POTENTIAL USE OF BACTERIA IN BIODEGRADATION OF TANNERY WASTE WATER IN DINDIGUL DISTRICT

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Abstract: Tannery effluent contains enumerous quantities of chemicals and high level of pH, TDS, TSS, BOD and COD which gets directly into natural aquatic environment, thus contaminate to the water quality. Hence it is important to develop an eco-friendly and cost-effective technology to treat the tannery effluent. Our present research work has been carried out to analyze the physico-chemical characteristics of tannery effluent and to reduce the load of pH, BOD and COD by the process of bioremediation using microorganisms. Among the physical chemical parameters analyzed pH, BOD and COD were found to be very high. *Bacillus cereus* and *Pseudomonas aeruginosa*, were identified and isolated and used in the reduction of pH, 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 48 hrs (2 days). It is inferred from the results that *Bacillus cereus* to be more effective in reducing pH, BOD and COD than the bacterium, *Pseudomonas aeruginosa* in the untreated tannery effluents.

KEY WORDS: *Bacillus cereus*, *Pseudomonas aeruginosa*, bioremediation, pH, BOD, COD.

1. INTRODUCTION

Industrial pollution is one of the problems presently facing India and several effects are being vigorously pursued to treat it. With increasing population and industrial expansion, the need for the treatment and disposal of the waste has grown. The tannery effluent waste are 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, pH, TDS, TSS, BOD and COD in the water stream or land. The conventional leather tanning technology is highly polluting as it produces large amount of organic and chemical pollutants, which are a series threat to the environment. 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 of tannery effluents is an attractive eco-friendly, safe and cost effective alternative technology to conventional methods. Microbes in the environment play an important role in cycling and destroying them through bio-degradation**.** The present study deals with the characterization tannery effluents biodegradation of certain important parameters viz. pH, BOD and COD using *Bacillus cereus* and *Pseudomonas aeruginosa* in the untreated tannery effluents. The tannery industry belongs to one of the most polluting industrial sector. Almost every tannery industry uses significant amounts of chemicals in the process of transforming animal hides into leather (Dargo and Ayalew 2014). In Bangladesh, about 90% of tannery industries are engaged in the chrome tanning process because it is simple in operation and renders excellent properties to the leather. The tanning process is almost completely a wet process that consumes significant amount of water, and generates about 90% of the used water as effluent (Chowdhury et al. 2013). Tannery effluents carry heavy pollution loads due to a massive presence of highly coloured compounds, sodium chloride and sulphate, various organic and inorganic substances, toxic metallic compounds, different types of tanning materials which are biologically oxidizable, and large quantities of putrefying suspended matter (Akan et al. 2007; Khan et al. 1999). The tannery effluent damages the normal life of the receiving water bodies and land surface (Cooman et al. 2002). Tanning effluents is one of the most difficult-to-treat wastewaters on account of their considerable amount of weakly biodegradable and often toxic substances such as dyes, heavy metals, detergents, surfactants and other additives.

2. MATERIALS AND METHODS

In the present study, effluent was collected from a tannery in Dindigul 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 polystyrene containers [2 litres capacity] and were brought to the laboratory with due care and stored at -20^{o}C.

The physico-chemical parameters such as colour, odour, temperature, pH, Electrical conductivity (EC), Total dissolved solids (TDS), Total suspended solids (TSS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Oil and grease (OG), Chloride (Cl) and Total hardness of the effluent was analyzed following Standard methods outlined by APHA (1989). Dissolved oxygen (DO) (Durairaj, 1987), Sodium (Na), Potassium (K), Calcium (Ca) and Sulphate were determined (Jackson, 1958).

The isolation of bacteria from the tannery effluent was done by serial dilution technique (Charurvedi, 1992). After identification of the bacteria, culture was carried out in the laboratory to be used for biotreatment of the tannery effluent. Bacteria such as *Bacillus cereus* and was used for the treatment of tannery effluent.

2.1. Biodegradation of Tannery Effluent Using of Bacteria

Approximately 10 g (fresh weight) of *Bacillus cereus*, and of *Pseudomonas aeruginosa* 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 48 hrs and maintained at 28±2^{0}C. Three important physicochemical parameters such as pH, BOD and COD were estimated before and after 48 hrs (2 days) to check the degradation process by the bacteria.

2.2. Statistical analysis

The results obtained in various treatment were tested through the method of analysis of Variance (ANOVA) (Steel and Toorie, 1960). The ANOVA was conducted both within and between blocks to ascertain the effect of the control and the different concentrations of effluent on the degree of inhibition. The experimental data was statistically analyzed by adopting the procedure described by Panse and Sukhatme (1957).

3. RESULTS AND DISCUSSION

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 Total hardness, calcium, magnesium, sodium, chloride and sulphate. Based upon the dominant bacteria, *Bacillus cereus* and *Pseudomonas aeruginosa* were individually used to reduce the pH, BOD and COD in the effluent. Laboratory scale biodegradation of tannery in different concentrations (viz 25%, 50%, 75% and 100%) using the above bacteria. Three important physicochemical parameter namely pH, BOD and COD were analyzed in the biotreated tannery effluent after 48 hours of incubation.

Results of the tannery effluent treated with the Bacteria *Bacillus cereus* and *Pseudomonas aeruginosa* at different concentration (25%, 50%, 75% and 100%) for 48 hrs is shown in the Table 2, 3 & 4. The pH of tannery effluent before (control) and after biodegradation (48 hrs) by bacteria is shown in Table 2. The BOD of tannery effluent before (control) and after biodegradation (48hrs) by individual bacteria is shown in Table 3. The COD of tannery effluent before (control) and after biodegradation (48 hrs) by individual bacteria is shown in Table 4. In all the concentrations of tannery effluent Bacillus cereus was found to reduce pH, BOD and COD to maximum extent followed by the bacterium *Pseudomonas aeruginosa*. The decrease in pH, BOD and COD values in the biotreated effluent is statistically significant P<0.008.

Parameters	Inlet. (Raw)	Outlet – Final (Treated)
pH	10.8	6.7
Electrical Conductivity (dsm^{-1})	3.80	2.85
TSS (mg/1)	1700	100
TDS (mg/1)	2480	1470
Chloride	1550	1420
Sulphate	580	120
BOD	970	240
COD	2320	560
Oil & Grease	0.51	0.05

TABLE – I WATER QUALITY PARAMETERS OF TANNERY EFFLUENT AT TWO DIFFERENT UNITS.

Parameters	Concentration of the effluent	Mean + SD & % Reduction	Control	*Bacillus cereus*	*Pseudomonas aeruginosa*
pH	100%	Mean ± SD	6.5 ± 0.21	9.5 ± 0.17	8.4± 0.14
		% Reduction		**+46.15%**	**+26.15%**
	75%	Mean ± SD	7.5 ± 0.18	9.9 ± 0.24	8.8 ± 0.24
		% Reduction		**+28.94%**	**+14.47%**
	50%	Mean ± SD	8.7 ± 0.24	10.4 ± 0.32	9.8 ± 0.39
		% Reduction		**+17.04%**	**+10.23%**
	25%	Mean ± SD	10.5 ± 0.11	12 ± 0.58	10.8 ± 0.35
		% Reduction		**+12.26%**	**+0.94%**

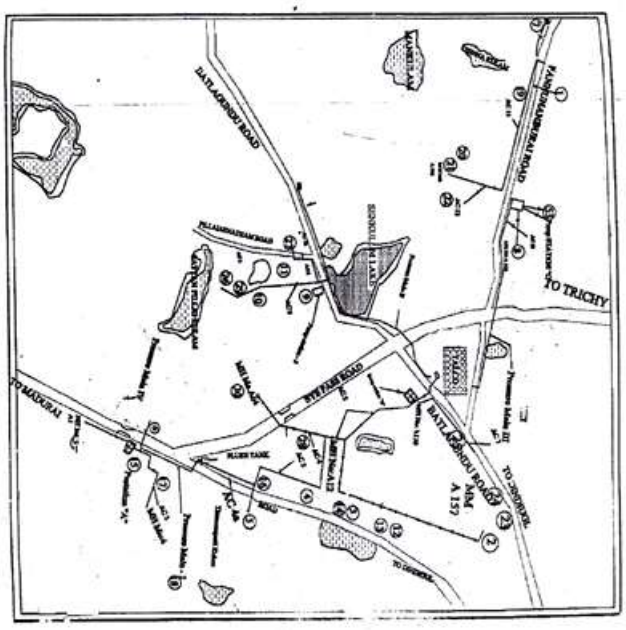
TABLE – II pH OF TANNERY OF EFFLUENT BEFORE (CONTROL) AND AFTER BIODEGRADATION (48 HRS) USING BACTERIA.

Parameters	Concentration of the effluent	Mean + SD & % Reduction	Control	*Bacillus cereus*	*Pseudomonas aeruginosa*
BOD	100%	Mean ± SD	948.5 ± 42.98	906.16 ±29.73	923.7 ± 35.30
		% Reduction		**-4.57%**	**-0.63%**
	75%	Mean ± SD	835.16 ± 27.28	622 ± 50.49	661.3 ±44.45
		% Reduction		**-25.67%**	**-21.08%**
	50%	Mean ± SD	636.83 ± 26.72	483.33 ±23.47	531.3 ± 44.00
		% Reduction		**-24.29%**	**-16.92%**
	25%	Mean ± SD	312.66 ± 58.70	254 ± 59.74	283.8 ± 26.53
		% Reduction		**-19.14%**	**-9.91%**

TABLE – III BOD OF TANNERY OF EFFLUENT BEFORE (CONTROL) AND AFTER BIODEGRADATION (48 HRS) USING BACTERIA.

Parameters	Concentration of the effluent	Mean + SD & % Reduction	Control	*Bacillus cereus*	*Pseudomonas aeruginosa*
COD	100%	Mean ± SD	2278.83±72.47	1837.5±39.97	1941.3±32.62
		% Reduction		**-19.42%**	**-14.91%**
	75%	Mean ± SD	1773 ± 42.66	1578.7±31.25	1679.6 ±29.26
		% Reduction		**-11.02%**	**-5.38%**
	50%	Mean ± SD	1453.5 ± 30.12	1364 ±22.36	1407.16±22.22
		% Reduction		**-6.64%**	**-3.33%**
	25%	Mean ± SD	1356 ± 64.18	1119.5± 33.27	1219.6± 31.57
		% Reduction		**-17.53%**	**-10.22%**

TABLE – IV COD OF TANNERY OF EFFLUENT BEFORE (CONTROL) AND AFTER BIODEGRADATION (48 HRS) USING BACTERIA.



Location of tanneries at Dindigul district

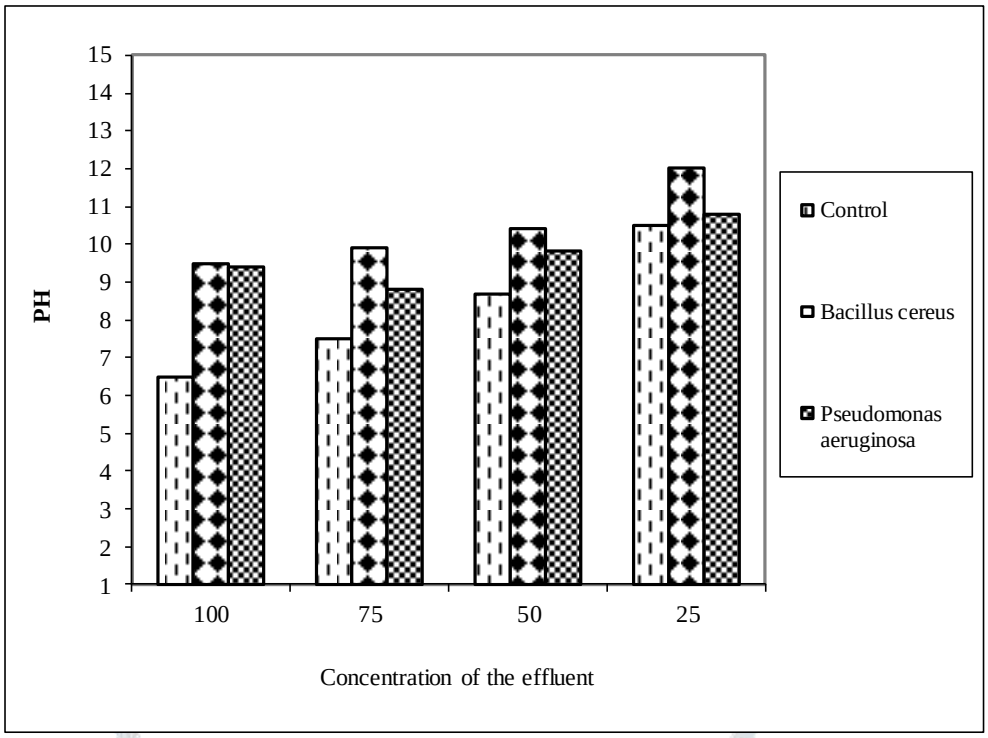


Fig. I. pH of the tannery effluent before (control) and after biodegradation (48 hrs) using bacteria.

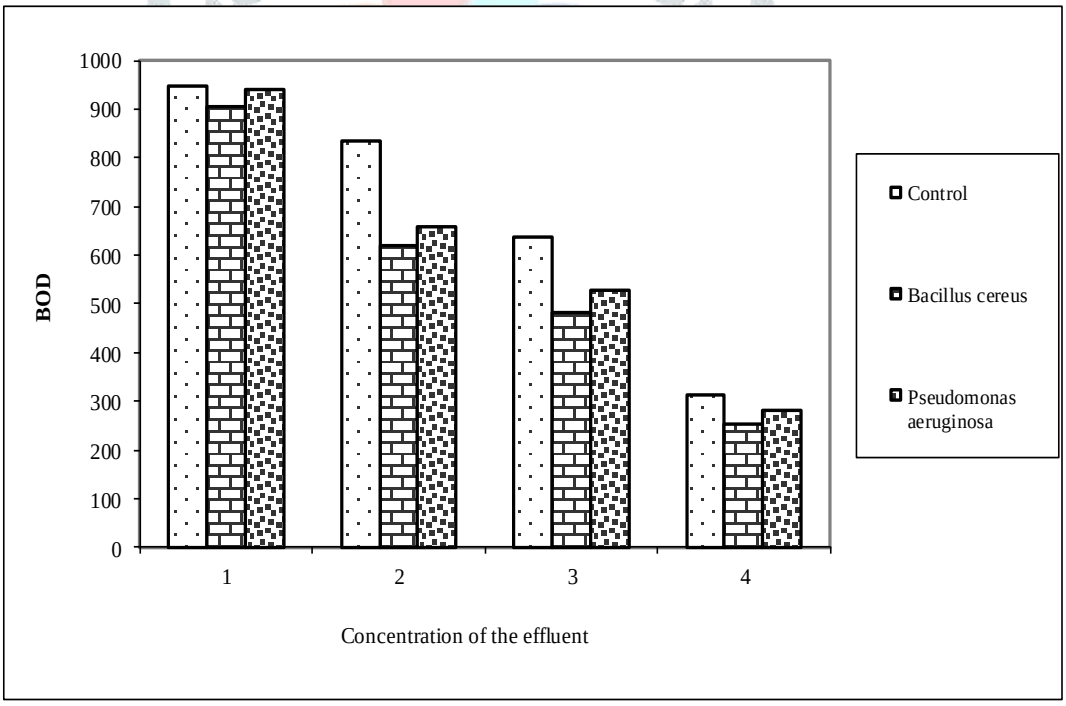


Fig. II. BOD of the tannery effluent before (control) and after biodegradation (48 hrs) using bacteria.

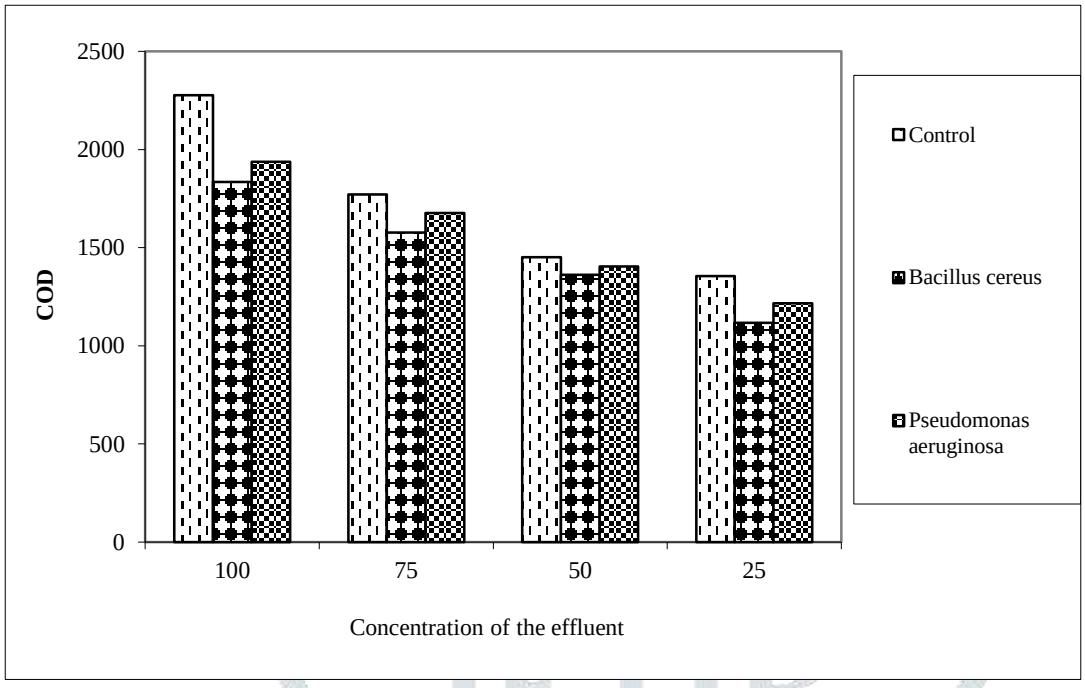


Fig. III. COD of the tannery effluent before (control) and after biodegradation (48 hrs) using fungi and bacteria.

Notable accomplishments of the environmental biotechnology include the cleanup of waste water especially from tanneries and other industries. Bioremediation is addressed as one example of an environmental biotechnology. 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.

In the present investigation, the physico-chemical characteristics of the untreated effluent have revealed that it is acidic with high pH, 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. Preset 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). M. Saleem et al., 2014 reported high potential of *Bacillus cereus* for bioremediation of pulp and paper industrial waste and the decreased of chemical oxygen demand and biological oxygen demand about 61 and 66 %, respectively, by *Bacillus cereus*. Noorjahan et al., 2014 observed a non-native *Bacillus sp* showed Biodegradation of Industrial effluent reduction percentage range of 56-95%.

4. CONCLUSION

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 *Pseudomonas aeruginosa* are able to reduce the pH, BOD and COD in all concentrations of the tannery effluent. Studies also reveal that *Bacillus cereus* was more efficient and has high degrading ability to reduce pH, BOD and COD than *Pseudomonas aeruginosa*. Hence it may be suggested that *Bacillus cereus* and *Pseudomonas aeruginosa* will be beneficial for biodegradation and purification of effluents.

5. ACKNOWLEDGEMENTS

The authors are grateful to the College Management and Principal Dr. S. Ismail Mohideen, Jamal Mohamed College for providing the facilities and Dr. I. Joseph Antony Jerald, Head, P.G. Department of Zoology for encouragement.

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