

BIOREMEDIATION OF PHENOL FROM PULP AND PAPER MILL EFFLUENT

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ABSTRACT

Pulp and paper mill is considered as one of the highly polluting industry responsible for surface water pollution. Wastewater from industry has high loads of organic as well as inorganic constituents. Direct discharge of effluent to aquatic bodies will alter the aesthetics and can induce various health hazards in exposed individuals. Compared to physical and chemical methods of wastewater treatment, bioremediation was found to be attractive and efficient technique. In the present investigation, *Pseudomonas pictorum* was utilized to study its phenol removal efficiency and results revealed that the organism was found to be potential in removal of phenol from paper mill effluent.

KEY WORDS : Aesthetics, Bioremediation, Phenol, Potential

INTRODUCTION

Pulp and paper mill is one of the important industries in India which causes water pollution and categorized as a core sector industry and is the fifth largest contributor to industrial water pollution (Singh, 2011). The estimated quantity of water required to produce 1 ton of paper is about 273-450 m³ and waste water generated is about 60-300 m³ (Selvam and Priya, 2011). Waste water from the industry causes huge environmental and economic problems. Waste water characteristics depend upon the manufacturing process.

The untreated effluent from pulp and paper industry discharged into aquatic bodies damages the water quality and disturbs the aesthetics. In many cases discharge of raw effluent to aquatic bodies will result in harmful environmental and social impacts.

Many physical, chemical and biological treatment techniques were already in practice to treat pulp and paper mill effluent. Biological remediation is a technique used to treat the contaminated environment using naturally occurring or

genetically modified organisms (Chandralatha *et al.*, 2008). According to Selvam *et al.*, (2011) biological method of effluent treatment is found to be cost effective and feasible and helps to remove color as well as BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand).

Many microbial strains have already been tested for their bioremediation potential such as bacteria, fungi, algae, actinomycetes etc., Microbes bioremediate the effluent by absorption, adsorption, ingestion or enzymatic activity. In the present investigation *Pseudomonas pictorum* was utilized to investigate the phenol removal efficiency from pulp and paper mill effluent.

MATERIALS AND METHODS

Effluent collection and analysis

Effluent for the present investigation was collected from a paper mill located in Karnataka, India. Samples were collected periodically from inlet of effluent treatment plant by grab sampling technique. Immediately after effluent collection it was brought to laboratory of Department of P. G. Studies and

Research in Environmental Science, Kuvempu University for further analysis. The sample was filtered through a 0.5 mm sieve to remove suspended particles and stored at 4 °C.

Bacterial strains utilized for effluent degradation studies

Pseudomonas pictorum (NCIM Acc No. 2077) was procured from National Collection of Industrial Microorganisms, Pune, India, to investigate the efficiency of organisms in pollution remediation of pulp and paper mill effluent. Bacterial strains were sub cultured and stored at 4 °C for further studies.

Experimental setup

Pseudomonas pictorum was tested for biodegradation ability under laboratory condition. For the treatment, effluent sample was diluted to 3 different concentration viz. 25%, 50% and 75%. The purpose of dilution is to study the degradation efficiency of the organism at different effluent concentrations. The organism was inoculated into each effluent concentration and treatment was conducted in laboratory for 7 days.

Removal of phenol from pulp and paper mill effluent

Phenol concentration in effluent was estimated by colorimetric method. In this method 50 ml of sample is transferred to tall-form Nessler tube to which add 0.3 ml of 2% 4-aminoantipyrine solution and 1 ml of 2N ammonium hydroxide solution. Mix the contents properly and add 1 ml of 2% potassium ferricyanide solution and mix again. Unknown concentration of phenol in sample is determined by comparing color with standards prepared from phenol solution of known concentration.

RESULTS AND DISCUSSION

Results are expressed as mean \pm SEM. The Statistical analysis was carried out using one way ANOVA followed by Tukey's t-test. The difference in values at

$p < 0.05$ or $p < 0.01$ were considered as statistically significant. Statistical analysis was performed using ez ANOVA 0.98 version.

Pseudomonas pictorum: 6.47 \pm 0.23 to 0.63 \pm 0.06 (raw effluent), 5.27 \pm 0.12 to 0.37 \pm 0.12 (75% concentration), 3.40 \pm 0.10 to 0.16 \pm 0.01 (50% concentration) and 1.47 \pm 0.06 to 0.04 \pm 0.01 (25% concentration) (Table 1). The percentage reduction in lignin was 90.90% (raw effluent), 93.26% (75% concentration), 95% (50% concentration) and 97.5% (25% concentration).

These findings are in accordance with the findings of Annadurai *et al.*, (2007) who investigated biodegradation of phenol using *Pseudomonas pictorum*. Effluent was treated with pH range over 7-9 and temperature 30 °C. Organism showed its potential in reduction of lignin at phenol concentration 0.200 (mg/l), temperature 30 °C and pH 7.

CONCLUSION

Results reveal that *Pseudomonas pictorum* had more potential in removal of phenol from pulp and paper mill effluent. For the selected parameter it was found that *Pseudomonas pictorum* performed well in lower effluent concentration, i.e 25 % concentration of effluent. This indicates effluent dilution enhances the growth and performance of microorganisms in pulp and paper mill effluent. Raw effluent is highly concentrated with pollutants which appeared to be unfavorable for growth and development of organisms. Hence, *Pseudomonas pictorum* can be recommended for bioremediation of paper mill wastewater.

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Table 1. Concentration of phenol (mg/L) at different effluent dilutions before and after treatment with *Pseudomonas pictorum*.

study organism	Raw Effluent		75% concentration		50% concentration		25% concentration	
	Before	After	Before	After	Before	After	Before	After
<i>P.pictorum</i>	6.47 \pm 0.23	0.63 \pm 0.06**	5.27 \pm 0.12	0.37 \pm 0.12**	3.40 \pm 0.10	0.16 \pm 0.01**	1.47 \pm 0.06	0.04 \pm 0.01**

Values are expressed as mean \pm SEM (n=3), * $p < 0.05$; ** $p < 0.01$, denotes significance with respect to initial values (before treatment) using one way ANOVA followed by Tukey's test.

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