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CO_2 Sequestration and Treatment of Municipal Sewage by Micro Algae

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Abstract— ***Treatment of wastewater by algae is receiving an ever increasing attention in the field of biofuel production, and carbon dioxide sequestration. In this study five genera's namely Anabaena, Diatoms, Spirogyra, Hyalophacus, Monoraphidium, were tested for its ability to reduce the organic and inorganic pollutants present in the wastewater, growth studies is carried out in a batch system with a working volume of 7- 10 litres. The growth of microalgae were analysed throughout the growth period for about 107 days and it is found that changes were taken place in certain parameters viz., biomass, Nitrogen and phosphate assimilations and CO_2 reduction***

Index Terms— ***CO_2 Sequestration, Micro algae, sewage, biomass .***

I. INTRODUCTION

The demand for clean water is currently a worldwide priority. Currently, the main challenge of a wastewater treatment plant (WWTP) is not only to produce reusable clean water, but it is also to find resources for supporting those new developments. The cur-rent global investment in water management is about€150 bilion per year, of which 95% is public capital **(Krozer et al., 2010)** . Microalgae represent an exceptionally diverse, but highlyspecialized, group of microorganisms adapted to various ecological habitats (Richmond, 2004; Abou-Shanab et al., 2011a, 2011b)Wastewater derived from municipal, agricultural & industrial activities is a source of nutrients for microalgae cultivation [Lardon et al., 2009]. In addition, microalgae-based systems can significantly reduce both organic matter and nutrients in municipal and piggery wastewater at minimal energy cost [Gonzalez et al., 2008, Mulbry et al., 2008, Zhou et al, 2012]. The use of wastewater could reduce the need for additional Nitrogen & phosphorus sources by approximately 55% [Yang et al.,2011]. Microalgae cultures offer an effective solution to tertiary & quaternary wastewater treatment due to the ability of microalgae to use inorganic nitrogen & phosphorus for their growth [Kumar et al., 2010]. One promising way to make algal biofuel production more cost effective is to integrate wastewater treatment with algal biomass production [Clarens et al., 2010]. This study focuses on the potential for using microalgae isolated from waste stabilization ponds in order to reduce the organic & inorganic pollutants from municipal wastewater..

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II. METHODS AND MATERIALS

A. Municipal Wastewater collection

The domestic wastewater is collected from the nearby sewage treatment Plant at the inlet point. The collected wastewater is taken to laboratory and maintained at room condition.

B. Algal Strain Details

The algal inoculum is collected from nearby waste stabilization ponds. The collected sample is maintained at room temperature. Then the algae are microscopically viewed for identification.

C. Experimental Design

The Microalgae were inoculated at different dilution rates such as 20%, 16%, 12%, 10%, 08% ($v_{inoculation}/v_{Domestic\ wastewater}$).The different dilution ratios are given in table 1. The experiment is carried out in a batch process of 10 litre capacity rectangular tank with a working volume of 7 litres. The cultures were incubated at 26±2ºC and illuminated with natural sunlight.

Table 1: The different dilution ratios

Batch reactor	Raw municipal wastewater (%)	Microalgae inoculum (%)
01	90	20
02	84	16
03	88	12
04	90	10
05	92	08
CONTROL	-	100

D. Microalgae growth Analysis

The Analyses of Microalgal growth parameters such as pH, Electrical Conductivity, Chemical Oxygen Demand, Dissolved Oxygen, Phosphorus, Total Kjeldhal Nitrogen, Total Dissolved Solids, Salinity, and Total Volatile Suspended Solids were measured as per the procedure given in standard methods for water and wastewater analysis, 2005 21st edition.

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III RESULTS AND DISCUSSION

A. Physiochemical characteristics of Municipal sewage and Algal Inoculum

The physicochemical parameters were analysed for municipal wastewater and microalgal inoculum and presented in Table 2.

Table 2: Average characteristics of Municipal sewage & Microalgal Inoculum

Sl.no	Parameters	unit	municipal sewage (Av.values)	Microalgal inoculum (av.values)
01	Color	-	Grayish Black	Light Green
02	pH	-	6.98	8.62
03	EC	mS	0.248	0.162
06	BOD $_{3,27c}$	mg/L	270	240
07	COD	mg/L	430	400
13	Phosphorus	mg/L	41	62
14	Ammonia Nitrogen	mg/L	12	23
16	TKN	mg/L	98	65
17	Total Solids	mg/L	6000	6000
18	TDS	mg/L	4000	4000
19	TSS	mg/L	200	2000
20	TVS	mg/L	4000	4000

B. Algae Strain Identification:

The algae inoculum collected from the waste stabilization pond is identified, and the prominent genera found in the sample are Anabaena, Diatoms, Hyalophacus Monoraphidium, Spirogyra.

C. Microalgal growth parameters

pH : Changes in pH values of the algal cultures were ranged between 7.06 and 8.67 (Fig: 01) Variation in pH can affect metabolism and growth of algae in a number of ways, including altering the equilibrium of inorganic carbon (C) species, changing availability of nutrients, and, at extremes, directly affecting cell physiology. The pH range for most cultured algal species is be-tween 7 and 9, with the optimum range being 8.2-8.7.

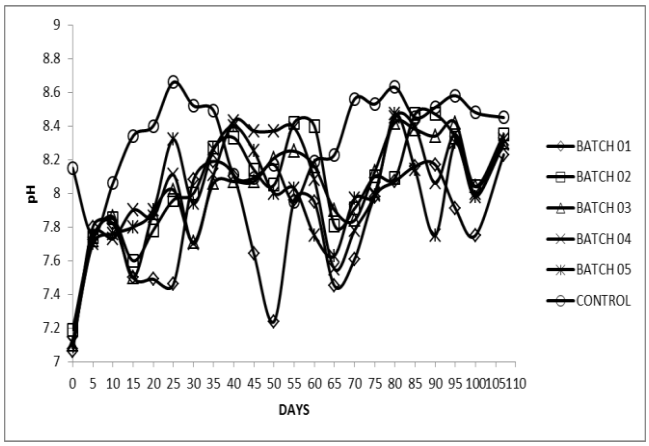

Fig 1: Changes of pH values of different batch cultures during the treatment period

Phosphorus: Phosphorus values were varied between 63 mg/L to 03 mg/L. The removal of phosphorus, from Municipal wastewater by microalgae cultivation as a function of incubation time are shown in Fig:2. After 107 days of algal cultivation, the total phosphorus content were reduced from 55 mg/L to 10 mg/L, 63 mg/L to 08 mg/L, 60 mg/L to 08 mg/L, 61 mg/L to 01 mg/L, 46 mg/L to 06 mg/L, 44 mg/L to 06 mg/L and their removal efficiency were around 82%, 87%, 87%, 84%, 86%, 86%. For the Respective Batch Cultures (01,02,03,04,05, CONTROL).

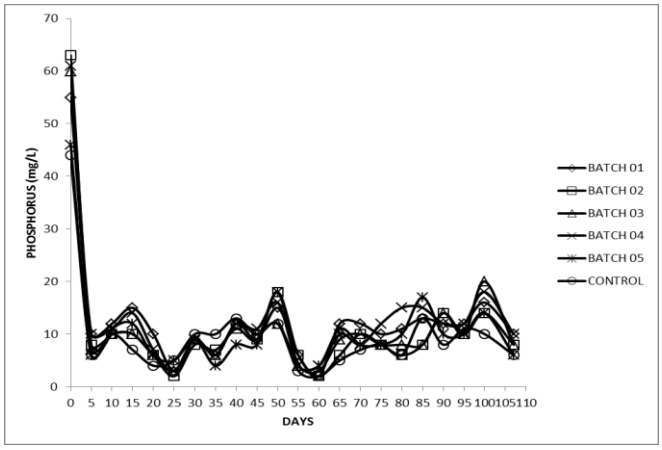

Fig 2 Changes of Phosphorus values of different batch cultures during the treatment period

Wang & Lan.,2011, conducted a experiment using secondary wastewater and the removal efficiency they obtained was about 100%. Cho et al.,2011 conducted a experiment in municipal wastewater and the maximum removal efficiency obtained was about 86%. In this study we obtained a maximum removal efficiency of 87%.

Total Kjeldhal Nitrogen*:* Total kjeldhal Nitrogen values were varied between 63 mg/L to 03 mg/L. The removal of phosphorus, from Municipal wastewater by microalgae cultivation as a function of incubation time are shown in Fig:3. After 107 days of algal cultivation, the Total kjeldhal Nitrogen content were reduced from 68 mg/L to 28 mg/L, 62 mg/L to 26 mg/L, 65 mg/L to 24 mg/L, 60 mg/L to 26mg/L, 64 mg/L to 28 mg/L, 36 mg/L to 30 mg/L and their removal efficiency were around 58%, 58%, 63%, 56%, 57%, 16%, for the respective Batch Cultures (01,02,03,04,05, CONTROL).

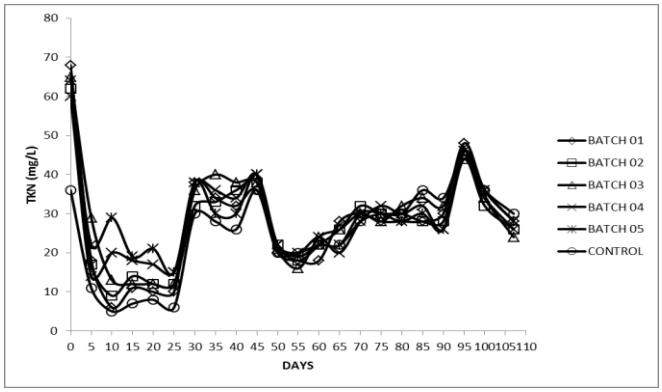

Fig 3 Changes of Total Kjeldhal Nitrogen values of different batch cultures during the treatment period

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Wang & Lan,, 2011, conducted an experiment using secondary wastewater and the removal efficiency obtained was about 78-99%. Cho et al.,2011 conducted a experiment in municipal wastewater and the maximum removal efficiency obtained was about 92%. In this study we obtained a maximum removal efficiency of 63%.

Chemical oxygen Demand: Chemical oxygen Demand values were varied between 430 mg/L to 60 mg/L. The removal of Chemical oxygen Demand from Municipal wastewater by microalgae cultivation as a function of incubation time is shown in Fig 4. After 107 days of algal cultivation, the Chemical oxygen Demand content were reduced from 410 mg/L to 110 mg/L, 240 mg/L to 120 mg/L, 280 mg/L to 130 mg/L, 430 mg/L to 90mg/L, 330 mg/L to 90 mg/L, 300 mg/L to 110 mg/L and their removal efficiency were around 73%, 50%, 53%, 79%, 73%, 63%, for the respective Batch Cultures (01,02,03,04,05, CONTROL).

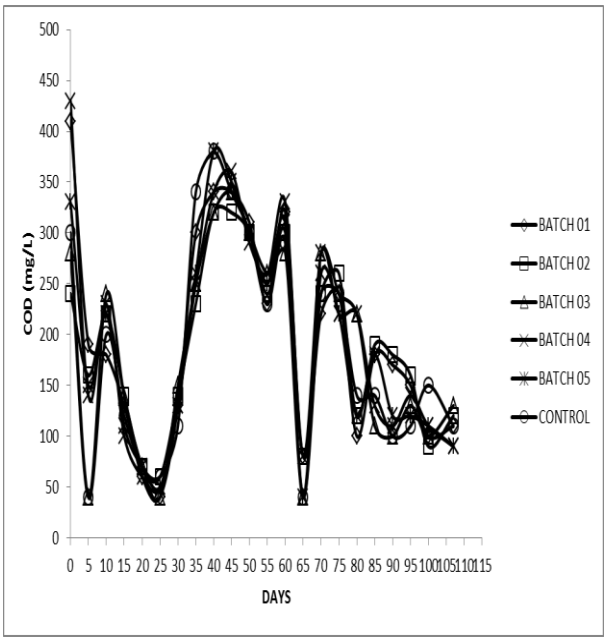

Fig 4: Changes of Chemical oxygen Demand values of different batch cultures during the treatment period

Cho et al.,2011, conducted a experiment in municipal wastewater and the maximum removal efficiency obtained was about 24.8%. In this study we obtained a maximum removal efficiency of 79%

Total Dissolved Solids Total Dissolved Solids values were varied between 2320 mg/L to 1040 mg/L. The growth of microalgae in terms of Total Dissolved Solids in Municipal wastewater as a function of incubation time is shown in Fig: 5 , respectively. After 107 days of algal cultivation, the Total Dissolved Solids content were increased from 1430 mg/L to 1880 mg/L, 1430 mg/L to 1990 mg/L, 1460 mg/L to 2005 mg/L, 1470 mg/L to 2180mg/L, 1470 mg/L to 2110 mg/L, 1080 mg/L to 2003 mg/L and their growth efficiency were around 31%, 39%, 37%, 48%, 43%, 85%, for the respective Batch Cultures (01,02,03,04,05, CONTROL). Of all the batch cultures CONTROL showed the greater increased efficiency for Total Dissolved Solids.

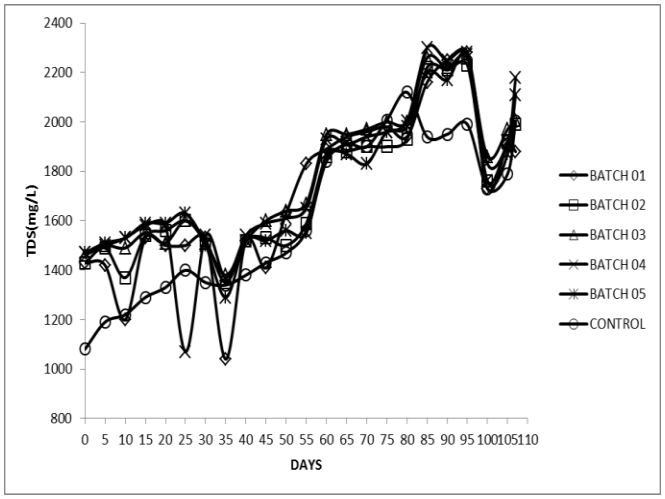

Fig 5 Changes of Total Dissolved Solids values of different batch cultures during the treatment period

Total Volatile Suspended Solids Total Volatile Suspended Solids values were varied between 1110 mg/L to 400 mg/L. The growth of microalgae in terms of Total Volatile Suspended Solids in Municipal wastewater as a function of incubation time is shown in Fig 6. After 107 days of algal cultivation, Total Volatile Suspended Solids content were increased from 500 mg/L to 1110 mg/L, 500 mg/L to 1000 mg/L, 400 mg/L to 800 mg/L, 400 mg/L to 800 mg/L, 400 mg/L to 800 mg/L, 400 mg/L to 800 mg/L and their growth efficiency were around 120%, 100%, 100%, 100%, 100%, 100%, for the respective Batch Cultures (01,02,03,04,05, CONTROL).

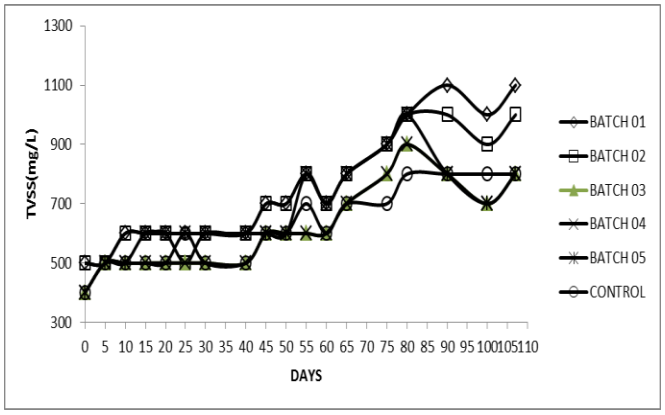

Fig 6 Changes of Total Volatile Suspended Solids values of different batch cultures during the treatment period

Li et al., 2011 conducted an experiment using municipal wastewater and the maximum biomass growth obtained was about 1.028 g/L. in this study the maximum biomass growth obtained in terms of TVSS is 1.11 g/L. *Salinity*: Salinity values were varied between 695 mg/L to 1560 mg/L The growth of microalgae in terms of salinity in Municipal wastewater as a function of incubation time. After 107 days of algal cultivation, salinity content were increased from 939 mg/L to 1500 mg/L, 940 mg/L to 1510 mg/L, 956 mg/L to 1560 mg/L, 965 mg/L to 1470 mg/L, 967 mg/L to 1400 mg/L, 695 mg/L to 1350 mg/L and their growth efficiency were around 60%, 61%, 63%, 52%, 44%, 94%, for the respective Batch Cultures (01,02,03,04,05, CONTROL). Of all the batch cultures CONTROL showed the greater increased efficiency for Salinity.

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IV. CONCLUSION

Municipal wastewater could support the growth of algal species isolated from water bodies. After 107 days of cultivating five genera's namely Anabaena, Diatoms, Spirogyra, Hyalophacus, Monoraphidium in municipal wastewater the total kjeldhal nitrogen was reduced to 58%,58%,63%,56%,57%,16% and the total phosphorus was reduced to 82%, 87%, 87%, 84%,87%, 86% respectively. The biomass produced can be used for combined benefit of sustainable biofuel production and wastewater treatment with simultaneous carbon dioxide sequestration

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AUTHOR PROFILE

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