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BIO-REMEDIATION OF PULP AND PAPER MILL EFFLUENT USING MICROBIAL CONSORTIA

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ABSTRACT

As paper industry is scattered all over the country, it may be said that no water may be spared from pollution due to the discharge of its wastewaters. Therefore it is important to treat this wastewater before discharging. A number of studies have been made regarding the pollution load on river due to pulp and paper mill discharge but hardly any study has been made on bio-remediation of this effluent. In the present study an attempt has been made to degrade various contaminants from pulp and paper mill effluent using microbial consortia.

INTRODUCTION

Industrial plants discharge huge volumes of aqueous effluents in water bodies. Effluents from pulp and paper industry are known to contain toxic as well as mutagenic and cacinogenic components. The major cellulosic raw materials for paper industry are bamboo, wood, bagasse, grasses and straws. A majority of mills use 70-80 percent bamboo, the balance being one or more of the other raw materials (Pandey 1999). The important characteristics of combined effluents of integrated pulp and paper mill with chemical recovery system are dark brown colour, characteristic odour, high content of suspended and dissolved solids, high COD and resistant to biological oxidation (Dara 2001). The dark brown colour of the effluent is due to the lignin compounds which are not easily biodegradable, and hence impart persistent colour to the receiving waters and inhibit photosynthesis and other natural self-purification processes. The chemicals present in the effluents like sulfites, phenols, free chlorine, methyl mercaptan and pentachlorophenol are harmful to flora and fauna of the receiving waters.

Today, the market for environmental biotechnology is developing at a faster rate. This is proved by the fact that biotechnology which has a growth rate of 7% in the market of food and pharmaceuticals application has 17 percent growth rate in the environmental clean-up areas. With the expected world market of over $100 billion by the year 2000, biotechnology is going to be the most leading technology in environmental clean-up in the next decade (Jogdand 1995). Bacteria and fungi are common microorganisms, which can degrade a large number of chemicals present in wastewaters.

Looking to the present need for pollution abatement strategy present study has been made to degrade various contaminants from pulp and paper mill effluent by using microbial consortia.

MATERIALS AND METHODS

For the present study a typical pulp and paper mill (Star Paper Mill Ltd., Saharanpur) was selected. The samples were collected from outside the factory boundary. In the present investigation, bacterial strains were isolated from soil sediment affected by pulp and paper mill's effluent. These strains were used to degrade various contaminants of the mill's effluent after incubating them in mineral salt

medium which is a sole carbon and energy source. The effluent is also treated with fungi called *Phanerochaete chrysosporium* which is known to be the lignin degrading fungi. Various parameters were analyzed by using the methods of APHA-AWWA-WPCF (1998) and Manivaskam (1996).

RESULTS AND DISCUSSION

The results of various parameters after bacterial and fungal treatment are shown in Tables 1 and 2. The observed value of color was found to be 1893.93 at 0 day; after bacterial inoculation it got decreased to 378.78 after 15 days. According to Trivedy & Goel (1984), color in natural water may occur due to the presence of humic acid and metallic ions such as iron and manganese. The color of the effluent of paper mill is brownish black before bacterial treatment but after treatment it becomes faint.

The observed value of pH was 7.36 on 0 day, which was increased to 8.58 at 15 day. The value of pH increases due to the incubation of bacteria in mineral salt medium for its nourishment. The values of pH of effluents remain generally high due to presence of mineral salts as also reported by Arya & Wescot (1985). BOD decreased from 1720 mg/L to 598 mg/L. COD value was 1080 mg/L on 0 day observation and decreased to 360 mg/L on final day of the experiment. The higher value of COD revealed that the most organic waste was oxidized but the oxidation was still incomplete (Klien 1957, David & Ray 1966).

The lignin degradation is an important parameter of the study. In the present study lignin is degraded by bacterial as well as fungal treatment. The value of lignin was 5971.65 mg/L at 0 day, but after bacterial inoculation it was degraded to 910.93 mg/L at 15th day. For fungal treatment of lignin three sampling sites were selected. At Site-I the lignin degradation was from 1578.94 mg/L to 206.47 mg/L, at site-II from 1821.86 mg/L to 194.33 mg/L and at site-III from 1700.40 mg/L to 202.42 mg/L.

Table 1: Observations on various parameters after bacterial treatment.

	Days (after inoculation)					
Parameters	0 day	1 day	3 day	6 day	10 day	15day
Colour, Pt-Co scale	1893.93	1098.48	984.84	675.18	568.18	378.78
Lignin (mg/L)	5971.65	5060.72	2226.72	1518.21	1417.004	910.93
COD (mg/L)	1080	780	740	675	440	360
BOD(mg/L)	1720	1440	1320	1090	675	598
pH	7.36	7.72	7.78	8.53	8.58	8.58

Table 2:- Observations after fungal treatment *(Phanerochaete chrysosporium)*.

	Days after *Phanerochacte chrysosporium* inoculation					
Parameter	0 day	1 day	3 day	6 day	10 day	15 day
Lignin (mg/L) (Site I)	1578.94	1457.48	971.65	526.31	364.37	206.47
Lignin (mg/L) (Site II)	1821.86	1538.46	1295.54	971.65	485.82	194.33
Lignin(mg/L) (Site III)	1700.40	1376.51	1214.57	890.68	348.17	202.42

CONCLUSION

Microorganisms are the oldest inhabitants of earth. They are the masters in versatility and adaptability to the changing environment. They will definitely prove to be most cost-effective partners in our efforts for sustainable development. So limitations faced by physical and chemical methods of pollution control will overcome if we take the help of these environmental masters (microorganisms).

The use of biotechnology for pollution control is well documented. With the advancement of bioreactor design, the use of genetically engineered or adapted cultures and biodegradation technology has been successful in making its impact felt on pollution abatement efforts. Cost effectiveness, working at normal temperatures and pressure, small reactors, energy and chemicals production, continuous processing, and the elimination and not mere conversion (to different forms) of pollutants can be claimed to be the advantages of bio-treatment technology.

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