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Environmental Impact Assessment of micro algae employed in phycoremediation of sewage-effluent from Madras Christian College, Chennai, India

Vijayalakshmi. S[1], Alice Jennifer.C[1], Sharon Maria Jacob[1], Mukund.S[2] and Ranjith Kumar.R[1*]

[1]Department of Botany, Madras Christian College (Autonomous), Chennai, Tamil Nadu.
[2]Phycospectrum Environmental Research Centre (PERC), Chennai, Tamil Nadu. *Corresponding author E-mail: ranjithkumar@mcc.edu.in

Abstract

In this study, the microalgae *Chlorella vulgaris* Beij. and *Scenedesmus* sp used for the phycoremediation of sewage effluent from Madras Christian College (MCC) were subjected to Environmental Impact Assessment (EIA). The EIA assay was carried out by proper utilization of microalgal biomass in applications such as plant growth and germination of seeds. Microalgal biomass and treated wastewater effluent were employed. Navathaniyam (nine seeds) was used in this experiment. Among the nine varieties of grain, 3 different grains such as Chick pea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*) and Black gram (*Vigna mungo*) showed maximum growth compared to control and hence the microalgae can very well be used as a bio-fertilizer. Thus, the microalgae were not only effective in effluent treatment, but also safe to the environment.

Key words: Phycoremediation, algae, Environmental impact assessment, Navathaniyam

Introduction

Water is the first and foremost source of life. Water is the most important perspective in both physical and normative. From the physical perspective, the water is almost comprised of blue water, green water and grey water. Wastewater is the by-product of many uses of water. This includes household wastes, laundry, commercial activities and institutional wastes *inter alia*. The statistical report says that around 1.8 billion people globally use a source of drinking water that is fecally contaminated. Some 2.4 billion people lack access to basic sanitation services, such as toilets or latrines. The impact of Water scarcity would affect more than 40 per cent of the global population and is expected to rise further. More than 80% of wastewater resulting from human activities is discharged into rivers or sea without any treatment, leading to pollution. Wastewater is considered as both “a Resource and a Problem” (Hanjra *et al.,* 2012). Thus, it says that it maximizing the resource potential and minimizing the problems. Farmers in Greece use this water for irrigation purposes; it is called as the recycled water rather in treated wastewater (Menegaki *et al.,* 2009).

Algae are generally microscopic organisms, are usually thought of as simple aquatic plants which do not have roots, stems or leave and have primitive methods of reproduction. They are carbon fixing and oxygenating organisms. Phycoremediation is the use of macro-algae or micro-algae for the removal or biotransformation of pollutants, including nutrients and Xenobiotics from wastewater and CO_2 from waste air. The micro-algae used in phycoremediation are already present in nature and are at work consuming unwanted materials. After phycoremediation is completed, the environment is virtually restored to its pristine condition. The important factor for its social acceptance, particularly by environmentalists, is the conclusive impact of micro-algae on the biodiversity and this crtical factor is best accepted in phycoremediation when compared with other remediaton methods.

Benefits of phycoremediation are that it microalgae can simultaneously implemeent more than one problem. Phycoremdiation is more case specific as the process can be operated batch wise, semicontinuous or in continuous manner. Harvested algal biomass has commercial benefits which could be used as source for extracted biochemicals. It is cost effective and compatible with existing operations. Microalgae could prove effective against CO_2 sequestration – a solution for the threat of global warming.

Environmental impact assessment institutional systems vary from country to country and reflecting different types of governance. In some countries, either the ministry of environment or designated authority or planning agency administers EIA (Achieng Ogola, 2007). Environmental impact assessment is also now practiced in more than 100 countries (Petts, 1999 and Wood, 2003) including many developing countries and transitional economies (Lee and George, 2000). Environmental impact assessment increasingly being positioned within a border context of sustainable forms of development is being rediscovered (Glasson *et al*., 2005 and Hanumantha Rao *et al.,* 2010).

Present Investigation

In the current study, phycoremediation was employed to treat the effluent of Madras Christian College's sewage waste (referred as MCC's Sewage). Madras Christian College is an educational institution situated at East Tambaram, Chennai, and Tamil nadu and the treated water and the biomass generated were employed for EIA analysis.

MATERIALS AND METHODS

In the present study, sewage effluent was collected from Madras Christian college sewage pond, Tambaram, Chennai. Both the untreated (control) and effluent treated with Chlorophyceae members were analysed from various physico-chemical parameters to assess the water quality (APHA.2012). In the present study, two species of Chlorophyceae (*Chlorella vulgaris* and *Scenedesmus* sp.) were selected for further treatment processes. Actively grown microalgae of *Chlorella vulgaris* and *Scenedesmus* sp. was harvested and the algal biomass was used for the soaking seeds.

Effect on seed germination and seedling growth

Seeds of nine grains so called as "NAVATHANIYAM" The nine grains are, Paddy (*Oryza sativa*), Wheat (*Triticum*), Sesame (*Sesamum indicum*), Horse gram (*Macrotyloma uniflorum*), Green gram (*Vigna radiata*), Black gram (*Vigna mungo*), Chickpea (*Cicer aertinum*), Lablab bean (*Lablab purpureus*) and Pigeon pea *(Cajanus cajan*) were obtained.

The seeds were soaked overnight 12 hours in 35ml of microalgal consortia in the form of pellets as a treatment likewise, nine grains were soaked overnight (12hrs) in tap water and this was served as a control. The next day these nine grains were sowed at an optimum depth in a small mud pots of which the width of the pot was 9.5cm and the length was 5cm each. These mud pots were filled with garden soil. In each pot 5 grains were sown to observe the germination behaviour. The mud pots were sprayed with normal water for control and effluent treated waste water was sprayed for treatment.

RESULTS AND DISCUSSION

An observation of this study with these 9 grains Paddy, Wheat, Sesame , Horse gram, Green gram, Black gram, Chickpea, Lablab bean, Pigeon pea using untreated and algal treated sewage effluent revealed that there was a marked variation in germination percentage of plants when treated with effluent. The physico-chemical parameters of MCC sewage effluent in untreated water with treated water had a drastic difference.

They results showed the reduction of sodium and potassium of about 42.81% and 78.6%. Phosphate has reduced by 4.85%. The electrical conductivity was also decreased by 22.4%. The treatment of algae with aquasap resulted in the reduction of oxides of nitrogen like nitrite and nitrate in Below Detectable limit (BDL) which is 100% reduction. The heavy metal like lead and chromium was in below detectable limit in MCC sewage waste water however, they heavy metal zinc has been reduced upto 61.5%. The oxides of nitrogen like nitrite and nitrate along with Total Kjeldahl nitrogen showed 100% reduction. Nitrogen plays significant role in algal metabolism. Biological oxygen demand (BOD) and Chemical oxygen demand (COD) were drastically reduced as 66.6% and 87.5% respectively (Table 1).

Table 1- Physico chemical parameters of treated and untreated effluent.

Parameters	Untreated	Treated
pH	8.8	9.7
Conductivity @25°C µs/cm	1624	1266
Total Hardness (as $CaCO_3$) mg/L	473	84
Calcium (as Ca) mg/L	126	75
Magnesium (as Mg) mg/L	38	26
Sodium (as Na) mg/L	54.1	9.46
Potassium (as K)	5.8	2.71
Total kjeldahl Nitrogen (as N) mg/L	2.4	BDL
Free Ammonia (as NH_3) mg/L	0.54	BDL
Turbidity (NTU)	2	5
Nitrite (as NO_2) mg/L	9.2	BDL
Nitrate (as NO_3)mg/L	1.13	BDL
Biochemical Oxygen demand (BOD) mg/L	6	< 2
Chemical oxygen demand (COD)mg/L	32	< 4
Phosphate (as PO_4) mg/L	3.14	3.3
Zinc (as Zn) mg/L	0.13	0.05

The environmental impact assessment study was done with the treated wastewater treated water for plant growth with NINE GRAINS so called Navathaniyam. The experiment shows the growth of plants. The emergence of radicle was considered to be indication of germination. This experiment was monitored for 12days (244 hours) of period. The growth of plants was monitored once in 3days to measure the growth and the treated wastewater was sprayed to treated pots and normal tap water for control pots. On the 12th day all the well grown plants were uprooted from the pots for observing the length of radicle and plumule, thus it was compared. (Figure.1 a,b & c).

Fig1. A- 6th day Growth of treated plants

Fig1. B- 9th day Growth of treated plants

Fig1. C- 12th day Growth of treated plants.

The surface area of each matured leaves along with growth of radicle and plumule was calculated. Among the nine grains, three grains such as Chick pea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*) and Black gram (*Vigna mungo*) in treatment showed maximum growth. The length of radicle of chickpea observed and recorded as 7.3cm in treatment and observed as 6.9cm in control. Pigeon pea observed and recorded as 9.3cm in treatment and noted as 6.2 cm in control and black gram observed and recorded as 4.7cm in treatment and noted as 4cm in control.(Table 2)

Table 2- Length of Radicle (Compared with Treatment and plumule).

		Length of Radicle (cm)	
S.No	**Name of the plants**	**Control**	**Treatment**
1	Horse Gram	7.3	7.4
2	Green gram	5.3	3.7
3	Lablab bean	10	09
4	Chickpea	6.9	7.3
5	Wheat	16.5	11
6	Pigeon pea	6.2	9.3
7	Black gram	4	4.7

The length of plumule of chickpea was observed and recorded as 16.6cm in treatment and noted as 14.2cm in control. The pigeon pea was observed and recorded as 15.6cm in treatment and noted as 14.5cm in control and black gram in treatment observed and recorded as7.5cm and control it shows 6.7cm (Table 3).

Table 3- Length of Plumule (Compared with Treatment and Plumule).

		Length of Plumule (cm)	
S.No	**Name of the plants**	**Control**	**Treatment**
1	Horse Gram	5.56	5.4
2	Green gram	11.7	7.5
3	Lablab bean	14.4	14.2
4	Chickpea	14.2	16.6
5	Wheat	16.68	15.3
6	Pigeon pea	14.5	15.6
7	Black gram	6.7	7.5

The surface area of treated plants was recorded. The chick pea surface area was observed and recorded in treatment as 315mm^2 and 217 mm^2 in control. The pigeon pea shows 446 mm^2 and 356 mm^2 in control potted plants. The black gram surface area was recorded and observed as 250 mm^2 and 233 mm^2 respectively. The highest leaf surface area was recorded in pigeon pea as 446 mm^2, whereas the lowest surface area was recorded in 250 mm^2 (Table 4).

Table 4- Surface area (Compared with Treatment and control).

		Surface area of leaf (mm^2)	
S.No	**Name of the plant**	**Control**	**Treatment**
1	Horse Gram	212	214
2	Green gram	264	260
3	Lablab bean	157	159
4	Chickpea	217	315
5	Wheat	206	209
6	Pigeon pea	356	446
7	Black gram	233	250

When compared with control the treated plant shows the fast growth, it may be helpful for better cultivation, luxuriant growth and a massive growth of plants. This growth is mainly due to the presence of elevated the total dissolved solids. The solids may inhibit the uptake of necessary elements like phosphorus, magnesium etc.by plants (Thabaraj *et al.,* 1964).Thus, the experimental data revealed that the length of shoot and leaf of Chick pea, pigeon pea and Black gram varied considerably under the influence of the treated effluent treatments. Thus the shoot and root length of treatment were considerably high than the control plants (Figure 2).

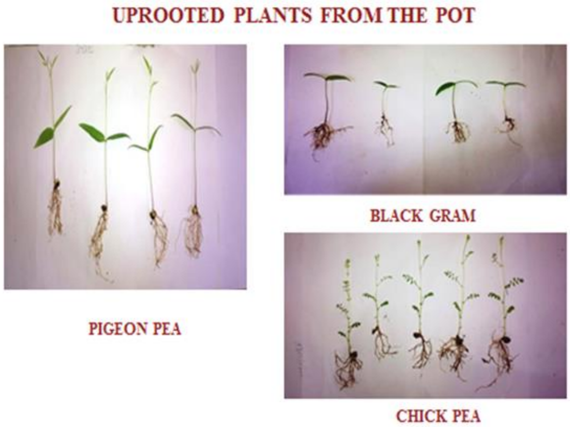

Fig.2 Uprooted plants from the pot.

In the present study, it was observed that the changes in the length of radicle and plumule showed a maximum growth. The treated plants also show the luxuriant growth of roots and also length of root and number of secondary roots when compared to control potted plants. Hence, the current investigation revealed that the treated effluent can be effectively utilized for irrigating agricultural crops. It can be employed to ensure effectiveness and environmental study.

CONCLUSION

In the presents study we have examined the potential of Chlorophyceae species in treating Madras Christian College waste water effluent, yield a good results. The harvested algal biomasses were used as algal biofertilizers .The results were found to be good.and also produced good yield of grains.the process is very cost effecttive with a simple application. Therefore we conclude that phycoremdiation is an effective method and harvested algal biomass can used as biofertilizers.

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