International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 06 | June - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

An Efficient and Eco-Friendly Approach for Bioremediation of Tannery Waste Water

Dr. M. Aneez Mohamed

Associate professor & Head
P.G. Department of Zoology,
Jamal Mohamed College (Autonomous),
(Affiliated to Bharathidasan University)
Tiruchirappalli –620020, Tamilnadu.

Abstract

Bioremediation is the tool for the treatment of tannery waste water which utilizes microbial agents like bacteria, fungi, and their consortia. The present research work has been carried out to analyze the physico-chemical characteristics of tannery effluent and to reduce the load of BOD and COD by the process of bioremediation using microorganisms. Among the physical chemical parameters analyzed TDS, TSS, BOD and COD were found to be very high. One bacterium, *Bacillus cereus* and one fungal species, *Aspergillus niger* were identified and isolated and used in the reduction of BOD and COD in the tannery effluent. Four different concentrations of untreated tannery effluents (control, 25, 50, 75 and 100%) were prepared. The experiment was carried out for 72 hrs (3 days). It is inferred from the results that *Aspergillus niger* found to be more effective in reducing BOD and COD than the bacterium, Bacillus sp. in the untreated tannery effluents.

Key words: Microorganisms, *Bacillus cereus*, *Aspergillus niger*, bioremediation, Tannery effluents, BOD, COD.

INTRODUCTION

Industrial revolution has generated unprecedented disturbances in the environment due to the introduction of anthropogenic pollutants such as organic, inorganic and xenobiotic chemicals in the form of untreated industrial waste water. With increasing population and industrial expansion, the need for the treatment and disposal of the waste has grown. The tannery effluent waste is ranked as high pollutants among all other industrial wastes (Eye & Lawrence 1971).. The lack of awareness in the modern industrial practice has resulted in the discharge of tannery effluents which exhibit very high value for Cr, Sulphide, and chloride, TDS, TSS, BOD and COD in the water stream or land. In the course of the last two decades a wide variety of technologies had been developed for cleanup operations of contaminated sites. Bioremediation has evolved as the most promising one because of its economical safety and environmental features, since organic contaminants become actually transferred and some of them are fully mineralized. Bioremediation is the degradation of pollutants using organisms, from bacteria to plants, or their derivatives. The chief advantage of bioremediation is its reduced cost compared to conventional techniques. Bioremediation of tannery effluents is an attractive environment friendly, safe and cost effective alternative technology to conventional methods. The present investigation essentially deals with the characterization tannery effluents and to biodegrade certain important parameters viz. BOD and COD using microbes like fungus, *Aspergillus niger* and bacterium, *Bacillus cereus* in the untreated tannery effluents.

MATERIAL AND METHODS

In the present study, effluent was collected from a tannery at Tiruchirappalli District, Tamil Nadu, India. The effluent samples were collected raw as well as from final discharge point where in effluent from all the stages of processing are released together. The effluent was collected in polythene containers [1 litres capacity] and were brought to the laboratory with due care and stored at 20^{o}C

The physico-chemical parameters such as pH, Electrical conductivity (EC), Total dissolved solids (TDS), Total suspended solids (TSS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Oil and grease (OG) and Chloride (Cl) and sulphate of the effluent were analyzed following Standard methods outlined by APHA (1989).

The isolation of bacteria from the tannery effluent was done by serial dilution technique. (Charurvedi, 1992). After identification of the bateria, culture was carried out in the laboratory to be used for bioremediation of the tannery effluent. Bactrerium such as *Bacillus sp.* was used for the treatment of tannery effluent. Tannery effluents collected were used for the analysis of Mycoflora. The fungi were isolated using dilution plating method. The fungi were mounted in lactophenol cotton blue and observed through light microscope. They were identified using standard manuals. (Gilmann, 1967; Subramanian, 1971, Ellis, 1971; Barnett and Hunter, 1972). After identification of the fungi, culture was carried out in the laboratory to be used for bioremediation of the tannery effluent. Fungi such as *Aspergillus niger*, was separately used for the treatment of tannery effluent.

Bioremediation of Tannery Effluent Using Fungus and Bacterium

Approximately 10 g (fresh weight) of mycelia of *Aspergillus niger*, and 10 ml (fresh weight) of *Bacillus sp*. were transferred to experimental jars containing 1000 ml of different concentrations (25%, 50%, 75% and 100%) of tannery effluent. They were kept in an orbit shaker for 72 hrs and maintained at 28 ± 2°C. Two important physicochemical parameters such as BOD and COD were estimated before and after 72 hrs (3 days) to check the degradation process by the fungus and the bacterium.

RESULTS AND DISUSSION

The water quality parameters of the tannery effluent were analyzed and its results are presented in the table 1. The results of the analysis showed that the tannery effluent was grey coloured with a disagreeable odour, acidic pH, with high organic and inorganic load indicating high EC, BOD, COD,TSS,TDS, chloride and sulphate. Based upon the dominant fungus and bacterium, *Aspergillus niger* and *Bacillus cereus* were individually used to reduce the BOD and COD in the effluent. Laboratory scale biodegradation of tannery in different concentrations (viz 25%, 50%,75% and 100%) using above fungus and bacterium. Two important physicochemical parameters namely BOD and COD were analyzed in the biotreated tannery effluent after 72 hours of incubation

Results of the tannery effluent treated with the fungi *Aspergillus niger* and Bacterium *Bacillus cereus* at different concentration (25%, 50%, 75% and 100%) for 72 hrs is shown in the Table 2 & 3. The BOD of tannery effluent before (control) and after bioremediation (72 hrs) by individual fungus and bacteria is shown in Table 2. The COD of tannery effluent before (control) and after biodegradation (72 hrs) by individual fungus and bacteria is shown in Table 3. In all the concentrations of tannery effluent *Aspergillus niger* was found to reduce BOD and COD to maximum extent followed by the bacterium *Bacillus cereus* The decrease in BOD and COD values in the biotreated effluent is statistically significant $P<0.001$.

DISCUSSION

Bioremediation is addressed as one example of an environmental biodegradation. Due to its comparatively low cost and generally benign environmental impact, bioremediation offers an attractive alternative and/or supplement to more conventional clean-up technologies. Use of microbes to concentrate pollutants is an emerging research area. Microorganisms, bacteria and fungi are nature's original recyclers. Their capability to transform natural and synthetic chemicals into sources of energy and raw materials for their own growth suggests at hat expensive chemical or physical remediation processes might be replaced or supplemented with biological processes that are lower in cost and more environmentally benign.

The present study on tannery waste water from Tiruchirappalli is aimed at analyzing the characteristics to tannery effluent and to reduce certain parameters that pose threat to the environment. In the present investigation, the physico-chemical characteristics of the untreated effluent have revealed that it is acidic with high BOD and COD, organic matter, unpleasant odour and colour. The present study has revealed that high levels of BOD in the tannery effluents indicating high organic load. Present investigation is in agreement with the studies on tannery effluent. (Kulkarni, 1992). Further the presence of organic matter will promote anaerobic action leading to the accumulation of toxic compounds in the water bodies (Goel, 2000). In the present investigation, high level of COD in the tannery is recorded. Raj *et al*., 1996 have recorded higher values of COD from the tannery effluent of Chrompet. Further high COD may be due to high amount of inorganic compounds which are not affected by the bacterial decomposition (Nagarajan and Ramachandramoorthy, 2002).

Microbes in the environment play an important role in the cycling and fate of organic chemicals and can destroy them through bioremediation. The present study reveals that *Bacillus cereus* and *Aspergillus niger* are able to reduce the BOD and COD in all concentrations of the tannery effluent. Studies also reveal that *Aspergillus niger* was more efficient and has high degrading ability to reduce BOD and COD than Bacillus sp. Hence it may be suggested that fungus will be beneficial for bioremediation and purification of effluents.

TABLE – 1

Water quality parameters of Tannery effluent at two different units

Parameters	Inlet. (Raw)	Outlet – Final (Treated)
pH	10.4	6.9
Electrical Conductivity (dsm^{-1})	3.90	2.90
TSS (mg/1)	1600	100
TDS (mg/1)	2510	1480
Chloride	1600	1450
Sulphate	570	110
BOD	947	230
COD	2277	520
Oil & Grease	0.61	0.02

TABLE – 2

BOD of tannery of effluent before (control) and after biodegradation (72 hrs) using fungus and bacterium

Parameters	Concentration of the effluent	Mean + SD & % Reduction	Control	***Aspergillus niger***	***Bacillus* cereus**
BOD	100%	Mean ± SD	947.5 ± 42.98	904.16 ±29.73	921.7 ± 35.30
		% Reduction		**-4.57%**	**-0.63%**
	75%	Mean ± SD	834.16 ± 27.28	620 ± 50.49	658.3 ±44.45
		% Reduction		**-25.67%**	**-21.08%**
	50%	Mean ± SD	635.83 ± 26.72	481.33 ±23.47	528.3 ± 44.00
		% Reduction		**-24.29%**	**-16.92%**
	25%	Mean ± SD	311.66 ± 58.70	252 ± 59.74	280.8 ± 26.53
		% Reduction		**-19.14%**	**-9.91%**

TABLE – 3

COD of tannery of effluent before (control) and after biodegradation (72 hrs) using fungi and bacteria

Parameters	Concentration of the effluent	Mean + SD & % Reduction	Control	***Aspergillus niger***	***Bacillus* cereus**
COD	100%	Mean ± SD	2277.83±72.47	1835.5±39.97	1938.3±32.62
		% Reduction		**-19.42%**	**-14.91%**
	75%	Mean ± SD	1772 ± 42.66	1576.7±31.25	1676.6 ±29.26
		% Reduction		**-11.02%**	**-5.38%**
	50%	Mean ± SD	1452.5 ± 30.12	1362±22.36	1404.16±22.22
		% Reduction		**-6.64%**	**-3.33%**
	25%	Mean ± SD	1355 ± 64.18	1117.5± 33.27	1216.6± 31.57
		% Reduction		**-17.53%**	**-10.22%**

Fig. 1. BOD of the tannery effluent before (control) and after biodegradation (72hrs) using fungi and bacteria.

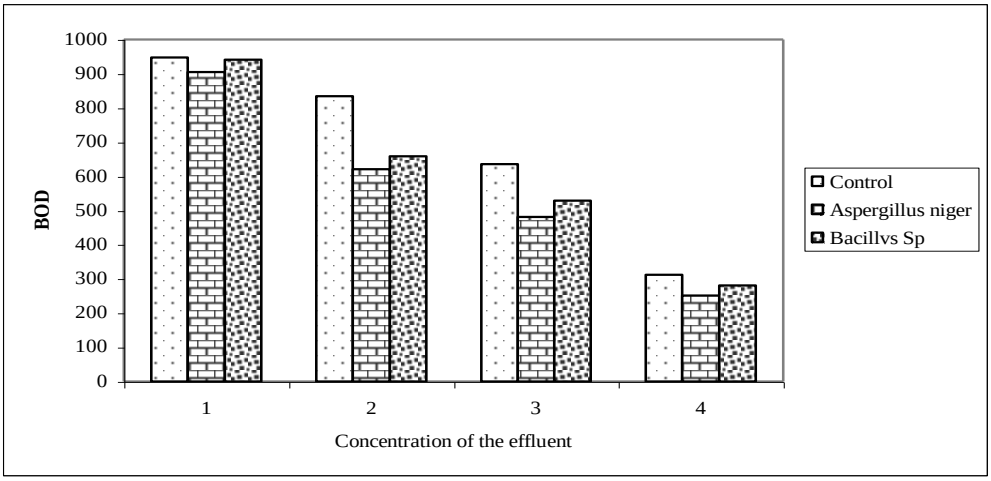
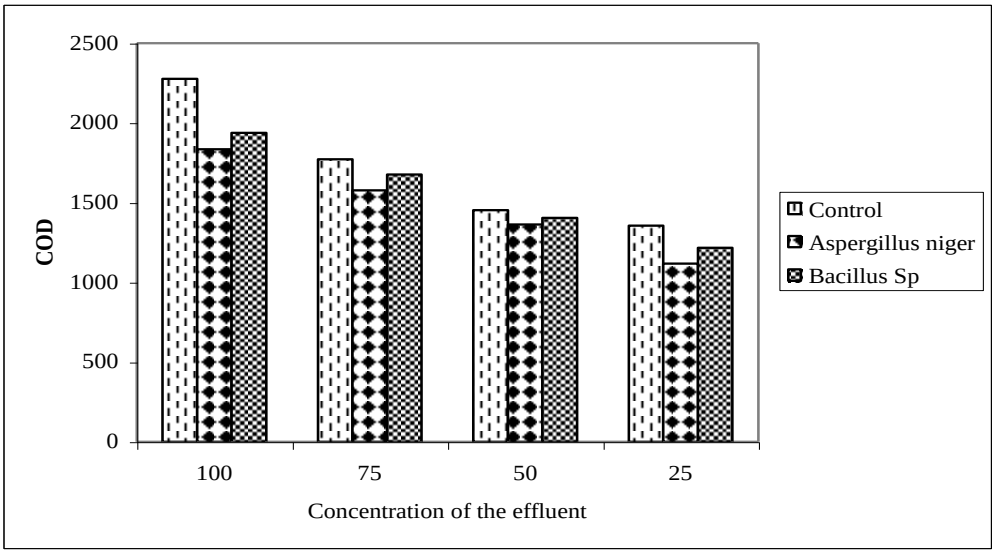


Fig. 2. COD of the tannery effluent before (control) and after biodegradation (72hrs) using fungus and bacterium



CONCLUSION

The present study demonstrates the efficacy of bioremediation as an eco-friendly and economical method for treating tannery effluents. The research clearly indicates that tannery effluents contain high levels of organic and inorganic pollutants, including BOD and COD, which significantly impact environmental and water quality. The use of microbial agents such as *Aspergillus niger* and *Bacillus cereus* has proven to be an effective strategy for reducing these components. Among the two, *Aspergillus niger* exhibited a higher efficiency in degrading pollutants across all concentrations of effluent tested. The significant reduction in BOD and COD after 72 hours of treatment confirms the potential of bioremediation as a sustainable, cost-effective, and eco-friendly alternative to conventional treatment methods. These findings highlight the potential of using native microbial strains for the bioremediation of industrial effluents. Thus, microbial treatment, especially using fungi, offers a promising alternative to conventional methods and can be effectively employed in wastewater management strategies for sustainable environmental protection.

ACKNOWLEDGEMENT

The author gratefully acknowledges the College Management Committee and the Principal Dr. D. I. George Amalarethinam, of Jamal Mohamed college (Autonomous) Tiruchirappalli for their constant encouragement and for providing the necessary facilities
that supported the successful publication of this research work.

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