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Purification of waste water using Algal species

Deviram GVNS*, Pradeep K.V and R Gyana Prasuna

Department of Microbiology, Gitam Institute of Science, GITAM University, Visakhapatnam, India

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ABSTRACT

A novel alternative method for waste water treatment was developed using a special constructed column treatment plant. The microbial mats used for the study are dominated by the algal species like Ulva sp, Cladophora sp and Chlorella sp. Various parameters like Chemical oxygen demand (COD), Biological oxygen demand (BOD) were observed after the treatment process in three phases, free cell process, batch process and continuous flow process. Better results in percentage of reduction were observed with continuous flow process using chlorella sp and the reduction rate was 52.1 (COD) and 50.8(BOD) along with changes in dissolved oxygen (DO) and pH. The results clearly enunciate the potentials of chlorella sp for employing in waste water treatment. This is an innovative, economical and environmentally safe alternative for treating waste water.

Keywords: Chlorella sp, BOD, COD, Continuous flow process, Batch process.

INTRODUCTION

Most of the Indian towns are not sufficiently planned to contain large population and on many occasions small towns have grown eccentrically into cities by adding up of settlements, rather by a planned development. Water is one of the major products of nature used enormously by human beings and it is not unnatural that any growing community generates enormous waste water or sewage. As a clean environment is a prerequisite for a healthy living in any urban settlement, proper treatment and safe disposal of sewage call for prime attention. Untreated waste water can cause pollution of surface and ground waters. Many new developments in the field of sewage treatment are eventually taking place. These developments include improvements for more effective removal of pollutants and new treatment processes capable of removing pollutants not ordinarily removed by conventional methods. One such method with enormous potential is the use of biological catalyst process involving free cells. Attempts in the treatment of effluents

containing materials such as Phenols [1], paper mill sludge [2], distillery wastes [3], rubber press wastes [4], olive oil mill wastes [5], and heavy metals [6]. Though the treatment of domestic waste water using cyanobacteria was attempted to evaluate the efficiency of marine algae in treatment of waste water (Municipal waste) under different growth conditions with a view to develop a more efficient technology which strives for less expensive technical modifications.

MATERIALS AND METHODS

2.1 Study area and Sampling

Visakhapatnam municipality was selected as the study area. Visakhapatnam is situated in the coastal Andhra Pradesh in between longitudes E 83□ 15′ 0″ and latitudes N 17□ 41′ 60″ with Bay of Bengal on its eastern side it is fast developing city in Asia with many industries. The population of the town is around 2.5 million. Waste water samples are collected from different points for a period of 3 months. The samples collected were analyzed for their physico-chemical properties. Samples for bacteriological analysis were aseptically collected in sterile containers and are transported immediately to the laboratory and subjected to physical chemical and biological analysis within 3hours of collection.

Physical characteristics such as color, odor, temperature and total solids (suspended and dissolved) and chemical characteristics such as pH, dissolved oxygen, Biochemical oxygen demand, chemical oxygen demand, hardness amount of chlorides, phosphates, and silicates nitrogen were estimated following the analytical procedures outlined by the APHA [7], Chlorophyll [8], protein [9] and carbohydrates [10].

2.2 Construction of Treatment Column

The construction of waste water treatment plant is designed in such a way that that the sample water which has to be treated will undergo different treatment steps in specially designed parts of the plant.

- Primary treatment column
- Secondary treatment column
- Algal mat tank
- Light source

2.3 Algal sampling techniques

Algal samples used for the study are collected from the seashore and industrial effluent regions. *Ulva sp* and *Cladophora sp* were collected from seashore of Tennati Park, Visakhapatnam. *Chlorella sp* was obtained from the industrial effluent regions Visakhapatnam. The cultures were transferred with the help of a sterile spatula into sampling bottles and were brought to the experimental laboratory aseptically in their respective medium.

Type of medium		Organism
a.	Aquil medium	*Cladophora sp, Ulva sp*
b.	Bolds Basal medium	*Chlorella sp*

Total bacterial population present in the freshly collected sewage samples were enumerated as colony forming units employing standard pour plate technique. Student's t-test was employed to know the significance of sample site 1 and sample site 2.

2.4 Characteristics of waste water

a. Physical: The color of the waste water was brownish black at sample site 1 and light green color at sample site 2.
b. Temperature: Temperatures were in the range 27°C to 31°C at both sample sites. Lower temperatures were observed in the month of December and temperatures above 29°C were recorded in the month of May.
c. Total solids: In the sample site 1 total solid varied from a minimum of 605mg/l in may and a maximum of 910mg/l in the month of December. Suspended solids also showed the similar fashion where as dissolved solids were in range 450-445mg/l.
d. Dissolved oxygen: Dissolved oxygen was found to be absent in the waste water from both sample sites. However after the treatment there is a slight increase in D. O 0.5mg/l-1.0mg/l
e. Biochemical oxygen demand: BOD in waste water fluctuated sharply by recording a trough during December and a peak in the month of March. The values showed 148mg/l and 192mg/l.
f. Chemical oxygen demand: Variations in COD were appreciable at both stations during the study period. A minimum of 310mg/l in December and a max of 427mg/l in April were recorded.

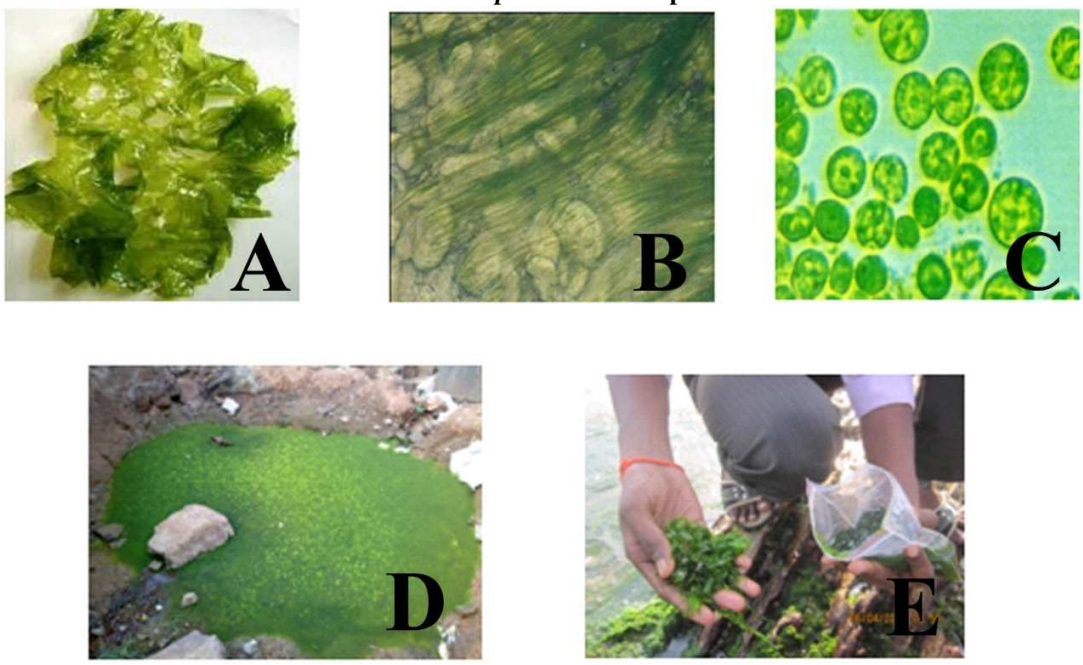
2.5 Bioremediation of waste water using algae

Three algal strains were used for the present study. They were primarily screened among from other algae based on the efficiency to reduce maximally the BOD and COD. The strains were identified to their species level

a. Ulva sp
b. Cladophora sp
c. Chlorella sp

All the strains were brought to the laboratory in aseptic conditions and were grown on large scale by providing the required nutrients and proper light source and the auxenic cultures are maintained for further use.

Figure 1: (A) *Ulva sp,* (B) Cladophora sp, (C) Chlorella sp, (D) *Chlorella sp* from Industrial area and (E) *Ulva sp* from Tennati park



2.6 Treatment process

A cell column of size (15x15x15cm) was prepared with culture of algae with inlet and outlet valves and the column was packed with algae.

Table 1: Effect of innoculum concentration of *Ulva sp* on free cell treatment of waste water
(Expressed in terms of percentage reduction)

Variable	Incubation period (hours)	Innoculum concentration(wt in gm)			
		5	10	15	20
COD	48	15.8	16.3	17.2	14.5
	72	42.4	41.9	42.6	44.2
	96	43.7	46.3	48.9	49.5
BOD	48	6.5	10.2	14.5	11.3
	72	37.1	40.9	48.3	41.7
	96	43.2	46.8	47.3	48.2

**Initial levels of COD-380mg/L, BOD186mg/L*

Table 2: Effect of innoculum concentration of *Chladophora sp* on free cell treatment of waste water
(Expressed in terms of percentage reduction)

Variable	Incubation period (hours)	Innoculum concentration(wt in gm)			
		5	10	15	20
COD	48	12.8	14.3	16.2	15.5
	72	31.4	33.9	38.6	39.2
	96	31.7	40.3	42.9	43.5
BOD	48	5.5	11.2	14.5	15.3
	72	33.1	42.4	44.3	42.7
	96	36.2	37.8	41.3	42.2

**Initial levels of COD-380mg/L, BOD186mg/L*

Table 3: Effect of inoculum concentration of *Chlorella sp* on free cell treatment of waste water
(Expressed in terms of percentage reduction)

Variable	Incubation period (hours)	Innoculum concentration(wt in gm)			
		5	10	15	20
COD	48	15.8	16.3	17.9	18.5
	72	33.6	37.4	39.2	40.7
	96	33.2	41.3	46.2	50.5
BOD	48	11.5	12.2	16.2	17.3
	72	35.2	44.4	47.1	49.7
	96	39.2	54.8	51.3	52.2

**Initial levels of COD-380mg/L, BOD186mg/L*

2.8 Batch treatment process

The packed bed column was tested for its treatment of waste water. The coloumn was filled with and allowed to remain as such for treatment for a total period of 96hours. At regular intervals samples were drawn and analyzed for residual COD and BOD. Algal strains were also removed while sampling and cell content was estimated in terms of chlorophyll and protein.

2.9 Continuous treatment

Waste water was subjected to continuous treatment by algal cells loaded in the packed column. The prepared column was fed with waste water from bottom to the top at flow rate 25ml/h, 50ml/h and 75ml/h using peristaltic pump. At regular intervals the samples were drawn over a total period of 5hrs and percentage reduction of COD and BOD were estimated.

RESUTS AND DISCUSSION

Chlorella sp showed maximal growth in municipal waste water at 30°C, pH 8. Results presented in table 3 indicate that the free cells of this algae 20gm inoculums concentration without any additional nutrients could bring about more than 50percent reduction in COD and BOD after 96hrs. Whereas other two strains could reduce upto 49.5 and 48.3 (Ulva sp) and 43.5 and 42.2 (Cladophora sp) for COD and BOD respectively under packed column (Table 2, 3).

Table 4: treatment of waste water using cells of *Ulva sp, Cladophora sp* and *Chlorella sp* in a packed column Batch process (Expressed in terms of percentage reduction)

Variable	Contact time	Strain type		
		Ulva sp	*Cladophora sp*	*Chlorella sp*
COD	4	17.5	16.9	21.0
	8	19.2	18.7	24.2
	12	21.3	24.2	30.2
	24	25.6	28.3	35.6
BOD	4	5.5	6.3	7.8
	8	11.3	13.2	15.3
	12	16.7	18.1	23.1
	24	21.2	24.5	30.1

**Initial levels of COD-380mg/L, BOD186mg/L*

Table 5: Comparison of the various modes of treatment of waste water employing *Chlorella sp*

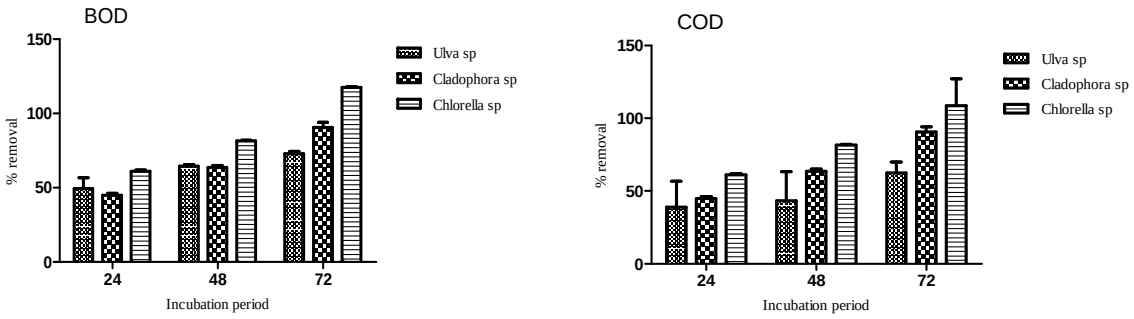
Mode of treatment	Time (h)	Percentage reduction	
		COD	BOD
Free cell treatment	48	18.5	17.3
	72	40.7	49.7
	96	50.5	52.2
Batch process	4	21.0	7.8
	8	24.2	15.3
	12	30.2	23.1
	24	35.6	30.1
Continuous process 25ml/h flow rate	1	52.1	50.8
	2	49.6	48.2
	3	46.2	44.8
	4	44.3	42.1
	5	41.2	39.8

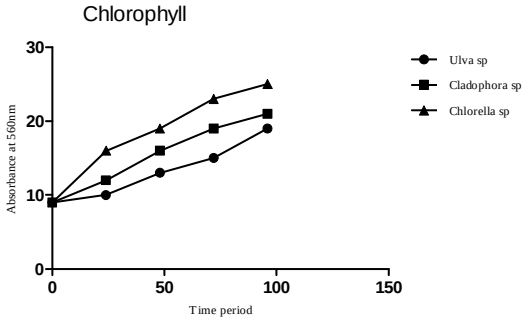
CONCLUSION

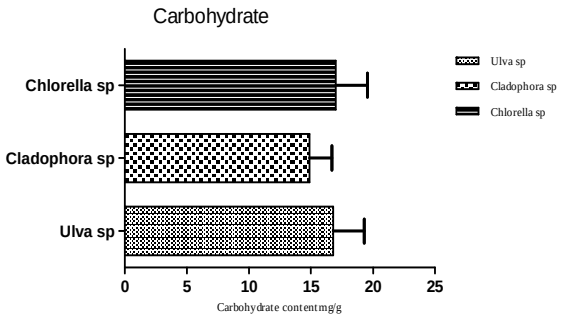
It is evident from table 5 that continuous treatment of waste water with chlorella cells is more suitable and ideal since a maximum of 53.1and 51.2 percentages of COD and BOD reduction could be observed respectively for the 20ml flow rate per one hour of treatment, although there was a marginal decline of 6percent in the percentage reduction of both COD and BOD after 5hours of continuous treatment. Enhanced activity in COD and BOD reductions could be observed with chlorella cells under continuous treatment compared to batch process and free cell treatment. The increased activity may be due to the slow movement of waste water along the column which could have facilitated better contact and activity by all cells and cumulatively contributed to the total reduction in COD and BOD.

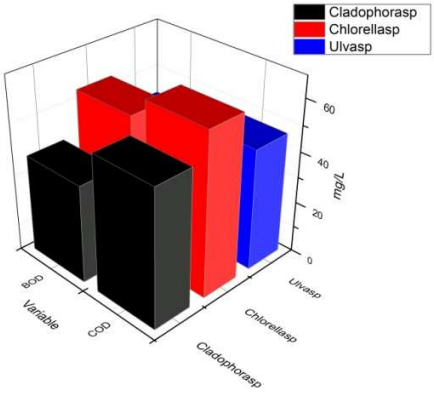
Since *Chlorella Sp* was isolated from industrial effluent area and adapted to conditions thereof, it could have expressed a maximal activity in short periods of activation and retention. The results

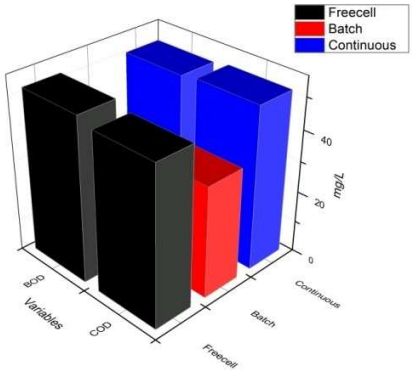
Clearly enunciate the potential of *chlorella sp* to express enhanced activity in continuous treatment compared to static contact of waste water in batch process. The present study is speculated that there is unlimited scope for using such potential strains for enhanced activity towards rapid treatment and probable recycling of waste water for useful purposes.











REFERENCES

[1]. Wisecarver, K. D. and Fan, L. S. *Biotechnol. Bioengg.*, **1989**, 33(8):1029-1038.
[2]. Gijzen, H. J., Schoemakers, T. T. M., Caereteling, C. G. M. and Vogels, G. D. *Biotechnol. Letters.*, **1988**, 10:61-66
[3]. Subramaniyan, G. and Shanmughasundaram, S. *Indian J. Environ Health.* **1986**, 28(3): 250-253.
[4]. Jayachandran, K., Suresh, P.V. and Chandrasekharan, M. *Biotechnol. Lett.* **1994**, 16 (6): 649-654.
[5]. Vassilev, N., Fenice, M., Fedirici, F. and Azcon, R. *Process Biochem*, **1997** 32 (7): 617-620.
[6]. Stoll, A. and Duncan, J. R. *Process Biochem*, **1997**, 36 (6): 467-472.
[7]. APHA. Standard method for the examination of water and waste water, joint Ed Board: Clesceri, L.S; Greeberg, A. G. and Rhodes Trussel, R. American Public Health Association, Washington, D. C. pp 10-223, **1989**.
[8]. Mackinney, G. **1941**, *J Biol Chem* 140: 315-22.
[9]. Lowry, O. H, Rosebrough, N. J, Farr, A. L. and Randall, R. J. *J Biol Chem*. **1951**, 193(1): 265-75
[10]. Spiro, R. G. Analysis of sugars found in glycoproteins.**1966**, *Methods enzymol* 8: 3-26.