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Study of Phyco-remediation Technique for Removal of Total Dissolved Solids

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Abstract:The main objective of this study is to assess the suitability of using micro algae for removal of TDS from synthetic water containing high TDS values. An experimental unit consists of set of synthetic water with different concentration of TDS (500 - 35,000 mg/l) under laboratory conditions were kept for conduction. The micro-algae were sampled, isolated and cultivated in the laboratory using respective media to encourage its growth under saline water. Especially various species of algae were utilized for phyco-remediation of saline water. The set had several concentration of saline water from 500 up to 35000 ppm. The experimental work concludes that the removal efficiency for TDS varied between 75 – 80 %. The results depicted high removal efficiency for TDS which may be used as a new conceptual technique using micro-algae under the natural circumstances.

***Index Terms - Chlorella,* Phyco-remediation, de-salination, *Scenedesmus*, TDS**

I. INTRODUCTION

Increase in urban population and rapid industrialization is placing an enormous pressure on water quality and demand. There are numerous other factors such as poor infrastructure, inefficient urban and municipal regulation, lack of financial services together set to bring deterioration in water quality [Kumar V *et. al*, 2016].

In recent years, increases in fresh water contamination gave lead to a progressive deterioration of a qualitative water bodies. This resultant situation challenges global society for mitigation measures by applying bioremediation method to reverse the threat.

Presently there are application of few conventional methods such as electro-dialysis, reverse osmosis and ion exchange. However it has been observed that all the said methods are costly and expensive, therefore it is better to adopt the biological techniques which is helpful to remove both dissolve organics and inorganics in an eco-friendly manner. Hence the application of phyco-remediation will work as a promising option to overcome this problem.

Several researches have been carried their research work using microorganisms to remove solids and nutrients from waste water. In addition, researches initiated for the application of various algae species under phyco-remediation to treat waste water and effluent from industries with successful results [El Serganyet. *al*, 2014].

Algae constitute a board category of organisms including photoautotrophic microalgae and prokaryotic cyanobacteria. Algae are prominently found in fresh and marine aquatic environment, with a wide range of diversity and habitat. [Kumar V *et. al*, 2016]. Additionally algae also have high tolerance limit for absorbing minerals and nutrients from effluent in adverse conditions.

The present research study was made to assess the removal efficiencies of total dissolve solids from synthetic water by the means of the green algae,*Chlorella* and *Scenedesmus* sp. for the phyco-remediation.

Chlorella: This species are small, spherical, green unicells. They are generally found in fresh water of ponds and ditches. The common example of free living species is *Chlorella vulgaris* and *C. variegate*. Chlorella is known for it's extremely simplicity. The plant is unicell which at the most way grow to 10 micron in diameter. The small cells are non-motile, round or oval, usually found solitary, sometimes in groups. (Figure 3)

Scenedesmus: *Scenedesmus*is a common fresh water alga commonly found in standing water of lakes and ponds. The genus is represented by about 100 species. The thallus of *Scenedesmus*is a coenobium consisting 4, 8 & 16 cells. The coenobium is a flat sometimes curved plate of fusiform to elliptic cells which are arranged in a single to double series with their long axes parallel to one another. Cells ovoid, arranged side by side in one or two alternating rows; spines short, mostly arising from the poles of the cells only.(Figure 4)

II. RESEARCH METHODOLOGY

2.1Sampling, identification and incubation of algae

The samples were collected from Sakkardara and Gandhisagarlake located in the heart of Nagpur city, Maharashtra. Both the lakes are surrounded by thick population hence due human activity both the lake are dying slow death in form of eutrofication. The sampling site was selected on the basis of availability of algal sample, 1000 ml of sample was collected from each lake in previously sterile plastic bottle. The bottle was well labeled and brought immediately to the laboratory.

The sample was allowed to settled and the settled material was used for identification of algal species. The taxonomic keys given in G. W. Prescott (1954)& Prasad and Mishra (1992) wasused to identify the available algal species. The micro-algae speciesidentified under microscope namely were *Chlorella*and *Scenedesmus*. The identified algae were then isolated with the help of serial dilution technique and isolated algae furtherincubated in separate conical flask using Chlorella and BGA 11 media respectively for 25 day on tissue culture rack for pure culture formation.

3.2 Preparation of synthetic water and media

The synthetic water with different concentration of TDS (500, 5000, 15000, 25000 & 35000 mg/l) were prepared by adding NaCl in distilled water. The TDS of synthetic water were calculated with the help of gravimetric method (APHA, 2010). Bold and Basal nutrient media was prepared for additive nutrient requirement of algae during experimental work.

3.3 Experimental framework

A set of 100 ml of synthetic water having different concentration of TDS (500, 5000, 15000, 25000 & 35000 mg/l) were prepared for bio-absorption. Bold and Basal nutrient media were added in the synthetic water. A uniform suspension of 1 ml of pure culture of *Chlorella* and *Scenedesmus*algae were inoculated in each flask. One control containing 100 ml distilled water with 1 ml pure culture was also kept for study. The flasks were hand shaken twice a day for exchange of gases and to avoid sticking of algae on wall. The setup was kept on tissue culture rack for conduction. White fluorescent artificial light of 40 watt was provided for LD 10 hours per day. The experiments set-up was kept for 20 days.

The initial pH and TDS were determined of each flask before adding algae and the same parameters were analyzed periodically after every 5 day interval. pH were measured with pH meter after standardization of the instrument and TDS were measured with gravimetric method (oven dry method). The experiments were operated at room temperature.

IV. RESULTS AND DISCUSSION

4.1 Removal efficiency

The initial TDS value of synthetic water wereobserved 500, 5000, 15000, 25000 & 35000 mg/l before phyco-remediation. The decrease in TDS value after bio-absorption using *Chlorella sp.* was90, 990, 2830, 4880 and 7490 mg/L respectively. The rate of removal for TDS was 82%, 80.2%, 81.13, 80.48 and 78.6% after 5th, 10th, 15th and 20th day respectively with *Chlorella*. The results were present in Table 4.1 and the rate of removal is shown in (Fig. 1).

In *Scenedesmus* sp. the removal of TDS values were observed 100, 1080, 3220, 5510 and 7390 mg/L after 5th, 10th, 15th and 20th day respectively after phyco-remediation. The results were depicted in Table 4.2. The TDS removal efficiency of *Schendesmus*were 80%, 78.4%, 78.53%, 77.96% and 78.88% (Fig. 2). The considerable and progressive removals of the TDS of synthetic water are likely due to the uptake of salts by *Chlorella* and *Scenedesmus*sp.

After the study under taken it has been observed that suitable strains of green algae which is less effected by the adverse conditions of the saline water, but is helping in removing the dissolved salts to a higher extent.

Table 4.1: Table 1: Removal of TDS by*Chlorella*

Initial	**During Treatment**							
	5th day		**10th day**		**15th day**		**20th day**	
TDS (mg/L)	***TDS***	***%***	***TDS***	***%***	***TDS***	***%***	***TDS***	***%***
500	370	26	230	54	170	66	90	82
5000	3780	24.4	2320	53.6	1820	63.6	990	80.2
15000	11250	25	7150	52.33	5480	63.46	2830	81.13
25000	18500	26	12240	51.04	9660	61.36	4880	80.48
35000	26600	24	16680	52.34	13840	60.45	7490	78.6

Table 4.2: Removal of TDS by*Scenedesmus*

Initial	**During Treatment**							
	5th day		**10th day**		**15th day**		**20th day**	
TDS (mg/L)	**TDS**	**%**	**TDS**	**%**	**TDS**	**%**	**TDS**	**%**
500	370	26	290	42	200	60	100	80
5000	3600	28	3000	40	1910	61.8	1080	78.4
15000	11250	25	8900	40.66	5940	60.4	3220	78.53
25000	18500	26	15200	39.2	10100	59.6	5510	77.96
35000	26600	24	21720	37.94	14550	58.42	7390	78.88

4.2 Conclusion

The present study was on the performance efficiency of phyco-remediationfor desalination ofsynthetic water containing high TDS by two micro algae. The phyco-remediation process showed regular and progressive performance in synthetic water with 20 day retention time to achieving removal of TDS by 78 – 82 %. The results concludes that *Chlorella* have high removal rate of TDS concentrations compared to *Scenedesmus*. Hence, both the algae can be used to promote a low cost, green technology for water & wastewater treatment for TDS removal in developing countries. India is a tropical country with abundant of sunshine which is suitable for the implementation of phyco-remediation as aneffective technology. The present phyco-remediation technique will be an emerging tool for the removal of TDS from water and waste water.

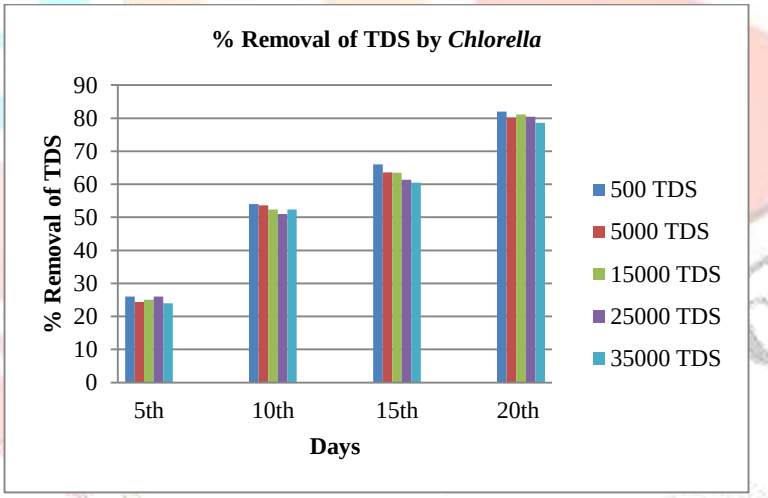

Figure 1: A plot of days verses % Removal of TDS by *Chorella*

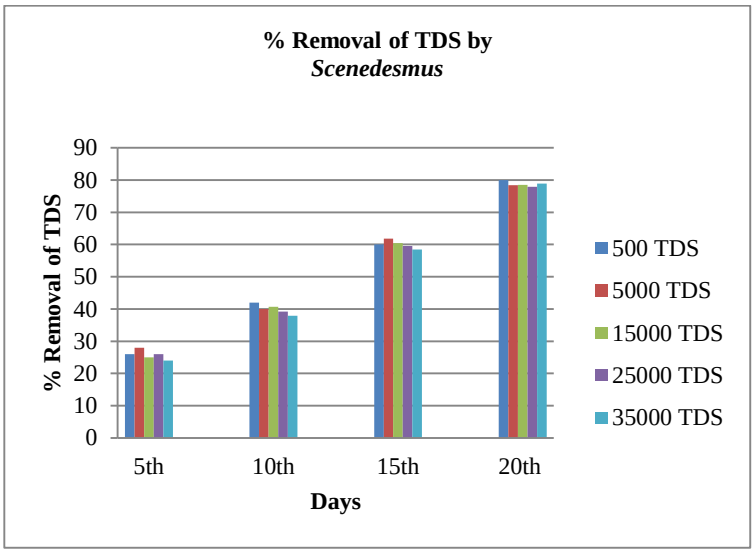

Figure 2: A plot of days verses % Removal of TDS by *Scenedesmus*

Figure 3: Isolated Culture of *Chlorella*

Figure 4: Isolated culture of *Scenedesmus*

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