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Bioremediation of thermal wastewater by *Pithophora* sp

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ABSTRACT

The interaction of microorganisms with pollutants has opened up new vistas to an exciting field of research for environmentalists. The unprecedented interest in bioremediation and its applications stems from the failure of aggressive and invasive treatment methods that disturb ecosystems by cleaning them with unnecessary quantities of chemicals. Therefore, the use of microorganisms represents a viable, cost-effective decontaminated alternative that is based on natural processes and can be adhered to for further industrial or other purposes.

Key words: Bioremediation thermal wastewater-micro alga-nutrient reduction.

INTRODUCTION

Water is the most ubiquitous material of nature and a vital fascination of all God's creation. In recent years, increasing industrialization, urbanization and developmental activities to cope with the population explosion has given rise to them inevitable waste crisis. Increases in environmental contamination have lead to a progressive deterioration of a qualitative environment. This condition challenges global society and paves way for redemptive measures to reverse the negative condition that poses a severe threat to man and his environmental health. A discuss based on the progress being made toward this goal was convened through the application of bioremediation techniques. Bioremediation continues to be the favored approach for processing biological wastes and avoiding microbial pathogenesis.

Phycorermediation applied to the removal of nutrients from wastewater and other high organic content wastes is a field containing great potential and demands consideration towards the surface and underground water bodies in several regions of the world facing the changes of eutrophication. However, the development of efficient nutrient removal algal systems requires further research in stipulated areas. Micro algae have vast industrial and economic potential (Rai *et al*., 2000) as valuable sources for pharmaceuticals (Park and Lee, 2001), dyes fine chemicals, biofuels and others. The history of the commercial use of algal cultures with various applications covers about 50 years (Borowitzka and Borowitzka, 1991). Furthermore, they may be able to solve emerging environment problems, such as the green house effect (Nagase *et al*., 1998) and waste treatments (Lee *et al*., 2001). They can fix carbon di oxide by photosynthesis (Lee *et al*., 2001) and remove excess nutrients efficiently at a minimal

cost (Murakami and Ikenouchi, 1997). In addition, photosynthetically produced oxygen can relieve biological oxygen demand (BOD) in wastewater. Micro algae also have the ability to take up various kinds of nitrogen (Kim *et al.,* 2000) and to absorb heavy metals (Joen *et al*.,2001) and phosphorus (Adamsson *et al*., 1988). Recent developments with rapid screening assays could identify organisms capable of degrading specific wastes and new gene-probe methods can ascertain their abundance at specific sites. The present study aims at analysing physico-chemical properties of raw and treated thermal wastewater to evolve effective and economic biological treatment methods by using micro alga.

MATERIAL AND METHODS

Effluents were collected from the Thermal Power Station at Ennore (a suburb of Chennai). In the present study of algal culture was maintained in Bold Basal medium following Nicholas and Bold (Nichols and Bold, 1965).

To study the role of green alga in thermal effluent, the following protocols were employed. i) Effluent without *Pithophora* sp (control) and ii) Effluent treated with *Pithophora* sp. Two ml of uniform suspension of *Pithophora* sp were inoculated in each flask containing 2 litre of effluent (i). The experiment was conducted under controlled conditions (temperature 27 ± 2°C) with a light intensity of 2000 lux, provided from overhead cool light white fluorescent tubes (16L+8D) for a total duration of 15 days. Samples were periodically (every 6th day) analyzed for various physico-chemical parameters such as pH, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, nitrate, sulphate, phosphate, chloride, iron, BOD and COD etc using standard methods (2000).

RESULLTS AND DISCUSSION

Physico-chemical parameters of untreated and *Pithophora* sp degraded thermal wastewater are depicted in Table 1. Physico-chemical parameters of wastewaters showed that, wastewater contains toxins and if discharged, could cause serious environmental problems and harmful effects to human beings, animals and aquatic life However, bioremediation using *Pithophora* sp is versatile, inexpensive and can potentially transform these toxins into harmless end products.

The thermal wastewater was slightly yellowish in colour giving of an unpleasant odour. This was due to the presence of increased amount of oil and grease along with the presence of various contaminants.

The present study takes in to the account the amount of total solids reduced to 42.71 percent by *Pithophora* sp.

Total dissolved solids are generally found in polluted water, this also contributes to the dissolved solids. Total dissolved solids in the present study were reduced to 42.77 percent when the effluent was treated with *Pithophora* sp. With regard to TDS, both untreated and untreated effluent were found to contain high levels of TDS compared to the permissible limits of CPCB (1995) and these levels of TDS could be due to salt content present which renders it unsuitable for irrigational purposes. Kamaleswari *et al*., (2007) reported reduction of TDS when the industrial effluents treated with algae. Conductivity is the measure of a substance or solution to conduct an electric current. It is a reciprocal of resistance. Electrical conductivity of a treated effluent was reduced to 44.27 percent by *Pithophora* sp. The higher level of electrical conductivity in raw effluent could be attributed to the use of inorganic chemicals in thermal manufacturing. An increase in electrical conductivity of soil by distillery effluent has already been reported (Kaul *et al*.,1995).

The study, also found that pH was increase in thermal effluent from 5th day onwards The pH of the thermal effluent with *Pithophora* sp continued to remain higher than control (Manoharan and Subramanian, 1993) found a rise in pH value up to 10th day growth in paper mills wastewater effluent inoculated with blue green algae. The values of pH in effluent discharged indicate that it was well within the permissible limits (CPCB, 1995). The study also found that the pH increase was from 6.60 to 8.41 when the effluent was treated with alga, whereas there was no change in pH under control.

Alkalinity is a popular measurement used in the process control of diverse water treatment processes. Alkaline nature of effluent showed gradual reduction, the effluent was reduced to 51.13 percent by *Pithophora* sp, it was found to be high which is harmful to aquatic life (Nemerow, 1978). In the area of algal treatment, CO_2 is consumed by the algae, resulting in relatively lower concentrations of bicarbonate in the water samples. Inorganic carbon (IC) a major factor, since it is the only carbon source used by algae. Murugesan *et al*.,(2007) reported 28.00 present reduction of alkalinity when oil refinery effluent treated with *Spirulina platensis*. The total hardness of the thermal wastewater was higher due to the increased amounts of calcium and magnesium ions. When the calcium level exceeded the desirable limits encrustation in water supply and domestic use of water was adversely affected. The study showed that calcium and magnesium reduced to 32.75 percent and 37.50 percent the thermal effluent was treated with *Pithophora* sp (Senegar, 1990). The study on purified river water by algae showed found a reduction of 67.10 percent of Ca^{++} and 67.40 per cent of $K^{+.}$ Manoharan and Subramanian (1993) in their study on sewage cyanobacteria interaction found that 25 percent reduction of Ca^{++} by the Blue green algae, *Oscillatoria pseudogerminata* var. *Unigramulata.*

The treated thermal effluent consisted of increased amount of sodium and potassium when compared to untreated effluent. The sodium content was reduced to 51.16 percent when the effluent was treated with *Pithophora* sp. Similarly the level of potassium was reduced to 33.33 percent when treated with *Pithophora* sp. The treated effluent contained increased amounts of sodium and potassium and this was due to the additions of nutrients in the treatment process (Somashekar, 1984). High concentration of these metal ions in drinking water could causes harmful effects.

Table 1: Physico-chemical analysis of thermal effluent treated with *Pithophora* sp

S. No	Parameters (mg/L^{-1})	Initial	5th day	10th day	15th day	% of reduction
1	Appearance	Slightly Yellowish	Slightly Yellowish	Yellowish green	Slightly turbid	-
2	Odour	Offensive smell	Offensive smell	Offensive smell	-	-
3	Total Solids	30628	26271	21891	17546	-42.71
4	TDS	44892	26189	21789	17528	-42.77
5	Conductivity	44892	38267	31610	25015	-44.27
6	pH	6.6	7.1	7.8	8.41	+21.52
7	Alkalinity tot	176	146	114	86	-51.13
8	Calcium	1160	1034	904	780	-32.75
9	Magnesium	384	340	290	240	-37.50
10	Sodium	8600	7206	5700	4200	-51.16
11	Potassium	300	267	228	206	-33.33
12	Iron	0.31	0.27	0.23	0.20	-35.48
13	Nitrate	4	4.2	4.8	5.2	+23.07
14	Chloride	15840	13250	10600	5044	-49.21
15	Fluoride	0.58	0.50	0.41	0.32	-44.82
16	Sulphate	2064	1684	1295	826	-59.98
17	Phosphate	0.22	0.83	1.44	2.07	+89.37
18	Oil & Grease	0.0381	0.0264	0.0140	0.003	-92.12
19	BOD	34	24	13	4	-88.23
20	COD	98	70	40	12	-87.75

The iron content was reduced to 35.48 percent when the effluent was treated with *Pithophora* sp. Most algal forms occurred in polluted fields having a well defined sheath. Murugesan *et al*., (2007) reported 57.32 percent reduction of iron when oil refinery effluent treated with *Spirulina platensis*.

Nitrate may be produced during secondary wastewater treatment, when ammonia-N is biologically converted to the oxidized forms by nitrifying bacteria. Excess concentrations could also result in changes towards aquatic structures and may result in reduced oxygen when plant material dies or decomposes. In the percent study 23.07 percent of nitrate increased from thermal effluent by *Pithophora* sp. Although nitrate levels in wastewater discharged on surface waters were not likely to be of concern, but groundwater for irrigational purposes was effluent impacts.

Chloride and sulphate levels beyond the tolerance limit caused corrosion, potability of water and gastro intestinal irritation etc. Chloride and sulphate in the effluent was found to be reduced 49.21 percent and 44.82 percent respectively when the thermal effluent was treated with *Pithophora* sp by Vijaykumar *et al*., (2005) reported 40 percent reduction of chloride in dye effluent treated with *Oscillatoria* sp.

Fluoride also entered aquatic systems and as a result of this addition to domestic water supplies there were resulting effluent discharges. Fluoride content in the present study was reduced to 44.82 percent the effluent was treated with *Pithophora* sp. The presence of calcium and chloride reduce the toxicity of fluoride in fish CCREM, 1987) because of the limited effluent concentration data availability for fluoride, it was recommended that effluent surveys could expand its database, hence allowing for assessment of the significant potential substance.

Phosphate content in the effluent was found to increase to 89.37 percent. The removal of phosphate with all carbon sources was appreciably higher at lower NH_4+-N concentrations in the wastes, but it was quite low at higher concentrations[5] reported that 90 percent of phosphorus removal by activated algae was due to chemical precipitation, The total removal of all types of phosphates by *Pithophora* sp either alone or in combination with natural microbial population, was not able to remove phosphorus efficiently, compared to when natural population was alone.

High amounts of oil and grease obstruct the air effluent interaction to increase the DO level as well as oxygen supplement for oxidation process. The study showed that oil and grease was reduced to 92.12 percent when the effluent was treated with *Pithophora* sp, this was due to the presence of the surface-active agents in thermal wastewater. Murugesan *et al*.,(2007) reported 99.90 percent reduction of alkalinity when oil refinery effluent treated with *Spirulina platensis*.

The BOD and COD of thermal wastewater were found to be higher in untreated effluent. BOD and COD values are also considered as an index for the survival of living organisms in industrial effluent or waste high organic pollution indicates higher values of BOD and COD. Higher values of BOD and COD may be due to presence of organic and inorganic load in wastewater which was decamping and increasing temperature (Singh *et al.,* 1988) found higher values of BOD and COD due to high organic pollution, which reduces the flow of water. Due to the presence of excess of organic matter, the BOD level increased and caused eutrophication. The BOD value in the effluent was found to be reduced 88.23 percent when the effluent was treated with *Pithophora* sp. The COD level in thermal wastewater was greater than permissible limits (250 mg/L). The level of COD was reduced to 87.75 percent when the effluent was treated with *Pithophora* sp. The BOD and COD load was high and caused low DO level in the effluent, capable of affecting the quality of water receiving wetland. This observation was in conformity with (Amudha *et al*., 1999) and Kumar *et al*., 1974) different industrial effluent.

CONCLUSION

The results collected were discussed upon and it was concluded that *Pithophora* sp along with natural population of microbes played a major role in removal of several pollutants from the effluent, in

turn influences on the physiological activities of *Pithophora* sp was noted. Attempts were to be made to select suitable strains of green alga which would be minutely influenced by the adverse conditions of the effluents, but would help in removing the pollutants to a great extent.

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