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Bioremediation of Industrial Effluents using *Rhodoblastus acidophilus*

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Abstract:
The study was carried out to evaluate the effectiveness of the use of some phototrophic bacteria for improving the quality (bioremediation) of industrial effluents. A common species of *Rhodoblastus* (i.e., *Rhodoblastus acidophilus) was* used as bioremedial agent. Certain parameters for the assessment of quality of effluents were considered, including nitrates, sulphates, phosphate, ammonia and metal ions (Pb^{2+}, Hg^{2+}, etc.). Parameters were tested before, during and after the use of bioremedial agents. A comparison amongst three stages of testing has been of great help in assessing the bioremedial impact of *Rhodoblastus* species. The results of the study indicate that *Rhodoblastus acidophilus* is a potent species in an effective bioremediation of industrial waste water.

Keywords: Bioremediation, Bioreactor, *Rhodoblastus acidophilus.*

I. INTRODUCTION

Contamination of drinking water supplies from industrial waste is a result of various types of industrial processes and disposal practices. Industries that use large amounts of water for processing have the potential to pollute waterways through the discharge of their waste into streams and rivers, or by run-off and seepage of stored wastes into nearby water sources.

At Mathura (India), majority of the industries do not have a 'water treatment plant' due to lack of rigid administrative implementation and high cost involved. Consequently, the industrial effluents are being dropped directly, through more than a dozen wide drains, into the historic and religious river Yamuna, which adversely affects the aquatic life and the river ecosystem. The purpose of the present study was to remediate the quality of these effluents to some extent using biological agents.

Many workers have reported that several species of some photosynthetic bacteria such as *Rhodoblastus* sp. are helpful in improving the quality of water. The aim of this study was therefore, to assess the efficacy of some *Rhodoblastus* species in improving the quality of industrial effluents. *Rhodoblastus* is a Gram negative, facultative photoheterotrophic bacterium capable of growing phototrophically or chemotrophically as either a heterotroph or lithotroph in the presence or absence of O_2, depending on the energy source. In present investigation, a common species of *Rhodoblastus* i.e., *Rhodoblastus acidophilus* was used.

II. MATERIALS AND METHODS:

The effluent samples were collected from various outlets from the industrial area in the city in clean bottles. One part of the samples was analysed for physico chemical parameters in the laboratory using APHA guidelines. The parameters tested, include – nitrates, sulphates, phosphate, ammonia and metal ions (Pb^{2+} and Hg^{2+}).

The other part of the sample was used for bioremedial treatment. It was filtered and divided into four parts A, B, C and D. Part A was inoculated with *Rhodoblastus acidophilus* and kept in anaerobic and light conditions. Part B was also inoculated with *Rhodoblastus acidophilus* and kept in aerobic and light conditions. Part C was also inoculated with *Rhodoblastus acidophilus* and kept in anaerobic and dark conditions. Part D was also inoculated with *Rhodoblastus acidophilus* and kept in aerobic and dark conditions.

The strains of the *Rhodoblastus acidophilus* were obtained from ATCC (Global Bioresource centre), pure cultures (inocculum) were developed to increase the number of bacteria using Sistrom's minimal medium. Stirred tank Bioreactor (Batch type) was used for the bioremediation programme.

The bioreactor has a two litre capacity glass column (tank). The glass tank bioreactor was selected to provide necessary lightening conditions for the growth and action of bacteria. A tungsten lamp was placed 40 cm away from the glass column ($200W/m^2$ intensity). 500 ml of sterilized sample plus 500 ml Sistrom's minimal medium was taken into the reactor and 10 ml of inocculent was added to it. For optimal mixing the agitator system was set at 10 rpm. The bacteria were able to grow in the changed medium as log phase achieved well in time in both cases. Two readings were taken - a. After 12 hours of mixing, b. After 48 hours of mixing.

OBSERVATION AND DISCUSSION

The observations which were recorded have been summarized in following tables.

Table.1. Changes in Physico-chemical parameters by *R. Acidophilus* in light conditions.

Parameters	unit	PART A of the sample (Anaerobic light conditions			PART B of the sample (Aerobic light conditions)		
		Before Mixing	After 12 hours of mixing	48 hours of mixing	Before Mixing	After 12 hours of mixing	48 hours of mixing
pH		8.8	8.6	7.5	8.8	8.6	8.2
Sulphates	mg/l	4.26	3.06	3.22	4.26	2.62	5.19
Sulphide	mg/l	8.37	5.12	3.54	8.37	7.20	4.21
Nitrates	mg/l	2.46	1.78	3.47	2.46	2.07	2.15
Ammonia	mg/l	10.41	09.32	3.38	10.41	8.42	4.08
Pb^{2+}	mg/l	1.02	0.87	0.49	1.02	1.01	0.95
Hg^{2+}	mg/l	0.16	0.12	0.09	0.16	0.11	0.06

Table. 2. Changes in Physico-chemical parameters by *R. Acidophilus* in dark conditions

Parameters	unit	PART C of the sample (Anaerobic Dark conditions			PART D of the sample (Aerobic Dark conditions)		
		Before Mixing	After 12 hours of mixing	48 hours of mixing	Before Mixing	After 12 hours of mixing	48 hours of mixing
pH		8.8	8.5	8.4	8.8	8.2	8.0
Sulphates	mg/l	4.26	1.18	1.11	4.26	3.17	2.72
Sulphide	mg/l	8.37	8.28	8.09	8.37	7.42	5.72
Nitrates	mg/l	2.46	1.67	1.58	2.46	1.87	2.27
Ammonia	mg/l	10.41	11.28	10.08	10.41	9.41	4.27
Pb^{2+}	mg/l	1.02	0.97	0.91	1.02	0.86	0.63
Hg^{2+}	mg/l	0.16	0.15	0.14	0.16	0.11	0.07

pH is an important valuable indicator which shows the acidic or alkaline nature of water. The pH of effluent sample was alkaline. This was mainly because of a high concentration of ammonia in the sample water. A reduction in the pH was noted during and after the treatment in all the cases. This was perfectly correlated with the values of ammonia. Due to increasing concentration of oxygen, ammonia was oxidized to nitrates. So, nitrates exhibited a trend opposite to that of ammonia. Hence, a higher value of nitrate contents was observed. In aerobic light conditions, no external air was given to the sample but significant reductions in ammonia values were noted. In these cases, the oxidizing conditions were developed by microbial photosynthetic oxygen (Bergey's manual, 1994). This clearly shows that *Rhodoblastus species* are good oxidizing biological agents which in the presence of light, even under anaerobic conditions, can have a strong oxidizing impact. (Niel R Batsion et al, 1991). The conclusion further gains strength from the fact that in case of part C (where the condition was dark and anaerobic), instead of reduction, a slight increase in the ammonia value was noted after 12 hours of mixing. Also, there was no significant change in the pH value. Similar to nitrates, the sulphates exhibited an increase in the anaerobic light conditions and aerobic dark conditions. On the other hand, during both these conditions, a reduction in the value of sulphides was noted. This also proves that under anaerobic light condition, the oxidation of sulphides to sulphates was because of the photosynthetic oxygen, produced by the *Rhodoblastus acidophilus.* Higher values of nitrates and sulphates show the degree of oxidation by the Rhodoblastus species. (Bergey's manual, 1994). The impact of *Rhodoblastus acidophilus* on metal ions like mercury and lead was also assessed. It was found that *R. acidophilus* has some definite impact on reducing the concentration of these metal ions. A slight but significant reduction in the amount of Hg^{2+} and Pb^{2+} ions were noted in each experiment. The best reduction was noted in anaerobic light conditions. (Adebowale Adenij, 2004).

III. CONCLUSION

From the above discussion and analysis it could be concluded that *Rhodoblastus acidophilus* is a metabolically diverse species, being capable of growing in a wide variety of growth conditions. It can be used commercially on a large scale to treat both industrial and municipal waste water. The best growth conditions for the species were found to be anaerobic light conditions, where its oxidizing impact becomes intense. Bioremediation, using *R. acidophilus* can be a cost effective and environmental friendly way to treat the contaminated water bodies.

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