand, biochemical oxygen demand, total suspended solids, total dissolved solids and heavy metals. The lack of wastewater treatment facilities or their inefficiency is the single greatest cause of water pollution. To reach the full objective of zero pollution, adoption of alternative technologies is necessary (Srinivasan *et al.*, 2014). Nowadays, the focus is to look for a sustainable approach in developing wastewater treatment techniques (Pardeshi and Vaidya, 2019). Bioremediation could be a viable option because of their ability to detoxify the effluent and it is a sustainable environmental friendly approach. Bioremediation is a treatment process that uses naturally occurring microorganisms as well as plants to breakdown, or degrade hazardous substances into less toxic or non toxic substances (Krishnaveni *et al.*, 2013). The costs associated with this remediation method are usually lower than other well-known remediation technologies and problems like atmospheric emissions and waste generation are nonexistent (Kedia and Sharma, 2015). Many researchers have reported the application of microremediation techniques for treating different types of wastewater. Various microorganisms (bacteria and fungi) have been used for the removal of a wide range of pollutants in industrial waste water with good results (Saritha *et al.*, 2010).

Hence, the present study was aimed to determine the potential of *Aspergillus niger* in reducing the COD level in textile industry effluent to meet water quality standards. The study was conducted by isolating fungi from the soil contaminated with textile effluent.

MATERIALS AND METHODS

Collection of Textile Effluent

The effluent was collected from a Textile mill at Bangalore, India. From the inlet, effluent was collected by grab sampling technique. Immediately after collection, the effluent was bought to the laboratory and analysed for further studies.

Isolation of fungal strains and screening

The soil microorganism was isolated by serial dilution technique on potato dextrose agar medium (PDA). One gram of soil from the sample was separately suspended in 10 ml of distilled water and mixed well for 15 minutes. Each suspension was serially diluted from 10^{-1} to 10^{-8}. Spread plate technique was carried out to isolate the organism from the diluted sample. 0.1 ml was pipetted out onto plates with PDA media and spread with a glass L shape rod and incubated at 37 ^{o}C for 6 to 7 days. The most prominent fungal colonies which appeared on the media were isolated and sub-cultured to obtain pure isolates. Pure strains were maintained at 4 ^{o}C for further studies.

Identification of fungi

Fungal isolate was identified on the basis of morphology i.e., the spores, conidia, mycelia fragments etc. Isolated fungi was identified as *Aspergillus niger* (Fig. 1) using microscope at 40X magnification (Fig. 2) by the culture identification technique (Aneja, 2014).

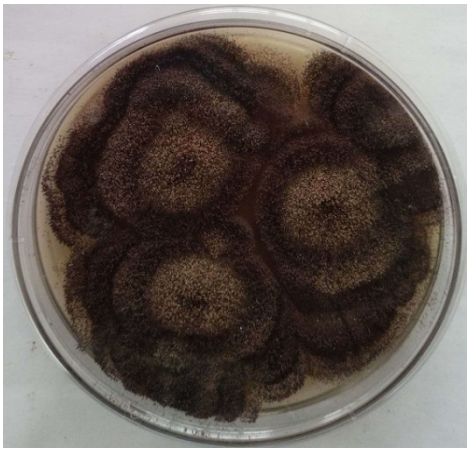

Fig. 1. Growth of *Aspergillus niger* observed in petriplate

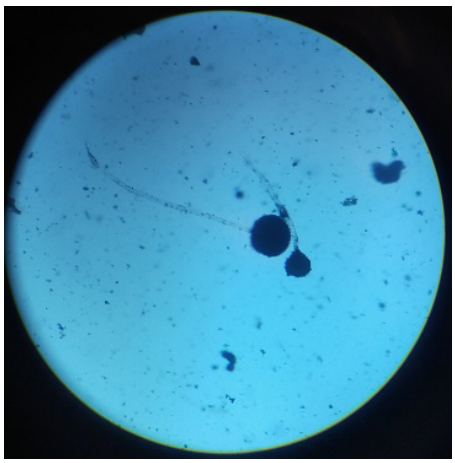

Fig. 2. Microscopic observation of *Aspergillus niger*

Analysis of COD

COD of effluent was analysed using closed reflux

unit by titrimetric method. The effluent was refluxed in strong acid (H_2SO_4) solution with $K_2Cr_2O_7$, silver sulphate and mercuric sulphate. Oxygen consumed was measured by titrating the sample against ferrous ammonium sulphate using ferroin indicator (APHA, 2017).

Experimental setup for reduction studies

Reduction of COD in textile industry effluent was attempted at laboratory scale. For the treatment, effluent was diluted to three different dilutions viz., 25%, 50% and 75% using distilled water or de-ionized water. To study the efficiency of the organism, 5 ml of spore suspension was inoculated into effluent treatment systems having 250 ml of effluent under aseptic condition and treatment was conducted for a period of 7 days. Treatment under static condition favors the biofilm formation and improves the organism efficiency in pollution remediation. After treatment the effluent was taken out for COD analysis.

The percentage reduction of COD after treatment with the study fungal isolate *Aspergillus niger* was calculated using the following formula:

$$\text{Reduction } \% = \frac{\text{Initial value- Final value}}{\text{Initial value}}$$

Statistical analysis

The data was analysed as mean of triplicates ± standard deviation (SD).

RESULTS AND DISCUSSION

Chemical oxygen demand

The high level of COD in the effluent indicates the toxicity of the effluent and the presence of large amount of biologically resistant organic substances. COD is the measure of oxygen equivalent of the organic content of the sample that is susceptible to oxidation by a strong chemical oxidant. It is expressed in milligrams per liter (mgl^{-1}) that indicates the mass of oxygen consumed per liter of solution. The higher the COD, the higher the amount of pollution in the water sample. However, COD is considered one of the most important quality control parameters of an effluent in wastewater treatment facility. It is an evaluation used to measure the level of water contamination by organic matter.

In the present study, the capability of *Aspergillus niger* in reducing COD concentration of textile effluent was determined. The results clearly indicate that the fungal strain is highly efficient in reducing COD in all dilutions (Table 1and Figure 3). The COD concentration after treatment reduced gradually by 20.33% (raw effluent), 33.71% (75% concentration), 47.87% (50% concentration) and 75.62% (25% concentration). Where as, in control only 2.94% reduction of COD was observed. Maximum COD reduction was observed in 25% effluent dilutions and it was found to be less in 50%, 75% and raw effluent. The result agrees with the findings of Selim *et al.*, 2021 who studied the efficiency of *Aspergillus spe*. in bioremediation of textile industry effluent. The organism was able to remove 77.6% of COD from effluent. A study by Dhanushree and Kousar (2018) on treatment of pulp and paper mill effluent using *Aspergillus niger* showed high potential in reduction of COD i.e., 68.51%.

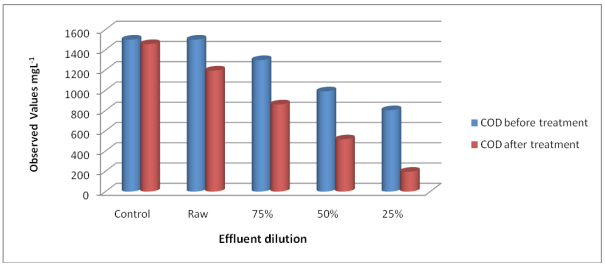

Fig. 4. Reduction of COD in effluent by *Aspergillus niger* at different dilutions

CONCLUSION

To study the treatment efficiency of *Aspergillus niger*

Table 1. COD concentration in different dilutions before and after treatment with *Aspergillus niger*

Effluent dilution	Before treatment (mgl^{-1})	After treatment (mgl^{-1})	Reduction (%)
Control	1500.53±0.1	1456.39±0.1	2.94%
Raw	1500.53± 0.05	1195.33±0.05	20.33%
75%	1298.3±0.1	860.6±0.1	33.71%
50%	989.66±0.15	515.83±0.05	47.87%
25%	803.63±0.25	195.86±0.05	75.62%

Key: mgl^{-1} = milligram per liter. Values are expressed as mean ± SD (n=3)

the textile industry effluent was diluted to three different dilutions i.e., 25%, 50%, 75% and raw. The diluted effluent shows a remarkable reduction in COD concentration. 25% diluted effluent shows maximum reduction of COD. This shows that with increasing dilution the efficiency of *Aspergillus niger* increases and reduction is achieved to a maximum extent. Maximum COD removal rate of 75.62% was achieved in 25%. Based on the present findings, it can be suggested that *Aspergillus niger* has enormous potential to resolve the problem of high COD from textile industry effluents. Hence, *Aspergillus niger* could be used for treatment of textile industry effluent.

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