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PHYCO-REMEDIATION AN EFFECTIVE TECHNOLOGY FOR TDS REMOVAL FROM WATER & WASTEWATER

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Abstract
Phyco-remediation refers to the technology of using algae for the remediation of wastes, predominantly in the treatment of wastewaters. The macro algae help to reduce nutrient load by reducing total dissolved solids (TDS) effectively. It increases dissolved oxygen levels thorough photosynthetic activity and keeps bacterial population under control. An experiment has been conducted by selecting two different macro algal species namely *Pithophora* and *Nitella* with respect to the study of reduction of TDS in the synthetic water. On 20th day the TDS reduction was 42% by *Pithophora & 38%* by *Nitella*. pH was slightly vary on 20th day. The results of the present investigations showed that both the algae are having potential effect to remove TDS from synthetic water. Moreover, the removal of TDS of the synthetic water was progressively increased at 5, 10, 15 and 20 days of phyco-remediation experiments using *Pithophora* and *Nitella* sp. Therefore, the phyco-remediation technique is to sequester the TDS along with other nutrients from wastewater need to be promoted in a large scale. Phyco-remediation is a cost-effective, eco-friendly and a safe process.
Keywords: Macro-algae, wastewater, *Nitella, Pithophora, Phyco-remediation*

1. Introduction

Many aquatic weeds are used to treat a variety of wastewater (Arivoli and Mohanraj, 2013).Several studies revealed the efficiency of the phytoremediation using Typha, *Thaliadealbata*, *Acoruscalamus*, *Zizanialatifolia*, and *Phalarisarundinacea* (Valipour et al., 2009, Valipour et al., 2011, Wang et al., 2012a, Wang et al., 2012b, Marchand et al., 2014). The selection of plant species is the important criteria for wastewater treatment. However, high TDS and metal containing wastewater needs stress tolerant plant (Calheiros et al., 2012).

The *Typha* sp is having novel role for wastewater purification, even for high TDS and pH. The effects of high TDS and heavy metal concentrations on the growth of *Typha* sp. have been studied (Manios et al., 2002, Manios et al., 2003, Macek and Rejmankova, 2007).
The aim of this study is to evaluate a phyco-remediation process by using two different types of algae and to determine the removal of TDS, treatment performance and the morphological characteristics through environmental aspects.

In the proposed studies it has been assessed that the treatment of synthetic water with reference to TDS removal by using algae. These assessments will allow us to explore better potential for using the constructed phyco-remediation by selecting appropriate macro-algal species under the variety of influence conditions as compared to conventional processes. In aquatic macrophytes the high TDS gets accumulated in tissues due to which the treatment is performed and tolerated by the plants (Shelef et al., 2013).

2. Materials and Methods

The synthetic water with different concentration of TDS was prepared by adding Sodium Chloride in distilled water. The TDS of synthetic water was calculated with the help of gravimetric method (APHA, 2010). The two macro-algal species namely *Pithophora* and *Nitella* were collected from Sakkardara and Gandhisagar lake for phyco-remediation of synthetic water.

Sr.No.	NaCl (g)	TDS of synthetic water
1	2.5	500
2	25	5000
3	75	15000
4	125	25000
5	175	35000

Table 1: Preparation of synthetic water in 5 lit.

The *Pithophora* and *Nitella* were cleaned thrice with distilled water and isolated in separate aquariums and cultivated separately. The 5th day isolated algae of both species were utilized for phyco-remediation of synthetic water with high TDS.

2.1 Optimization of pH: 100 ml of synthetic water containing TDS value 100 mg/L were feed in a set of beakers. 1 g of *Pithophora* and *Nitella* was added separately in each set containing different ranges of pH from 5 - 9. The sets were kept for 5 days to obtain the optimum pH value. The results are depicted in Graph no.-1 & 2.

2.2 Optimization of dose: Sets of beaker containing 100 ml of synthetic water with TDS value 100 mg/L were feed with different doses of algae. The dose of both the species were kept in range of 0.5 – 1.5 g. The sets were kept for 5 days with different doses of *Pithophora* and *Nitella* to obtain the optimum dose. The results are depicted in Graph no.-3 & 4.

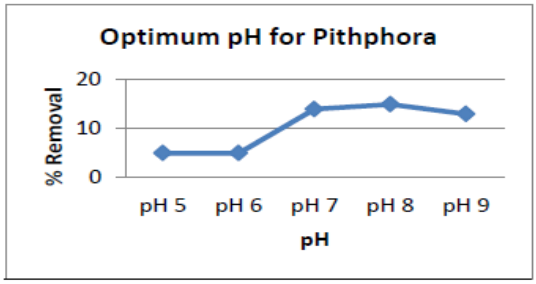
2.3 Optimization of temperature: After obtaining optimum pH & doses, the set were kept for optimization of temperature. 100 ml of synthetic water containing TDS value 100 mg/L were kept for 5 days with varying range of temperature from 15 - 35^0 C. 1 g of both the species were added in respective beakers for optimization of temperature. The results are depicted in Graph no.- 5 & 6.

2.4 Experimental Set-up:

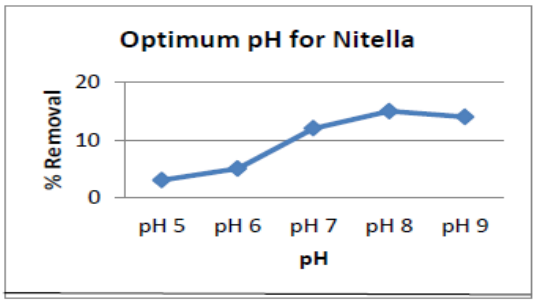
A set of 6 beakers were feed with 500 ml of synthetic water having different concentration of TDS (500, 5000, 15000, 25000 & 35000 mg/l) along with one control were kept for experiment. Nutrients were added accordingly in the synthetic water. The beakers were agitated twice a day regularly for exchange of gases and artificial light was provided by

white fluorescent bulb of 15 watts at a distance of 4 inches for photosynthesis for 10 hours per day.

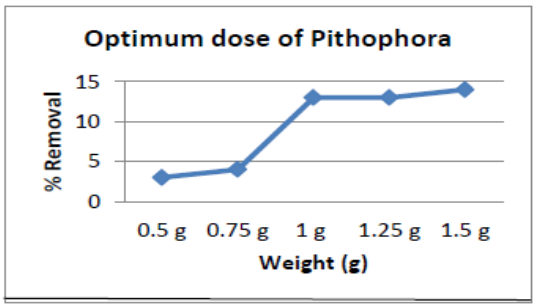
The initial pH and TDS were measured before adding algae. The experimental set-up was operated at room temperature. 5 g of each algae were added in respective beakers. The study was conducted at laboratory scale with optimize conditions for 20 days, after every 5 days interval the pH and TDS were measured of synthetic water.



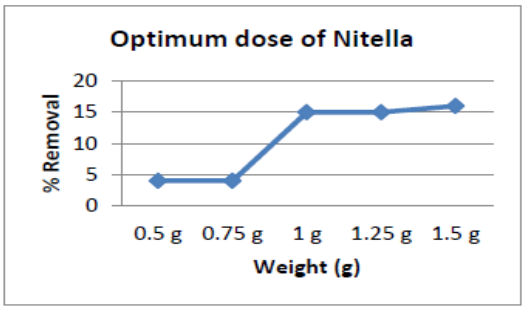
Graph no. 1: Optimum pH for Pithophora



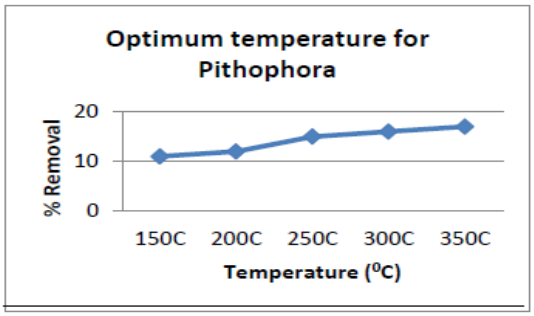
Graph no. 2: Optimum pH for Nitella



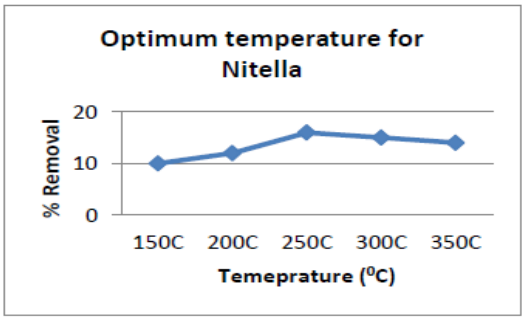
Graph no. 3: Optimum dose for Pithophora



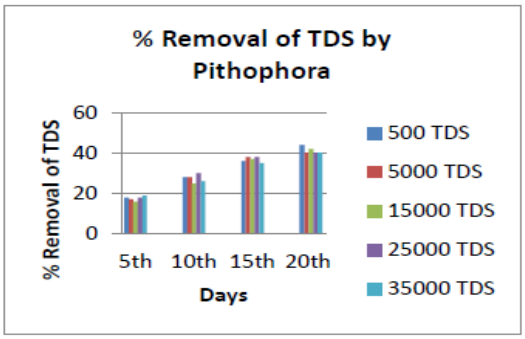
Graph no. 4: Optimum dose for Nitella



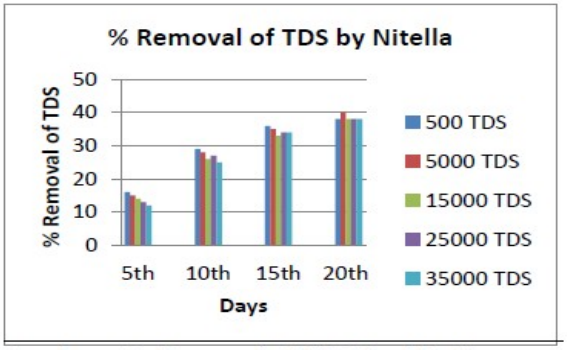
Graph no. 5: Optimum temperature for Pithophora



Graph no. 6: Optimum temperature for Nitella



Graph no. 7: Removal of TDS by Pithophora



Graph no. 8: Removal of TDS by Nitella

Plate no. 1: Sampling at Sakkardar Lake

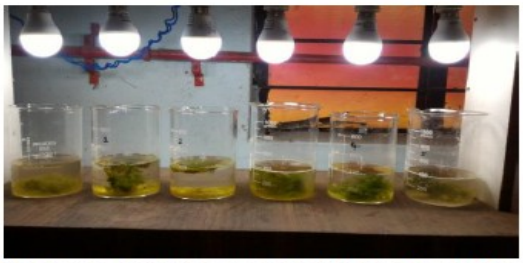


Plate no. 2: Experimental Setup for Pithophora

Plate no. 3: Experimental Setup for Nitella

3. Result

The optimum pH of both the species were found in range of 7 – 8, were as the optimum dose of *Pithophora* and *Nitella* was observed 1 g per 100 ml. The optimum temperature for both the species were obtained in range of 25-30 ^{0}C.

The pH value in both the sets changes slightly in 20 days. The removal of TDS by *Pithophora* was 42.00 % and in *Nitella* it was 38.00 %. The removal of TDS are shown in Graph no.- 7 & 8. The rate of removal of TDS by both the algae were progressively increased on 5th, 10th, 15th and 20th day. It has also been observed that the removal rate was decreased after 10 day.

4. Discussion

Macrophytes have an important function in constructed phyco-remediation systems through pollutant uptake, release oxygen and maintenance of habitats for micro-organisms; however, the quantitative role that the plant plays in wastewater purification is still a subject of great interest.(Zhang et al., 2009, Marchand et al., 2010).

After 10th day the algae start degrading and it may be the cause of decrease in the removal rate of TDS value. The algae grown in high TDS water showed that the condition was not prevailing for the growth of algae. The loss of chlorophyll pigmentation was observed after 10th day in beaker with high TDS value.

In this study, the comparison between two macro algae for removal of TDS from synthetic water leads to importance of phyco-remediation process. The lowest percentage removals of TDS were observed in *Nitella* (38 %) compared to *Pithophora* (42 %). A visual assessment of the algae showed loss of pigmentation caused by higher exposure of TDS.

Conclusions

The process performance of phyco-remediation with two macro algae is determined in the synthetic water with high TDS. The phyco-remediation process showed constant and consistent performance in synthetic water with 10 day retention time to achieving removal of TDS by 38 – 42 %. The results suggested that *Pithophora* have high removal rate of TDS concentrations compared to *Nitella*. Therefore, both the algae can be used to promote a low cost green technology for water & wastewater treatment for TDS removal in developing countries.

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