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ORIGINAL ARTICLE

Phycoremediation of Waste Water of Gandhi Sagar Pond, Bhilwara

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ABSTRACT
Bioremediation is a technique which is used to treat waste water with the help of living microorganisms. They degrade the pollutants from waste water by metabolic process. Microalgae play an important role in bioremediation of waste water through its photosynthetic ability, their high oxygenating potential. The waste water used in this study was collected from Gandhi sagar pond, Bhilwara. The culture of different algae Chlorella sp., Arthrospira sp., Spirulina sp., Spirogyra sp., were used for bioremediation process. Results showed that these algae were very effective in reduction of BOD, COD, hardness and TDS in waste water. Further, it had been observed that among all test microalagae, Spirulina sp. showed best phycoremediation potential. The water parameters obtained after phycoremediation gets improved upto permissible limits to be used in agriculture fields for irrigation. Inferring from the study it could be said that the use of algae for treatment of waste water can help in reducing pollution load on environment and on the other side it recycle the waste water for the agriculture and other use.
Keywords: *Phycoremediation, Waste water, Microalgae*

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INTRODUCTION

Water is one in every foremost necessary natural resource on our planet. Water is an important biotic factor for all kind of ecosystem and it additionally forms the surroundings for enormous variety of organisms. We cannot imagine earth with hot water. Every year march 22 is well known as world water day. The day is well known to concentrate on the importance of water and wish to preserve it as water could be a life giver even a life creator. With two third of earth surface lined by water and human body consisting of 75% of water. But in today's time eutrophication and pollution in water is one amongst the foremost widespread environmental issues of water. This widespread downside of pollution is jeopardizing our health. Toxic substances from farm, town, factories dissolve into and blend with it, inflicting pollution. The pollution of municipal, agricultural and industrial waste matter with a massive kind of organic and inorganic contaminants like microplastics, some metals, high concentrations of nitrates, phosphates and carbon compounds puts a strain on water convenience and then the premise of human life [1].

The term water quality is expounded to water pollution. Study on water quality have become increasingly vital in our country. Physico-chemical parameters are important for deciding the standard of water and that they play a very important role in determinative distribution of aquatic organisms. Our present analysis "Studies of physico-chemical parameters and bioremediation of waste water of Gandhi Sagar Pond, Bhilwara" primarily centered to treat waste water of Gandhi Sagar pond, Bhilwara. Bhilwara is located at 23^0 35' north latitude and $73^0$63' east great circle. It falls between Ajmer (in north) and

Chittorgarh & Udaipur (in south). Gandhi sagar pond, Bhilwara is placed inside the heart of main town and breeding place and preferred surroundings for several species.

Bioremediation of waste water

It's a technology that uses some biological system to degrade harmful chemical into less harmful kind. Bioremediation is eco-friendly technique and extremely cost-efficient. With the increasing environmental issues round the world, Protoctista has been found to be effective organisms for bioremediation. Microalgae are most beneficial than different organisms for bioremediation purpose due to their oxygenating potential, capability to repair greenhouse gas, victimization daylight, straight forward growth demand and its immense variety [3, 4].

Algae used in bioremediation

Algae used in bioremediation belongs to class commonly from Cyanophyceae and Chlorophyceae. All the samples have been collected from different water bodies and identified on the basis of their external morphology and their colour. Algae was cultured on growth media name Chu medium having some highly nutritive salts useful for the growth of algae. Medium can be prepared as either liquid as well as agar medium.

Table 1 : Different algae species with their Classes

Algae Species	Class
Spirogyra	Chlorophyceae
Chlorella	Chlorophyceae
Spirulina	Cyanophyceae
Arthrospira	Cyanophyceae

MATERIAL AND METHODS

Sampling: Samples of waste water has been collected from Gandhi Sagar pond, Bhilwara (Rajasthan) and then sufficient amount of samples have been stored at a cool place to prevent any further changes.

Fig 1: Gandhi Sagar Pond, Bhilwara

Analysis of physico-chemical parameters of water has been done before microalgal treatment (bioremediation) so that we can study comparative changes in parameters after bioremediation.

Physico chemical parameters analysis [5-7]: Selected physico-chemical parameters (pH, alkalinity, hardness, BOD, COD, TDS) has been analyzed to know the water quality. Different techniques/methods were used to calculate the parameters of water, they are as follows:

A. **pH:** pH was measured with Mettler Toledo pH meter.
B. **Alkalinity** was calculated by the titration method using phenolphthalein indicator and methyl orange indicator to the HCl solution. Based on the stochiometry of the reaction and HCl consumption till end point , the concentration of alkalinity is calculated.
C. **Hardness-** Hardness is a sum of total concentration of metal ions present in water. Hardness of water sample was measured by EDTA Titrimetric Method. In this method the titrant was EDTA and the indicator was EBT (Eriochrome Black T). Hardness is calculated in the equation of presence of Calcium and magnesium both . The amount of hardness is expressed in mg/L.
D. **Total Dissolved Solids (TDS) –** TDS is the number of suspended solids present in water. TDS test is used as an indicator test to determine the general quality of water. It can be measured by weighing method in which an evaporating dish is weighed. Put the water sample through filter paper to collect

the particulate matter. Transferring this filtrate to the same evaporating dish and letting it dry then weigh it. The difference in weight will be TDS of water.

E. **Biological Oxygen Demand (BOD) -** The BOD test measures the amount of oxygen used by bacteria to consume organic matter. The measure involves pouring of water sample in 4 BOD bottles in which 2 bottles also have diluted water. Initial DO is calculated immediately while final DO after 5 days by titration. Difference between the readings is the result, i.e. BOD.

F. **Chemical Oxygen Demand (COD) -** COD is laboratory assay which measure the amount of organic matter with the help of chemical oxidizing agents such as potassium dichromate.. Measure of COD involves both water sample and distilled water. Add potassium dichromate in both flasks having water. Keep these flasks in hot water bath, after cooling add potassium iodide and sulphuric acid. Titrate it with sodium thiosulphate.

RESULT AND DISCUSSION

All physico-chemical parameters were quantified for 30 days at 10 days interval respectively. Samples were kept at room temperature and in sufficient sunlight for proper growth of algae. The initial pH of wastewater was observed at 7.59 but after treatment by algae the **pH** value increased comparing with control in the above interval of period for 30 days show in the table number 2.

Table 2 : Analysis of pH of waste water after bioremediation by different microalgae

Organism	Control	10th day	20th day	30th day
Spirulina	7.59	7.7	7.9	8.2
Chlorella	7.59	7.6	7.9	8.1
Arthrospira	7.59	7.8	8.1	8.3
Spirogyra	7.59	7.5	7.5	7.7

Within the same experiment removal of **hardness** from waste water was also determined. Removal of hardness from waste water was 63 mg/l and 77 mg/l once treated with Spirulina sp. and Chlorella sp. respectively for 10 days interval upto 30 days. Arthrospira sp. conjointly show economical reduction in hardness to 69 mg/l. Khemka and Saraf, [8] observed that enhanced algal growth is responsible to decrease the hardness level.

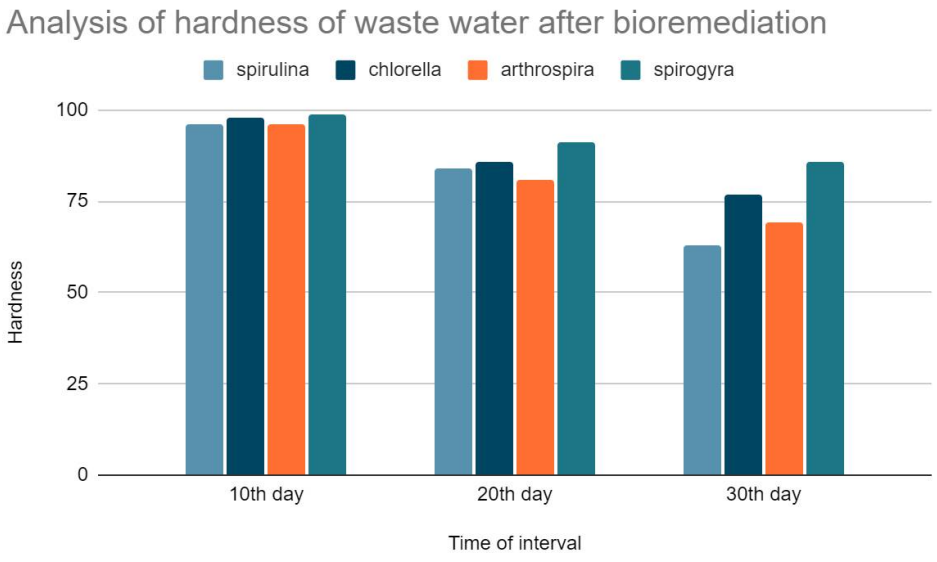

Figure 1: analysis of Hardness of waste water after bioremediation by different microalgae

After the treatment of effluents with all micoalgae, BOD level of waste water was considerably reduced however maximum reduction of BOD level was determined in Spirulina sp. As shown in table 3. Kumar *et al.*, [10] suggested in their study that maximum COD and BOD reduction in effluents after treatment with Spirogyra was 16% and 48%.

Table 3: Analysis of BOD of waste water after bioremediation by different microalgae

Microalgae	Control	10th day	20th day	30th day
Spirulina	34 mg/l	28 mg/l	21 mg/l	**13** mg/l
Chlorella	34 mg/l	29 mg/l	22 mg/l	15 mg/l
Arthrospira	34 mg/l	28 mg/l	23 mg/l	15 mg/l
Spirogyra	34 mg/l	31 mg/l	25 mg/l	18 mg/l

BOD & COD level of waste water was 34 mg/l and 53 mg/l respectively. However once treating waste products with protoctist, BOD level decreases upto 13 mg/l and 15 mg/l by Spirulina sp. and Chlorella sp. respectively within the same above sample. Changes in BOD level of waste water once treatment with protoctist has been checked in interval of 10 days upto 30 days. Different values of BOD (18 mg/l) and COD (27 mg/l) level was determined by test algae employed in bioremediation.

Table 4 : Analysis of COD of waste water after bioremediation by different microalgae

Microalgae	Control	10th day	20th day	30th day
Spirulina	53mg/l	42 mg/l	30 mg/l	18 mg/l
Chlorella	53mg/l	46 mg/l	33 mg/l	22 mg/l
Arthrospira	53mg/l	48 mg/l	33 mg/l	24 mg/l
Spirogyra	53mg/l	49 mg/l	36 mg/l	27 mg/l

As shown in table 4**COD** level conjointly reduced to 18 mg/l and 22 mg/l by Spirulina sp. Chlorella sp. whereas control was 53 mg/l showing efficient reduction after bioremediation method. Aziz and Nag [2] studied the feasibility of using an activated algae process to treat waste water and found that microalgae was able to remove 80-88% of BOD, 70-82% of COD with the retention period of 15 days using Chlorella vulgaris. Similarly, Ahmad et al., [1] during phycoremediation of Chlorella, Spirogyra etc reported upto 98% reduction in COD in sewage water. High level of suspended solids (**TDS-** Total Dissolved Solids) present in waste water are often effectively removed solely by protoctist, determined by Dolatabadi and Hosseini [4]. In the present study Spirogyra sp. removed 160 PPM of TDS in waste water throughout 20 days whereas control was 268 PPM. Maximum capability of removal was 84 PPM on 30th day of experiment. Such a high proportion of removal of TDS was found 156 PPM and 143 PPM by Chlorella sp, and Spirulina sp. during 20 days.

Table 5: Analysis of TDS of waste water after bioremediation by different microalgae

Organism	Control	10th day	20th day	30th day
Spirulina	268 PPM	201 PPM	143 PPM	79PPM
Chlorella	268 PPM	213 PPM	156 PPM	81PPM
Arthrospira	268 PPM	214 PPM	155 PPM	82PPM
Spirogyra	268 PPM	220 PPM	160 PPM	84PPM

Results show that these algae Chlorella sp., Spirulina sp., Arthrospira and Spirogyra sp. are effective in reduction of BOD, COD, hardness and TDS in wastewater. This study suggests that growing and in polluted waste water offers a new alternative of using algae for bioremediation of wastewater and after that biomass itself can be utilized for agriculture purpose.

CONCLUSION

Bioremediation is decomposition of organic wastes and breakdown dangerous substances into non toxic substances by microbial activity which are being used to reduce some physico-chemical parameters.

Results suggest that among all the algae was used *Spirulina* sp. is found to be most efficient in removal of pollutants of waste water followed by Chlorella sp., Arthrospira sp., Spirogyra sp. Consortium of Chlorella sp. and Spirulina sp. species used concluded that these algae show removal of pollutants upto 73%.
Unicellular green algae such as Spirulina sp. and Chlorella sp. have been widely used in waste water treatment as they have fast growth rates and high nutrient removal capabilities.
Thus it is concluded that in future algae may play an important role in treatment processing. Method provide an economical way to control water quality effectively as use of algae for bioremediation is safe and effective method.

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