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Bioremediation of sewage waste waters by the phototrophic bacterial consortium isolated from paddy fields

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Abstract: In continuation of our earlier studies, the present study showed that the remediation of sewage water in panagal by the bacterial consortium showed a decrease in dissolved oxygen, COD and BOD to the extent of 32 %, 23% and 34% respectively. The consumption of organic matter (74%) was relatively high. Levels of chlorides (35%), bicarbonates (20%) and sulphates (4%) also decreased. The final pH recorded was near neutral. The sewage water turned to yellowish-brown which may be attributed to yellow and red carotenoids of Photosynthetic bacteria. Treatment of sewage water prakasham bazar by bacteria revealed a decrease in dissolved oxygen, COD and BOD to the extent of 8%, 50% and 32% respectively. Bicarbonates, chlorides, sulphates 40%, 25%, 20% and organic matter (23%) also decreased significantly due to the activity of bacterial consortium.
Key words: remediation, sewage water, photosynthetic bacteria.

Introduction

Industrial discharge pollutes water bodies imparting a high BOD which could be due to the presence of organic substrates [1]. Compared to chemical methods biological treatment is attractive as it is economical and ecofriendly. Many new approaches are being investigated for understanding the metabolic pathways and enzymes involved in biodegradation processes. Bioremediation has been reported in some bacteria where toxic compounds are converted to less toxic compounds [2,3]. Phototrophic bacteria are present in anaerobic environments and in these groups purple non sulphur bacteria are more versatile as they can degrade more number of organic compounds. Purple non sulphur phototrophic bacteria consume high levels of phosphorus and nitrogenous compounds and have been reported to be efficient in bioremediation [4-9]. Different photosynthetic bacteria like *Rhodobacter sphaeroides*, *Rb.capsulatus*, *Rubrivivax gelatinosus* and *Rhodopseudomonas palustris* have been used for water purification and removal of toxic elements in water. Apart from this they are also known to produce useful bioproducts [10-24].

Paired sample t-test is a statistical technique which is used to compare two population means when the two samples are correlated. Paired sample t-test is used for before and after studies, matched pairs samples and case-control studies. For paired t test an hypothesis is made first and after making the hypothesis, a level of significance is chosen. the parameter calculation can be done with this equation

$$t = \frac{\bar{d}}{\sqrt{s^2/n}}$$

Where n is the size of the sample, d bar is the mean difference between two samples, s^2 is the sample variance and t is a paired sample t-test with n-1 degrees of freedom. An another way for paired sample t-test is:

$$t = \frac{\Sigma d}{\sqrt{\frac{n\left(\Sigma d^2\right) - \left(\Sigma d\right)^2}{n-1}}}$$

After calculation comparison of the calculated values with the table values is taken. If the calculated value is greater than the table value, then we will reject the null hypothesis for the paired sample t-test. In this test following assumptions such as only the matched pairs can be used to perform the test. Secondly, normal distributions are assumed and cases must be independent of each other. Bioremediation potentials of the anoxygenic phototrophic bacteria was studied and discussed in the light of the existing literature.

Material and Methods

Identification keys provided in Bergey's manual of systematic bacteriology (1994) [25] was adopted for the enriched culture of phototrophic bacteria grown in BP medium. The treatment procedure was the same that was used by our group earlier [7]. Methods for the estimation of various parameters were adopted from APHA (1995) [26].

Results and Discussion

Treatment of waste water by phototrophic bacteria has been reported by Nagadomi *et al*. (1999) [27]. *R.molischianum* [28], Kobayashi *et al*. (1995) [29], David and Ensign (2005) [30], Livia *et al*. (2006) [31] and Vijay *et al*. (2006) [32]. Treatment of sewage water by *consortium* revealed its ability to depollute sewage water (Table 1). In continuation of our earlier studies, the present study showed that the remediation of sewage water in panagal by the bacterial consortium showed a decrease in dissolved oxygen, COD and BOD to the extent of 32 %, 23% and 34% respectively. The consumption of organic matter (74%) was relatively high. Levels of chlorides (35%), bicarbonates (20%) and sulphates (4%) also decreased. The final pH recorded was near neutral. The sewage water turned to yellowish-brown which may be attributed to yellow and red carotenoids of Photosynthetic bacteria. Treatment of sewage water praksham bazar by bacteria revealed a decrease in dissolved oxygen, COD and BOD to the extent of 8%, 50% and 32% respectively. Bicarbonates, chlorides, sulphates 40%, 25%, 20% and organic matter (23%) also decreased significantly due to the activity of bacterial consortium. These results are similar to that of Nepple *et al*. (2000) [33] who have also reported the bioremediation potentials of this group of bacteria. The paired t-test was applied on both the samples drawn from Prakasham Bazar and Panagal, the test concludes that the there is a significant difference in the sample values before and after the bioremediation treatment. This group of organisms can be effectively used for remediation and also simultaneously produce hydrogen.

Table 1: Remediation of sewage water (Panagal) by Photosynthetic consortium

Parameters	**Before Incubation**			**After Incubation of 10 days**		
	Sample undiluted	**Sample + Medium + distilled water**	**Sample + Medium + Inoculum**	**Sample + Medium + distilled water**	**Sample + Medium + Inoculum**	**% of Reduction**
Colour	Light green	Light green	Reddish yellow	Green	Yellowish brown	--
pH	6.8	6.8	6.8	7.0	7.2	--
Temperature (^oC)	34	34	36	34	35	--

DO (in mg/litre)	4.14	3.82	3.96	3.32	2.8	32
BOD (in mg/lit)	220	240	256	140	80	34
CO_2 (mg/lit)	--	--	--	--	--	--
Carbonates (mg/lit)	--	--	--	--	--	--
Bicarbonates (mg/lit)	262	254	248	186	210	20
Chlorides (mg/lit)	146	136	158	112	96	35
Organic matter (%)	0.15	0.10	0.13	0.09	0.04	74
Sulphates (mg/lit)	330	342	360	335	320	4
COD (mg/lit)	3.1	4.8	5.8	4.2	2.4	23

Table 2: Remediation of sewage water (Prakasam bazar) by Photosynthetic consortium

Parameters	**Before Incubation**			**After Incubation of 10 days**		
	Sample undiluted	**Sample + Medium + distilled water**	**Sample + Medium + Inoculum**	**Sample + Medium + distilled water**	**Sample + Medium + Inoculum**	**% of Reduction**
Colour	Light green	Light green	Reddish yellow	Light green	Reddish yellow	--
pH	6.4	6.5	6.6	7.0	7.4	--
Temperature (^oC)	36	38	38	35	36	--
DO (in mg/litre)	4.0	3.6	3.4	3.9	3.7	8
BOD (in mg/lit)	290	258	296	210	200	32
CO_2 (mg/lit)	--	--	--	--	--	--
Carbonates (mg/lit)	--	--	--	--	--	--
Bicarbonates (mg/lit)	160	184	160	124	96	40
Chlorides (mg/lit)	280	295	320	270	210	25
Organic matter (%)	0.18	0.19	0.22	0.18	0.14	23
Sulphates (mg/lit)	400	420	440	360	320	20
COD (mg/lit)	12	18	24	12	6	50

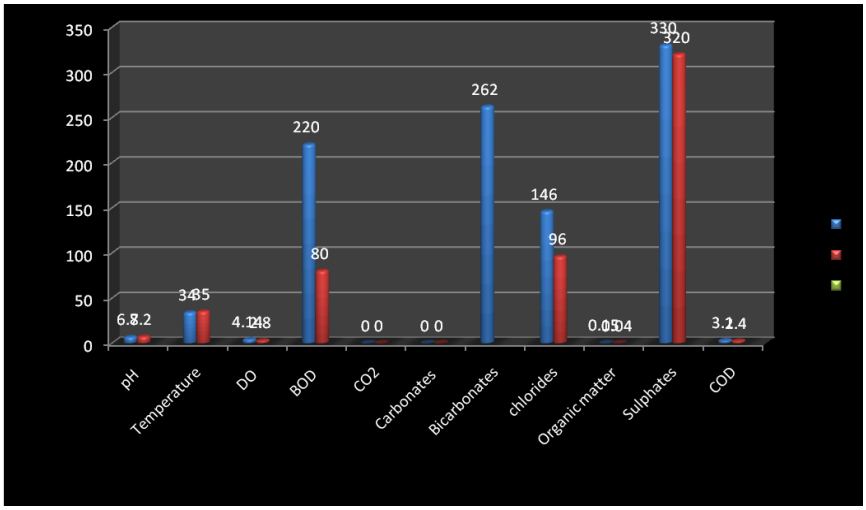

Figure 1: Remediation of sewage water (Panagal) by Photosynthetic consortium

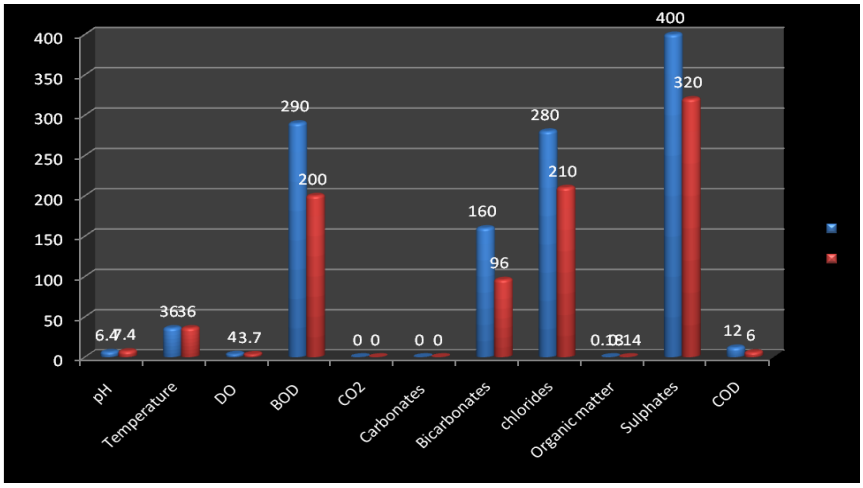

Figure 2: Remediation of sewage water (Panagal) by Photosynthetic consortium

Dissolved oxygen (DO)

	Before	**After**
Panagal	4.14	2.8
Prakasham Bazar	4	3.7

t-Test: Paired Two Sample for Means

	Before	**After**
Mean	4.07	3.25
Variance	0.0098	0.405
Observations	2	2
Pearson Correlation	-1	
Hypothesized Mean Difference	0	
df	1	
t Stat	1.576923	
P(T<=t) one-tail	0.179893	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.359785	
t Critical two-tail	12.7062	

Biological oxygen demand (BOD)

	Before	**After**
Panagal	220	80
Prakasham Bazar	290	200

t-Test: Paired Two Sample for Means

	Before	**After**
Mean	255	140
Variance	2450	7200
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	4.6	
P(T<=t) one-tail	0.068138	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.136275	
t Critical two-tail	12.7062	

Bi Carbonates

	Before	**After**
Panagal	262	210
Prakasham Bazar	160	96

t-Test: Paired Two Sample for Means

	Before	**After**
Mean	211	153
Variance	5202	6498
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	9.666667	
P(T<=t) one-tail	0.032812	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.065624	
t Critical two-tail	12.7062	

Chlorides

	Before	**After**
Panagal	146	96
Prakasham Bazar	280	210

t-Test: Paired Two Sample for Means

	Before	**After**
Mean	213	153
Variance	8978	6498
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	6	
P(T<=t) one-tail	0.052568	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.105137	
t Critical two-tail	12.7062	

Organic Matter

	Before	**After**
Panagal	0.15	0.04
Prakasham Bazar	0.18	0.14

t-Test: Paired Two Sample for Means

	Before	***After***
Mean	0.165	0.09
Variance	0.00045	0.005
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	2.142857	
P(T<=t) one-tail	0.138983	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.277965	
t Critical two-tail	12.7062	

Sulphates

	Before	**After**
Panagal	330	320
Prakasham Bazar	400	320

t-Test: Paired Two Sample for Means

	Before	***After***
Mean	365	320
Variance	2450	0
Observations	2	2
Pearson Correlation	#DIV/0!	
Hypothesized Mean Difference	0	
df	1	
t Stat	1.285714	
P(T<=t) one-tail	0.210417	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.420833	
t Critical two-tail	12.7062	

Chemical oxygen demand (COD)

	Before	**After**
Panagal	3.1	2.4
Prakasham Bazar	12	6

t-Test: Paired Two Sample for Means

	Before	***After***
Mean	7.55	4.2
Variance	39.605	6.48
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	1.264151	
P(T<=t) one-tail	0.213031	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.426062	
t Critical two-tail	12.7062	

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