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Bioremediation of Wastewater using A Photosynthetic Bacterial Isolate

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Abstract

Microbes especially bacteria have been found to play an important role in the remediation of wastewater and have garnered enormous attention in recent times. These bacteria have the ability to reduce the organic contents, removal of toxic chemicals and pathogenic microorganisms in the polluted water. The present research work involved the collection of wastewater samples from different locations of Hyderabad and analysed for physicochemical parameters. The waste water samples were inoculated with the photosynthetic bacterial isolate PB1 and then analyzed for parameters like pH, colour, nitrates, ammonia, chloride, fluoride, biological oxygen demand(BOD), chemical oxygen demand(COD), before and after using photosynthetic bacterial isolate for treatment. The results indicated that the bacterial isolate was efficient in decreasing chemicals levels as well as the BOD and COD levels. There was a great reduction in levels of nitrate using the bacterial isolate in both the water samples tested. Hence the bacterial isolate PB1 could be effectively used for treatment of wastewater effluents.

Keywords

Bioremediation, Photosynthetic bacteria, Physicochemical parameters, Biological oxygen demand (BOD), COD.

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INTRODUCTION:

Water contamination has emerged as an issue of greater concern in recent years. This contamination may be due to organic compounds, inorganic compounds and pathogenic microorganisms. [1] This wastewater when enter larger water bodies results in eutrophication, which disturbs the ecological balance and deteriorates the water quality thus making it unsuitable for drinking, irrigation or any other use. This Wastewater generally containing high levels of organic material, numerous pathogenic microorganisms, as well as toxic compounds must immediately be treated appropriately before final disposal. The main objective of wastewater treatment is the protection of environment, especially with respect to public health and socioeconomic concern. Many efficient processes are available to clean up the water bodies and minimize the water pollution. But the concern on the quantity and quality of waste generated and discharged into natural water bodies has necessitated the development and application of different strategies. An efficient wastewater treatment method suitable for degrading the contaminants of concern is of primary importance. In comparison to various physical and chemical methods, Biological methods have emerged as a favorable alternative for the removal of pollutants because of its simplicity, low processing costs, high efficiency and lack of secondary pollutions. Thus, most of the modern wastewater treatment systems rely on microbial processes to remove contaminants.

Bioremediation is one such strategy which uses naturally occurring microorganisms and other aspects of the natural environment to treat wastewater of its nutrients. [2] Bioremediation can prove less expensive than other technologies that are used for cleanup of hazardous waste [3]. Bioremediation is the most effective management tool to manage polluted water and to recover contaminated wastewater. It is the most preferable and successful cleaning technique for polluted environment, used all around the world.

Indigenous and extraneous naturally occurring organisms are used as prime agents in bioremediation process. Since numerous types of pollutants are to be encountered in contaminated water, diverse types of microorganisms are likely to be required for effective remediation. [4] Microbes adapt themselves and grow in water at suitable temperatures, desert conditions, high oxygen and anoxygenic conditions and also in the presence of hazardous chemicals or any waste system. This characteristic of microbes has paved a way to the bioremediation technique. The effectiveness of microbes for remediation of wastewater is affirmed by their ability of Reduction of organic content and decrease in BOD of wastewater, removal of toxic compounds as well as pathogenic microbes. Microbial degradation of wastewater involves the application of variety of microorganisms such as bacteria, molds, and yeasts, algae and protozoa which have demonstrated effective degradability. These organisms enhance degradation of pollutants as well as nutrient recycling like phosphorus and nitrogen. But in wastewaters bacteria have been the most studied microbes therefore are considered the most efficient organisms in degrading organic matters. There are usually large amount of heterotrophic microorganisms (bacteria) that can be employed in Bioremediation processes: *Pseudomonas fluorescens, Pseudomonas aeruginosa, Bacillus cereus, Bacillus subtilis, Enterobacter, Streptococcus faecalis, Escherichia coli* etc. [5] Many bacteria have been isolated and studied in relation to their level of occurrence as well as their biodegradable ability in both single and consortium form. The organisms that are utilized vary, depending on the chemical nature of the polluting agents, and are to be selected carefully as they only survive within a limited range of chemical contaminants. [6,7,8,9]

The extremely small size, large surface area volume ratio, easy handling, mass cultivation, resistance to environmental conditions and high degrading abilities of microbes gives them advantages over other organisms in wastewater remediation. Understanding the microbial processes that occur in these systems may provide the key to achieving these goals and meeting the current and future needs of the waste treatment industry. This has prompted a lot of research work to be carried out in pursue of finding best and adaptable biodegradable microbes for bioremediation purpose. The present study analyses the potential of the Photosynthetic bacterial isolate in the treatment of waste waters.

METHODOLOGY:

Collection of Samples:

The wastewater samples used in this study were collected from two different lakes from Uppal and HMT Nagar, Hyderabad.

Analytical Methods:

One part of the samples collected was analysed for physico chemical parameters in the laboratory using the standard techniques described by Aneja (2003) and APHA (1998). [10,11] Parameters measured/tested among include colour, pH, Temperature, total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorine, ammonia (NH3-N), nitrite (NO2-N), nitrate (NO3-N) and fluoride. The various chemical constituents of water samples like Chlorine, Chloride, Flouride, Nitrate, Nitrite, Ammonia were tested using the water analysis kits. The other part of the sample was used for bioremedial treatment. The samples were inoculated with the bacterial isolate and incubated for 7 days. The samples were again analysed for the parameters. The efficiency of the isolate in reducing the chemicals/ pollutants is then calculated and their efficiency determined to show the degradative ability of the bacterial isolate.

RESULTS:

The bacterial isolate PB1 was used in bioremediation studies and tested for its effect on various parameters in water samples obtained from different areas. The results are tabulated in table 1 and table 2.

Table 1: Remediation of wastewater sample I by the bacterial isolate PB1

Parameters	Control	After Incubation Of 10 Days	% Reduction
Temperature	31°C	29°C	---
PH	6.8	7	---
Colour	Pale yellow	Pale yellow	---
TDS	308 ppm	300 ppm	0.25%
Chlorine	0.0 mg/ml	0.0 mg/ml	---
Chloride	240 mg/ml	200 mg/ml	16.6%
Fluoride	1.5 mg/ml	1.5 mg/ml	0%
Nitrate	5 mg/ml	0.0 mg/ml	100%
Nitrite	0.5 mg/ml	0 mg/ml	100%
Ammonium	3 mg/ml	3 mg/ml	0%
DO	11.2 mg/ml	10.8 mg/ml	3.5%
BOD	6.0 mg/ml	4.8 mg/ml	20%
COD	98 mg/ml	80 mg/ml	12.2%

Table 2: Remediation of wastewater sample II by the bacterial isolate PBI

Parameters	Control	After Incubation Of 10 Days	% Reduction
Temperature	33°C	30°C	---
PH	7	7.2	---
Colour	Pale yellow	Pale yellow	---
TDS	550 ppm	500 ppm	9.09%
Chlorine	0.5 mg/ml	0.0 mg/ml	100%
Chloride	160 mg/ml	130 mg/ml	18.75%
Fluoride	1.5 mg/ml	1.5 mg/ml	---
Nitrate	3 mg/ml	0.0 mg/ml	100%
Nitrite	3 mg/ml	0.0 mg/ml	100%
Ammonium	5 mg/ml	3 mg/ml	40%
DO	24.4 mg/ml	24 mg/ml	1.6%
BOD	9.21 mg/ml	8 mg/ml	13.1%
COD	80 mg/ml	64 mg/ml	20%

DISCUSSIONS:

For wastewater sample 1, decrease in DO was 3.5% while the decrease in BOD and COD was 20 % and 12.2% respectively. Levels of chlorides, nitrates and nitrites also decreased by 16.6%, 100% and 100% respectively. There was no decrease in the fluoride levels.

For wastewater sample 2, decrease in DO was1.6% while decrease in BOD and COD was 13.1% and 20% respectively. Levels of Chlorine, Chloride, Nitrate, Nitrite and Ammonium also decreased by 100%, 18.75%, 100%, 100% and 40% respectively. There was no decrease in fluoride levels. Thus the results indicated that the bacterial isolate was efficient in decreasing the BOD and COD levels. The decrease in O2 content of water samples was only marginal but desirable. The chloride, nitrite and nitrate levels decreased significantly. There was a great reduction in levels of nitrate using the bacterial isolate in both the water samples tested.

CONCLUSION:

Thus, the bacterial isolate PB1 could be effectively used for treatment of wastewater effluents. The treated water could be used for various purposes such as irrigation, gardening, flushing, cooling of air conditioners, processing water for industries etc. Further research works will be taken up on identification of the bacterial isolate as well as optimization studies of the isolate so as to be effectively used in wastewater treatment.

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