ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Microalgae Application for Treatment of Textile Effluents

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ABSTRACT

The microalgae potential of *Chlorococcum vitiosum* was studied in treating the dye industry wastewater. The results obtained showed promising potential for treatment of industrial effluents with microalgae. Significant pH reduction and 23.23% reduction in turbidity was obtained. COD of the wastewater was reduced by 13% while alkali metals are eliminated considerably.
Keywords Microalgae; *Chlorococcum vitiosum; Textile* Effluent; Treatment

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INTRODUCTION

Water pollution is becoming a serious threat to existence of humanities. Industrial wastewater is highly polluted, contains very high COD and inorganic nutrients. Unchecked release and inadequate treatment may lead to tremendous aquatic loss and subsequent damage to the whole eco-system. Phycoremediation is a type of bioremediation defines it in a broad sense as the use of microalgae or macro algae for treatment of wastewaters [1]. Recent studies have shown that microalgae have a very high potential for phycoremediation.

Microalgae are reported for removal of heavy metals [2-3]. As well as there are reports on the usage of the algae for COD removal by the combination of heterotrophic/mixotrophic microalgal species [4]. Production of biogas through digestion by microalgae has also been reported [5]. Here in these study microalgae were used for the treatment of a dyeing industry effluent.

MATERIALS AND METHODS

Products and Raw Material

Thirunavukkarasu dyeing factory is colouring (dyeing) the cotton yarn 2.85 T/month. This is the tiny unit in which dyeing is done by manual labour. The industry is using cotton yarn, direct and vat Dyes and caustic soda as the main raw materials. The industry used typical dyeing processes like boiling, pre-washing, dyeing, post-washing and drying. In boiling section, the quantity of water used is 800 liters/day, the washing and post-washing section both uses 1000litres/day, 70 liters'/day is used for dyeing and approximately 700 liters of water are used for floor and vessel washing purposes every day. Thus the total wastewater generated from the dyeing industry is around 3570litres/day.

Microalgae Employed

Chlorococcum vitiosum is the microalgae employed for this study. It is a unicellular algae with spherical or slightly oblong cells of varied size. Both ultra structural and molecular data have revealed that *Chlorococcum* is polyphyletic. The morphology of the chloroplast and zoospore cell walls are different from those of other non motile, single-celled green algae.

Laboratory Growth Conditions

The cultures were grown at 24 ± 1°C in a thermo-statically controlled environmental chamber illuminated with cool white fluorescent lamps (Philips 40w, cool daylight, 6500k) at an intensity of 2000 lux in a 12/12 h light/dark cycle. The microalgae were grown in CFTRI medium (Table 1). The micro algal cultures were microscopically examined using Olympus (HB) microscope.

Growth Measurement

Growth was measured by counting cells using a haemocytometer (Neubauer) and the results were plotted in a semi-logarithmic graph. Growth rate (divisions/day) was arrived at using the formula.

$$\frac{\log N - \log N_0}{\log 2 \; x t} \qquad \text{Where,}$$

N - No. of cells per ml at the end of log phase or mg weight/L
N_o - Initial count of cells per ml or mg weight/L
t - Days of log phase

For dry weight method, the algal cultures were pelleted by centrifugation at 7500 rpm (Remi cooling microfuge) for 15 minutes. Cells were washed with glass distilled water, again centrifuged and dried in an oven for 24 hours or until constant weight.

Analysis

Physico-chemical parameters were analyzed by Systronics water analyzer kit. COD was analyzed using Hach colorimeter. Ca and Mg estimation was done using Flame photo-meter.

RESULTS AND DISCUSSION

Description of the Effluent

A study of the effluent generated from this type of manual dyeing activity, shows that the waste water is generated from washing of yarn, before and after dyeing the yarn. Hence the waste water is a dilute, coloured effluent without much organic load. The use of caustic soda and the removal of starch from yarn imparts some alkalinity to the effluent. The post washing water also adds some colour. The vessel washing and floor washing water also adds some colour. The total quantity of waste water when collected shows a coloured effluent.

Treatment of the Effluent

The growth rate of microalgae on dyeing effluent was studied after 7 days of inoculation. The initial cell count was 26 x 10^4 cells/mL which increased to 32 x 10^4 cells/mL resulting in the growth rate of 0.0335 divisions/day.

The overall result showed a reduction in pH in the effluent treated with algae. The pH reduction was significantly high with application of *Chlorococcum vitiosum*. Application of microalgae to the wastewater has also resulted in 13% of color change. Detailed physical parameters were studied and the results are tabulated in table 2.

As can be seen from the table, turbidity of the sample was initially high and decreased by about 23.23%. Other parameters have also resulted in the desired effect. COD variation with time was observed for the treated effluent (Fig 1). 13% COD removal was achieved using microalgae. Heteroptophic microorganisms have wider applicability in consuming the COD present in the wastewater and thus achieving significant COD reduction [6-7]. Generally phycoremediation is coupled with other bio-remediation process to achieve nutrients as well as COD reduction.

Table.1 CFTRI – Medium (pH 10)

Chemicals	g/L
$NaHCO_3$	4.5
K_2HPO_4	0.5
$NaNO_3$	1.5
K_2SO_4	1.0
NaCl	1.0
$MgSO_4.7H_2O$	0.2
$CaCl_2$	0.04
$FeSO_4$	0.01

Table 2. Physico-chemical changes in treated effluent

Parameters	Control	*Chlorococcum vitiosum*
Turbidity NTU	14.20	11.2
Total solids mg/L	5638	5594
Total suspended solids mg/L	428	395
Total Dissolved Solids mg/L	5235	5225
Electrical conductivity	7433	7414

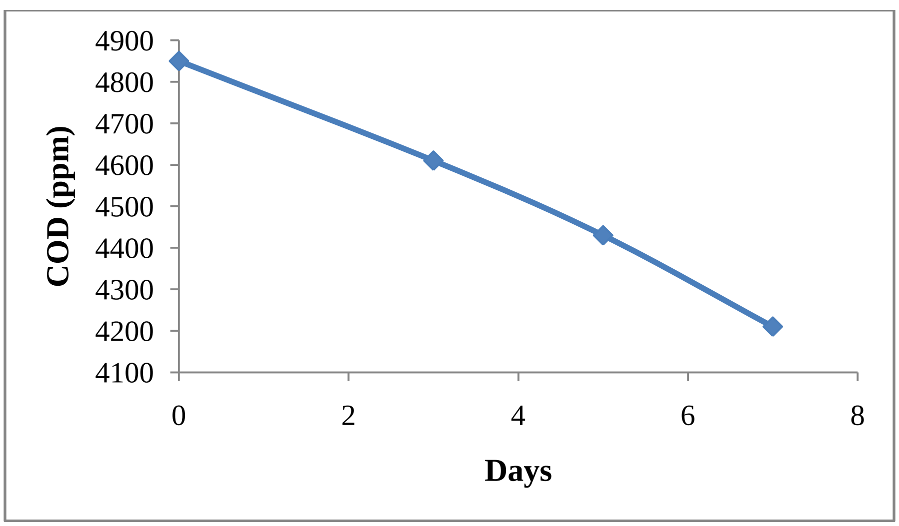

Fig 1: Variation in COD with respect to number of day for treated effluents

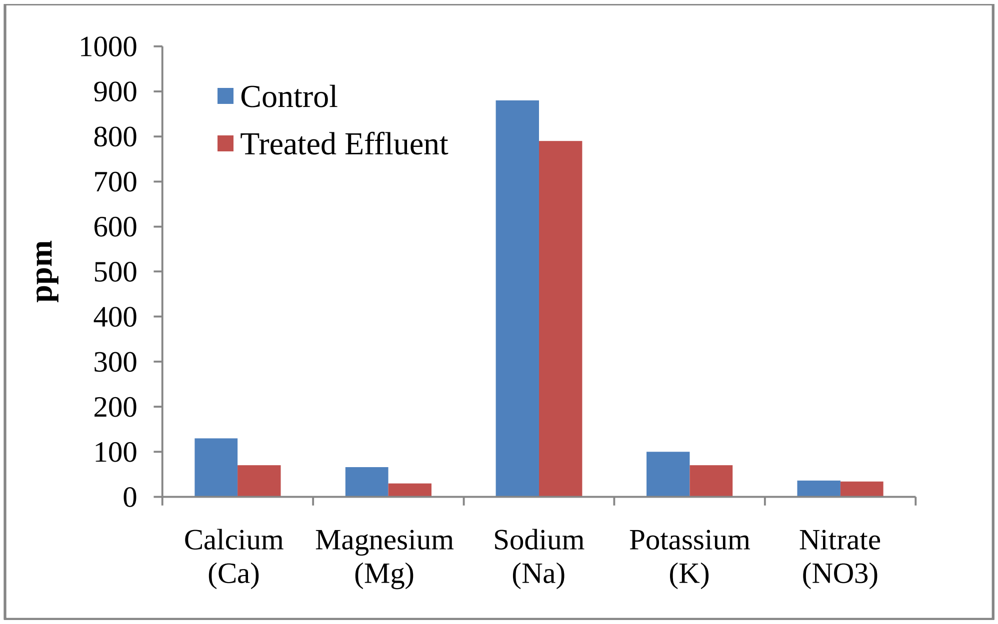

Fig 2: Reduction in alkali metal and NO_3 concentrations

Variation in alkali metal concentration and Nitrates concentration were also observed as dyeing process uses salts to maintain alkaline condition. Application of microalgae has led to reduction in all the four alkali metals, Na, K, Mg, and Ca. The results are shown in fig 2. It can be seen from the figure that both Ca and Mg were reduced considerably. Ca reduction was 46% while Mg reduction was 54.5%. 30% reduction in potassium was observed while microalgae could reduce only 10% of Na. However, only a minor NO_3 reduction was achieved. These results are significant as it shows the potency of microalgae in treating the metals present in the wastewater.

CONCLUSIONS

This work explores the application of microalgae in treating the textile effluents. Chlorococcum vitiosum was chosen as the microalgae. The algal treatment has resulted in considerable removal of alkali metals. Except Na, all other metals, Ca, Mg,and K were eradicated substantially. Higher pH and turbidity reduction was also observed. These results show that algal species can successfully treat the industrial wastewater.

REFERENCES

[1] Olugin E. J Biotechnol Adv 2003; 22: 81-91
[2] Munoz R and Guieysse B. Wat Res 2006; 40: 2799-2815.
[3] Ogbonna JC, Yoshizawa H, Tanaka H. J App Phycol, 2000; 12:277–284.
[4] Samson R, Le Duy A. Biotechnol Lett 1983;5(10):677-682.
[5] Yen HW, Brune DE. Biores Technol 2005;98:130-134.
[6] Craggs RJ, Sukias JP, Tanner CT, Davies-Colley RJ NZ. J Agric Res 2004; 47: 449–460.
[7] Kebede-Westhead E, Pizarro C, Mulbry W. J Appl Phycol 2006;18(1):41-46.