



Bioremediation of national thermal power corporation (NTPC) industrial waste water by using microalga *Scenedesmus dimorphus*

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Abstract

Now a days water pollution is a worldwide threat to public health and new initiatives are to be taken for the restoration of our aquatic environment. The conventional method of chemical treatment of waste water can only reduce the concentration of pollutants to a limited extent. In this context biological treatment is more reliable as it is cost effective and economical than mechanical or chemical treatment processes. Being primary producers, algae are of very important in this aspect. The present investigation focuses on the bioremediation of waste water by using a microalga *Scenedesmus dimorphus*. For the study the industrial waste water samples and algal samples were collected from Kayamkulam Lake near NTPC, Alappuzha district, Kerala. Samples were analysed for Physico- Chemical parameters such as pH, Total Alkalinity (TA), Dissolved Oxygen (DO), Chloride, Hardness, Calcium, Phosphate, Sulphate, Nitrate, BOD and COD using standard methods with an interval of five days till the colour of water sample changes. Algae were analysed quantitatively and qualitatively. Among the algal taxa *S. dimorphus* was found to be the most abundant and pollution tolerant one. *S. dimorphus* was isolated from the waste water and cultured in BBM medium. The percentage reduction of various parameters was recorded from the samples treated with the alga. Maximum percentage reduction attained with *S. dimorphus* were COD (71.23%) BOD (89.72%) Phosphate (86.14%) Nitrate (77.64%). The results were discussed in the text.

Keywords: bioremediation, physico- chemical parameters, *Scenedesmus dimorphus*

Introduction

In urban and semi- urban areas sewage disposal has become a serious ecological problem. The effluents from the industries and other sources are usually discharged in to open drains, which are finally joining the natural water bodies. It contributes high Biochemical oxygen demand (BOD), and nutrient loading of water bodies (Morrison *et al.*, 2001) [10]. The potential of biological organisms for environmental cleanup has been studied by many researchers (Varshney *et al.*, 1983; Tam and Wong, 1990; Han *et al.*, 2000; Sivasubramanian *et al.*, 2010; Nayana and Jasrai, 2016) [17, 15, 5, 11].

Phycoremediation is one of the biological treatments that are considered cost effective and eco-friendly method to eliminate pollutants from natural water bodies. This method has been in practice for over 40 years (Ahmad *et al.*, 2013) [1]. It is a pollution control strategy that utilizes macro or micro algae to catalyze the degradation or transformation of various harmful chemicals to less harmful forms. So the time is over to screen and develop the efficient algae for bioremediation of contaminated water. Keeping this fact Phycoremediation with the selected species of alga is included in the present work.

Materials and Methods

The industrial waste water and algal samples were collected from Kayamkulam backwater near NTPC Alappuzha district, Kerala. The waste water was analysed for Physico-Chemical parameters like pH, Total Alkalinity (TA), Dissolved Oxygen (DO), Chloride, Hardness, Calcium, Phosphate, Nitrate, BOD and COD were before and after algal treatment following the standard methods (APHA, 2005). The algal strain used in this study was isolated from

the industrial waste water near NTPC, Alappuzha, Kerala. *S. dimorphus* (Turpin) Berb. is one of the dominant alga with good survival capacity compared to other algae.

To evaluate the potentiality of this alga in the waste water treatment two experimental set up were made; one water samples without alga (control) and other with culture of *S. dimorphus*. 2 ml of uniform suspension of *S. dimorphus* (9 days old culture) are transferred in to a flask containing 200 ml of waste water sample. The experimental setup kept under controlled environmental conditions about 20 days. Samples were periodically analysed for Physico- Chemical parameters such as pH, Phosphate, Nitrate, BOD and COD.

Result

All Physico- Chemical parameters were quantified on 0th, 5th, 15th and 20th days of treatment (Table. 1). The initial pH of waste water was 5.67. When treated with *S. dimorphus* the pH was found to be increased in all samples. The maximum pH was observed on 20th day of treatment. Similar observation was made by Kshirsagar (2013) [9] and Rajasulochana *et al.* (2009) [12] by using *S. quadricauda*. The Total Alkalinity of the effluent was reduced from 96 mg/l to 51.84 mg/l on 20th day of treatment by *S. dimorphus*. Similar observation was also made by Rajasulochana (2009) [12] and Sumathy and Tripathy (2017) [14] by using *Scenedesmus sp.*. The DO of the effluent increased when treated with algae. The initial level of 2.3 mg/l of the DO was increased up to 3.82 by *Scenedesmus dimorphus*. Species of *Scenedesmus* is one of the most widely studied microalgae for nutrient removal (Tam and Wong, 1990; Gonzalez *et al.*, 1997; Ji *et al.*, 2013) [15, 3, 6]. In the present study *S. dimorphus* removed a maximum of 77.64% of nitrate on 20th day of treatment. In different studies made by Kshirsagar (2013) [9] and Ji *et al.*

(2013) [6] recorded a significant reduction in nitrate when treated with *S.quadricauda* and *S.obliquus*. Ji *et al.* suggested that *S.obliquus* is a promising candidate for the bioremediation and alternative source for bio- energy. Gonzalez *et al.* (1997) [3] suggested that *S.dimorphus* is able to remove 95% of ammonium nitrogen and 50% of phosphorous from waste water. In the present study also remarkable reduction of phosphate was noted in all the treated samples with a maximum reduction of 86.14% on 20th day of treatment. Kim *et al.* (2007) [8] observed that over 83% of phosphate was removed by *Scenedesmus* in fermented swine water with Phosphorous concentration of

120 mg/l. The industrial effluent had a high Chloride level of 346 mg/l and it was reduced up to 152.2 mg/l by *S.dimorphus*. The Calcium content of the effluent was 96 mg/l and it was reduced to 84.1 mg/l by *S.dimorphus*. Rajasulochana *et al.* (2009) [12] observed 10.83 % of reduction in Calcium by using *Scenedesmus obliquus*. Algal treatment reduced the Total Hardness (TH) significantly. *S.dimorphus* reduced the initial TH of 121 mg/l to 106.1 mg/l. Sumathy and Tripathy (2017) [14] observed noticeable reduction in TH of waste water by using *Scenedesmus dimorphus*.

Table 1: Variation in Physicochemical Parameters of industrial waste water by *Scenedesmus dimorphus*

| Parameters* | Mean ± SD | | | | | F-value (p-value) | Percentage reduction on 20 th day |
|-----------------------|-------------|-------------|------------|------------|-------------|-------------------|--|
| | 1 day | 5 days | 10 days | 15 days | 20 days | | |
| pH | 5.67±0.01 | 5.97±0.01 | 6.02±0.01 | 6.03±0.01 | 6.34±0.03 | 840.2 (<.01) | |
| Total Alkalinity(TA) | 96.33±0.29 | 87.43±0.42 | 79.37±0.15 | 66.57±0.32 | 51.53±0.31 | 9777.3 (<.01) | 46 |
| Dissolved Oxygen (DO) | 2.33±0.06 | 2.43±0.31 | 2.9±0.1 | 3.4±0.26 | 3.86±0.03 | 35.21 (<.01) | |
| Chloride | 346.33±0.29 | 296.67±0.25 | 231.6±0.2 | 176.5±0.2 | 152.53±0.15 | 39402.1(<.01) | 56 |
| Hardness | 121.33±0.29 | 119.47±0.25 | 117.5±0.36 | 112.5±0.46 | 106.53±0.32 | 909.9 (<.01) | 12.4 |
| Calcium | 96.33±0.29 | 94.6±0.1 | 90.57±0.42 | 87.5±0.2 | 84.4±0.36 | 832.1 (<.01) | 12.39 |
| Phosphate | 4.56±0.02 | 2.86±0.02 | 2.28±0.01 | 0.86±0.01 | 0.62±0.01 | 39989(<.01) | 86.14 |
| Sulphate | 79.33±0.29 | 73.83±0.21 | 66.5±0.36 | 59.47±0.35 | 52.57±0.25 | 3907.5 (<.01) | 33.16 |
| Nitrate | 5.65±0.05 | 3.84±0.02 | 2.65±0.01 | 1.58±0.01 | 1.25±0.03 | 12121.2(<.01) | 77.6 |
| BOD | 8.76±0.01 | 7.05±0.02 | 5.38±0.02 | 1.17±0.12 | 0.93±0.03 | 12284 (<.01) | 89 |
| COD | 216.33±0.12 | 134.53±0.25 | 102.7±0.2 | 67.87±0.02 | 62.23±0.02 | 50384 (<.01) | 71.2 |

The Biochemical Oxygen Demand (BOD) is the amount of oxygen required by the aerobic microorganisms present in the sample to oxidize the organic matter. In the present study BOD and COD levels of treated water were found to reduce significantly. BOD level was reduced to 89.72% on 20th day. Kshirsagar (2013) [9] reported that *Scenedesmus* was able to remove 70.97% COD and 89.21% of BOD on the 15th days of treatment. Zhang *et al.* (2008) reported that *Scenedesmus* has high removal efficiency of inorganic nutrients from domestic effluents. Here COD level in waste water was higher (216.4 mg/L) and reduced to 71.23% on 20th days of treatment. The results showed the removal efficiency of *S.dimorphus* for COD, BOD, Phosphate and Nitrate of waste water were 71.23%, 89.72%, 86.14% and 77.64% respectively on 20th days.

Conclusion

From the study it becomes clear that when the visible growth of alga increases in the waste water, there was a remarkable reduction of nutrients and other pollutants. *Scenedesmus dimorphus* showed best result for BOD and phosphate reduction. The present work concludes that *Scenedesmus dimorphus* is also a promising candidate for waste water remediation. So the outcome of this study will be useful to the industrial sectors for the treatment of waste waters.

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