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Biodegradation of Leather Industry Effluent using Indegenous Fungal Isolates

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In the present investigation, 11 species of fungi were isolated from a leather industry effluent and they were testified with reference to their potential biodegradation of the same effluent. Among the isolated fungal isolates, *Aspergillus niger* was found to be the most efficient one as it exhibited the higher rate of degradation when it was exposed with different type of leather industry wastes before and after sterilization. For the confirmation of optimum incubation period for such efficient degradation by *A.niger*, all experiments were carried out in triplicates with three different intervals viz; 5, 10 and 15 days and the maximum degradation potential was observed after 15 days of incubation. Except dissolved oxygen, all other physico-chemical parameters showed a notable reduction when compared to control. The BOD and COD level were reduced significantly in 15 days. When compared to unsterilized the sterilized effluent treated with *Aspergillus* sp showed better removal of organic and inorganic pollutants in the samples tested.

Key words: *Aspergillus* sp., Leather industry effluent, Water quality parameters.

Until very recently, the literature concerning biodegradation and bioremediation of organic chemical wastes dealt almost exclusively with bacteria. It is now becoming apparent that fungi also play an important role in degrading organic materials in the ecosystem, and that they have potential for remediation of contaminated soils and waters. The higher basidiomycetes fungi probably play the major role in recycling the wastewater pollutants than unsterilied effluent.

Thanh and Simard[1] reported the efficient treatment of wastewater 24 different yeast strains. Heremath *et al.*,[2] performed a similar study in seven fungal species isolated from a wastewater stabilization pond. They reported BOD removal between 53 and 72%, phosphate removal from 34 to 77%, and ammonia nitrogen removal between 49 and 77%. Cooke[3] advocated the use of fungi in waste water treatment as fungi appeared to show higher rates of degradation and show much greater ability to degrade cellulose, hemi-cellulose, and lignin materials. However, Cooke's attempt did not move beyond a survey of the populations to creating a waste water treatment

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system based on fungi due to the complexity of the reaction conditions and non-availability of efficient indigenous fungal flora.

Industrial pollution affects water quality in many ways in dissolved oxygen, temperature, pH etc., and some industrial effluents cause toxicity. Leather industry contributes higher percentage to industrial pollution problems facing the country and the pollution causing chemicals viz; lime sodium sulphide, salt, solvents, etc., arise mainly from the pre-tanning process of raw materials in leather industry.

In order to overcome the hazardous caused by the tannery effluent, use of enzymes as a viable alternative has been resorted to in pre-tanning operations such as soaking, bating, decreasing and offer treatment. Significant role of microbial enzymes as an alternate technology to the conventional methods and also authenticate the importance of these in minimizing pollution load. The direct discharge of effluents from tanneries into bodies of water has become a growing environmental problem effluents generated by the tannery industries are major sources of the pollutions most of the waste waters are extremely complex mixtures containing inorganic and organic compounds consequently, the tanning industry is a potentially pollution-intensive industry contaminated air, soil and water by effluents from tanning industries are associated with dangerous disease outbreak through tannery industry and cause excessive ecosystem damage which affects the entire world. Brooks[4] reported excellent removal of BOD, organic nitrogen, and ammonia nitrogen (90 to 95% and 95 to 99%, respectively) from Alcohol and leather industry effluent which was dark brown in colour with alcoholic odour and pH 7.5. and with high BOD and COD values before treatment was reduced remarkably. These correlations are very helpful in knowing the associations among the physico-chemical properties of effluents. Kasturi Bai and Ganga[5] attempted to decolourize distillery effluent using chemical coagulants and biological methods of ligninolytic fungi *Phanerochate chirysosporium*. Hence, the present study was carried out to evaluate biodegradation of effluent from leather industry by different fungal isolates obtained from the same effluent.

MATERIAL AND METHODS

The effluent samples were collected from outlet of leather industry, Chennai, South India. All the glass wares used in this present study are Borosil make. Before each use, the glass wares washed with diluted acid and alkaline solution and distilled water then sterilized in hot air oven at 160^0 C for 1 hour. 10ml of the effluent was taken in a 250ml conical flask and 90ml sterile distilled water was added with the effluent. The content were mixed well using orbital shaker and a homogenous suspension was obtained. This suspension was serially diluted up to 10^{-3} with sterile distilled water. Diluted samples were aseptically transferred into Petri dishes containing Potato Dextrose Agar medium (PDA) through pour plate technique. Streptomycin (100 mgl^{-1}) was added to the media to prevent the bacterial growth. The plates were incubated at 25 ± 2°C for five days and fungi appearing on the medium were mounted over a clean slide, stained with lactophenol cotton blue. It was observed under compound bright field microscope and photomicrographs were taken using Nikon Alphabet microphotographic unit in Konica 100ASA photographic film. Selected images were developed and printed in commercial laboratories.

Further enumeration and characterization of the isolated fungi were identified by using standard manuals, such as Manual of soil fungi Gillman[6], More D*ematiaceous* Hyphomycetes Ellis[7], Hyphomycetes Subramanian[8].

Biodegradation of Effluent

The experiments were conducted in batch cultures in triplicates for a total period of 15 days in 250ml Erlenmeyer flasks. Effluent samples (control and treated) were periodically (every 5^{th} day) analyzed for various physico-chemical parameters and recorded. The efficient fungal species isolated were used for further studies. The following are the different sets of treatments were maintained in this present study: Raw effluent sample[100ml]- C1, sterilized effluent sample[100ml]-CS2, Raw effluent sample treated with *A.niger* [100ml+ 10ml]-T1, sterilized effluent sample treated with *A.niger* [100ml+ 10ml] -TS2, Physico-chemical analysis of effluent

Table 1. Physicochemical characteristics of effluent

S. No	Parameters	Initial		5th Day				10th Day				15th Day			
		C	CS	Control		Treated		Control		Treated		Control		Treated	
				C1	CS2	T1	TS2	C1	CS2	T1	TS2	C1	CS2	T1	TS2
1	pH	6.8	6.7	6.8	6.7	6.8	6.7	6.8	6.8	6.6	6.7	6.8	6.8	6.6	6.7
2	Free CO_2	32	26	30	26	28	24	30	28	22	20	28	28	12	10
3	Alkalinity	108	102	106	102	78	96	106	98	62	48	104	98	20	21
4	Dissolved Oxygen	1.35	0.82	1.72	0.82	1.74	1.37	1.72	0.82	2.2	1.37	2.2	0.82	2.2	1.72
5	Nitrate	90	80	90	80	82	70	90	80	68	59	88	80	42	52
6	Nitrite	48	46	48	46	46	40	46	46	36	32	44	46	26	28
7	Ammonia	41	34	41	34	32	30	40	34	26	22	39	34	16	16
8	Total Phosphorus	147	142	146	140	136	130	144	140	126	168	142	144	80	78
9	Inorganic	83	80	82	78	78	23	80	78	72	62	78	80	42	42
10	Organic	64	62	64	62	58	57	62	62	54	44	60	62	38	30
11	Calcium	83	74	82	72	76	68	80	72	70	58	78	80	50	49
12	Magnesium	56	54	55	54	50	50	54	54	42	45	54	54	22	37
13	Chloride	49	47	44	45	48	44	49	45	46	42	48	45	44	40
14	BOD	340	310	320	300	250	260	310	300	220	180	310	300	160	110
15	COD	620	590	610	580	520	500	600	580	420	380	580	580	300	220

Except pH all values are expressed in mg l^{-1}

mg l^{-1} recorded in raw effluent.

BOD was recorded maximum as 340 mg l^{-1} initially and about 65% reduction was observed interestingly in sterilized effluent treated with *Aspergillus niger* when compared to control. Where as nearly 52% reduction was observed in raw treated effluent on 15th day.

High level of COD was recorded initially (620 mg l^{-1}) and as in case of BOD, there was a steep reduction was recorded in *Aspergillus* treated effluent. In both sterilized and raw effluent on 15th day raw effluent was recorded nearly 54% when compared to control. Similarly 62% reduction was observed in sterilized effluent treated with *Aspergillus*.

DISSCUSSION

The results of this present study was in conformity with the earlier reports of Watts *et. al*[10]. They isolated and recorded three species of *Trichoderma* from automobile industrial effluents. In this present study *Penicilllium helminthosporium, Cladosporium, Fusarium, Geotrichum* and *Rhizopus* were also recorded along with the abundant species of *Aspergillus.* High level colonization of these species in leather industry effluents reveal that they have a high degree of tolerance over the pollutants as they might have evolved an indigenous resistance against them Bennett & Faison[11]. So, the selection of these fungal species as representative test organism for such degradation studies are becoming a natural choice as well as a more acceptable and scientific one too.

In this present study, level of all pollutants were reduced in both un-sterilized and sterilized effluent while they were treated with *Aspergillus*. A similar analysis was done by Thanh and Simard[1]. They reported that treatment of waste water by fungi while maximizing reduction of phosphate, ammonia, and organic matter. The studies were conducted in batch 500-ml baffled culture, shake flasks containing 150 ml of sterile waste water. Phosphate removal ranged from 12 to 100%, total nitrogen removal from 22 to 93%, ammonia nitrogen from 27 to 90%, and COD removal from 0 to 72%. In this present study, it was able to compare the efficiency of *A. niger* with other fungal isolates. *A. niger* exhibited a high degree of tolerance and pollutant reduction efficiency when comparing other isolates.

The ability of fungi to transform a wide variety of hazardous chemicals has aroused interest in using them in bioremediation Alexander[12]. The white rot fungi are unique among eukaryotes for having evolved nonspecific methods for the degradation of lignin; curiously they do not use lignin as a carbon source for their growth Kirk *et al*[13]. Lignin degradation is, therefore, essentially a secondary metabolic process, not required for the main growth process . Lamar *et al*[14] compared the abilities of three lignin-degrading fungi, *Phanerochaete chrysosporium, P. sordida* and *Tramates hirsuta* to degrade PCP (Pentachlorophenyl) and creosote in soil. Inoculation of soil with 10% (wt/wt) *Phanerochaete sordida* resulted in the greatest decrease of PCP and creosote. *P. sordida* was also most useful in the degradation of PAHs (Polycyclic aromatic hydrocarbons) from soil. Davis *et al*[15] showed that *P. sordida* was capable of degrading efficiently the three ring PAHs, but less efficiently the four-ring PAHs.

From the results of this present study it has been suggested that the basic nutrients and complex organic materials found in the effluents might have been partially catabolised by the tested fungi and utilized by them towards their carbon and nitrogen needs. The accessibility and the secretion of specific enzymes required to initiate such catabolic activities will be the major factors which determine the onset of degradation. Moreover the adaptability of the experimental species could play a secondary role while the initiation of such catabolic or degradative activities. As *A.niger* could have developed such accessibility with the pollutants it was able to show a proportionate level of degradation in all parameters analyzed in this present study.

CONCLUSION

Leather industry contributes to one of the major industrial pollution problems facing country. Utilization of indigenous micro flora for the low cost and eco-friendly approach towards the reclamation of polluted sites are becoming a valid choice. In this aspect the results of this present study could yield a baseline data with

reference to the efficiency *A.niger* in comparison with other fungal species. Moreover, further characterization of such species and strain improvement strategies could have been routed with this basic observation.

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