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# Design of Algal Photo Bioreactor Using Recycled PET Bottles

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**Abstract -** *Algal farming offers favourable measures for providing the products from Recycled PET bottles to maintain the algae cutdown on $CO_2$ emissions. The growth of technology algae has fulfilled with the way to produce biofuel as water bottles. The nutrient treatment has added on the increased necessity with the increased algae production yield. In the study, it has been discovered on building an algae with the recycled water bottles as well as the treatment of nutrients needed for algae.*

***Key Words***: Algae, Photo Bio-Reactor, Recycled PET Bottles,

## 1.INTRODUCTION

Algae is a diverse range to the photosynthetic measures to the polyphyletic. This can also add a range of unicellular genera with the multicellular forms to which aquatic and autotrophic and lack of distinctive cell and tissue types such as xylem, stomata and phloem with the inland plants. The study provides a promising alternative to carbon-di-oxide mitigation through fixation measures. It has added a bio-fuel production and wastewater treatments. It can potentially added diminish the release into the atmosphere. The objective of the study is to determine the specific growth rate of algal species in PET bottles, different media, determination of carbon-di-oxide fixation rate for different media.

### 1.1 ALGAL PHOTO BIOREACTOR

An algal photo-bioreactor or bioreactor is used for purpose of attaining the burnout face where CO2 can fix on the bioethanol and biodiesel to add on animal feed with the pollutants with NO2 and CO2 through flue gases and adding power plants. The bioreactor has added on the photosynthetic reaction remarks on the dissolved oxygen and carbondioxide with the accessibility to growth in the certain range. The bioreactor must be made out of transparent material. The algae are photoautotroph organisms which perform oxygenic photosynthesis.

The equation for photosynthesis:

$$6\,CO_2 + 6\,H_2O \longrightarrow C_6H_{12}O_6 + 6\,O_2 \quad \Delta H^0 = +2870\ \frac{KJ}{mol} \quad \ldots\ldots\ldots\ldots (1)$$

Figure 1: Algal Photo Bioreactor
Source: Aguirre et al., 2011

### 1.2 METHOD OF CULTIVATION OF ALGAE

Algae has added environmental conditions to which applications of treatment of sewage, eutrophication prevention and fertilizer recovery, Carbon-di-oxide with the food source and attaining the biofuels from animals and phototrophic microorganisms. They need to supply with the nitrogen and phosphorous is the main nutrients needed to algae cultivation.

Open Pond System and Closed System needs to minimize the cultivation dark zone and power ingesting. It has added on the controlled way to guide the baffles placed in the flow channel.

### 1.3 TYPES OF ALGAE PHOTOBIOREACTOR

#### 1.3.1 Plate photo bioreactor

A plate photo bioreactor adds on the perpendicular with the inclined stages to the separated ways. The connections can remark on the process of filling and emptying the ways to flue gases as they were related to the time which maintain reactor fluid with photobioreactor. The pricing ranges adds on the enlarged foiling systems. It must be kept with the systematic ranges in a limited time to full balances. The investment requires

the support of hydrodynamic pressure with the improve photoconversion efficiency.

**Fig.1.2: Plate photo-bioreactor**

### 1.3.2 Tubular photo bioreactor

A tubular reactor has two vertical and horizontal ranged with the pipe system. The algae has suspended to meet with the plastics with transparent range of the constant circulation with pump and beginning the tube system. The gas causes the problem of carbon-di-oxide being affecting the circulation and bad efficiency.

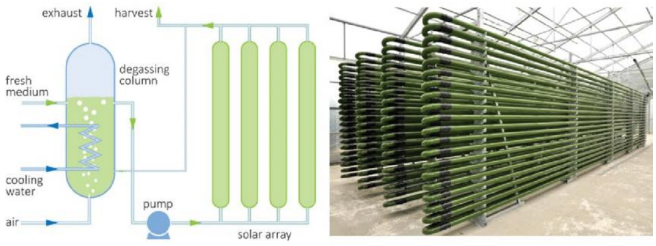


**Fig.1.3: Tubular photo bioreactor**

### 1.3.3 Bubble column photo bioreactor

A bubble column photo reactor with the cylindrical range to which preface of the bottom can meet the optimal range of the gas exchange. The turbulent stream to which gas exchange maximum diameter with 20 to 30 cm. The energy source is sunlight with the limited range to shape with the cone collectors and adding on constructions to column reactors with wider extent. The scale of the manufacturing the CO2 with the outweigh on the reactors.

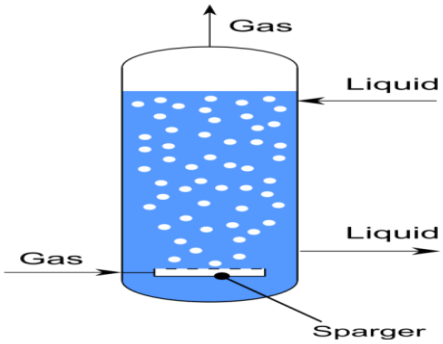


**Fig.1.4: Bubble column photo bioreactor**

## 2. LITERATURE REVIEW

**Adrianus Jan Hagendijk 2015**, Understanding the ideal circumstances for algal production with the best conditions. It has influence the needs of specific conditions which attains on the photobioreactor which meet with the capable optimum production to which the negative influence of the prohibited management. The cost analysis has added on the algae production with the biomass algae.

**Jean U and Hokemen, 2017**, it has alternative to conserve with the feedstocks owe to energy with the foreign exchange, socio-economic benefits. The way to increase manage the inorganic carbon-di-oxide meet with the quality of the lipids and proteins and conversion of algal feedstock into bio-crude.

**Mata T. 2012** analyzed the remarkability to biomass with the brewery wastewater. The parameters meet with the biomass productions to cultivate the utmost probability to biomass per litre and growth of the product through 9th Day.

**Cheirsilp B 2012**, has added on advanced amount of biomass products with the cultivation of the concentration level with the lipids production and batch cultivation tow appropriate consideration for biodiesel production.

**Khoeyi Z 2011**, presented the sample which are operated in the light conditions. The biomass might add on the records with 0.1g and 2.05g. The culture growth has added on the 62.5 mol photons/ms for added on the dark photoperiod duration.

**Demirbas and Faith Demirbas, 2011**, Alage has added on the complexities with the establishment of the energy, water along with the saline and adding on the growing needs to biotapes with the ecological diversity and physiological flexibility to specific environment.

## 3. METHODOLOGY

### 3.1 Experimental setup

The experiments basically consist of a simple setup consisting of the following: Recycled PET bottles, Algae, Nutrients, Water, Stand and Tube light

### 3.2 Chemicals

The chemical compounds used are:

NaHCO3, NH2CONH2, (NH4)2SO4, KH2PO4, K2HPO4, CaSO4.2H2O, MgSO4.7H2O and Distilled water.

### 3.3Preparation of the stock solution

#### 3.3.1 Nutrient media 1: Ammonium Sulphate and Urea

Stock solution of 1400 ml of nutrients is prepared using ammonium sulphate ((NH4)2SO4); molecular weight 132.14 and urea (NH2CONH2); molecular weight 60.06. For 1400 ml of stock solution of nutrients, 14 g of ammonium sulphate and 14 g urea is dissolved in 1400 ml of distilled water. With this stock solution at various concentrations of sodium bicarbonate (NaHCO3) i.e. 20 mM, 30mM, 40mM, 50mM, 60mM, 100mM and 150mM, 200 ml of each of the solution is prepared in seven PET bottles. Further 2 g of culture i.e. algae from fresh pond is added in each of the bottles.

#### 3.3.2 Nutrient media 2: Minimum Salt Media (MSM)

Same as Nutrient media 1, another media with stock solution of 1000 ml of MSM nutrient is prepared using the following composition.

| S. No. | Constituents | Quantity (g/L) |
|---|---|---|
| 1 | (NH4)2SO4 | 1 |
| 2 | MgSO4.7H2O | 0.5 |
| 3 | CaSO4.2H2O | 0.05 |
| 4 | K2HPO4 | 0.8 |
| 5 | KH2PO4 | 0.3 |

**Table.3.1: MSM Composition for sample prepared**

This time only two samples were prepared by dissolving the above components in table 2 in 1000ml of distilled water. With this stock solution two solutions at concentrations of 40mM and 50mM of NaHCO3 are prepared with 200 ml solution of each. Further 2 g algae are added to two of the solutions in the PET bottles.


**Figure 3.1 Day 1 Algae Cultivation**


**Figure 3.2 Day 9 Alage Cultivation**

The kinetic study is carried out for 12 days with an interval of 24 hrs. The study is performed at different concentrations of $NaHCO_3$. With nutrient media 1, 20mM, 30mM, 40mM, 50mM, 60mM, 100mM and 150mM concentration of $NaHCO_3$ are prepared from the stock solution of exactly 200 ml each. And similarly with nutrient media 2, 40mM and 50mM concentrated solutions are prepared. The experiment is conducted at approximately $26^0$C. It is observed that the samples of 100mM and 150mM could not survive the test. So study for the $CO_2$ fixation of other remaining bottles was carried for 12 days.

## 4. RESULTS

The analysis of kinetic study is carried out by formative biomass of algae cultivated at two different nutrient media. Hence specific growth rate is estimated through the plot between the no. of cell vs time, Finally $CO_2$ fixation rate was

calculated at different concentration of $NaHCO_3$ for both the media.

Biomass vs. time plot is shown in below table for nutrient media as ammonium sulphate and urea and for MSM media correspondingly. In case of Ammonium sulphate and urea the most favourable growth was found to be in case of 50mM $NaHCO_3$ as compared to other concentrations till 6th day. After that the growth ceases and death phase starts. In case of MSM the growth occurs till 8th day for both 40mM and 50mM $NaHCO_3$ and the decrement in growth was experiential.

**Table 1-** Media 1

| Samples | Specific Growth Rate | Adj. R Square | Max. Productivity (g/mL) | Biomass Productivity/Day (g/mL/Day) | $CO_2$ Fixation Rate(g/mL/Day) |
|---|---|---|---|---|---|
| 20mM $NaHCO_3$ | 4.80E-04 | 0.84249 | 0.002 | 0.00033 | 0.00062 |
| 30mM $NaHCO_3$ | 0.00204 | 0.43561 | 0.0068 | 0.00170 | 0.00318 |
| 40mM $NaHCO_3$ | 0.36366 | 0.72211 | 0.0016 | 0.00320 | 0.00598 |
| 50mM $NaHCO_3$ | 0.32135 | 0.88819 | 0.0098 | 0.00163 | 0.00305 |
| 60mM $NaHCO_3$ | 0.37716 | 0.89234 | 0.00898 | 0.00180 | 0.00336 |

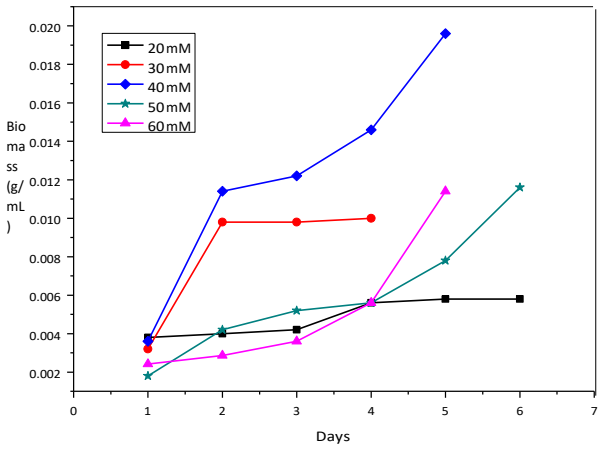


**Figure 4.1: Biomass Growth Curve for Media 1(Ammonium Sulphate-Urea)**

While $CO_2$ fixation rate determine the organic compounds to requisite for growth. It has access on the compound conversion by 1.87* Biomass productivity per day.

**Table 2**- Media 2

| Samples | Specific Growth Rate | Adj. R Square | Max. Productivity (g/mL) | Biomass Productivity/Day (g/mL/Day) | $CO_2$ Fixation Rate(g/mL/Day) |
|---|---|---|---|---|---|
| 40mM $NaHCO_3$ | 0.13722 | 0.74165 | 0.00642 | 0.00080 | 0.001501 |
| 50mM $NaHCO_3$ | 0.13063 | 0.89998 | 0.00662 | 0.00083 | 0.001547 |

The algal samples have added on solvent mixture and refluxed on 4 hours. The management of the extraction to which cooled with the residual lipids with the biomass and taking the separate funnel which focuses on 1% of the aqueous sodium and adding two times. The solvent layers were passed with the anhydrous sodium sulphate in glass funnel and adding solvent through rota-evaporator under vacuum to get algal oil.

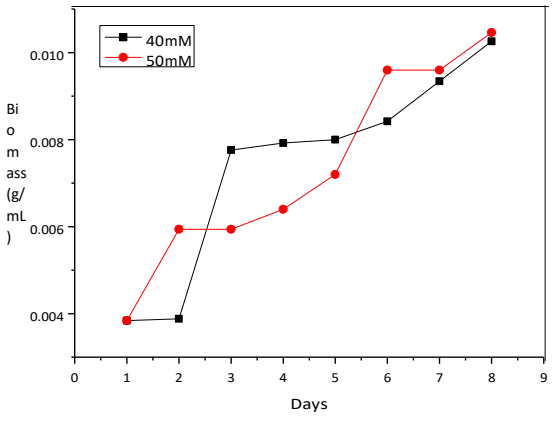


**Figure 4.2: Biomass Growth Curve for Media 2(MSM)**

The growth detection for the information has integrated on the equations and limits 0 and t and X and $X_0$. It can be plotted of ln(X/X0) vs time is plotted and linearly fit to conclude specific growth rate. The slope of the curve will define μ value to production value of the algae with $1.40 per litre. The petrol and diesel can add on the replacement with the current fossil fuel with algae with biofuel through no net effect on the environmental levels of carbon-di-oxide with the level of carbon-di-oxide in the atmosphere.

## 5. CONCLUSIONS

The role of the biomass initiatives needs to draw attention with the dependence of imported oil production, it has created economic, social and environmental worries with the national security. The algae with the antenna pigments with 50% of the photosynthesis and adding light energy with the attribute with the carbon cycle global measures. The algae with the carbon-di-oxide adds on the absorption and change with the solar energy into chemical energy.

As this study mention, carbon dioxide emission might be the cause of global warming, and one way to decrease the emission is by algae. Like all living belongings, an algae requirement the accurate environment in order for it to do at its best, and, for this case, capturing carbon dioxide. In this study, the specific growth rate of algae, $CO_2$ fixation amount, biomass productivity is resolute at different concentration of two different media. For nutrient media 1 i.e. with ammonium sulphate and urea as nutrient , the concentrations tested are 20mM, 30mM, 40mM, 50mM, 60mM, 100mM and 150mM of $NaHCO_3$, where 60mM is found to show the best growth rate. The growth rate was found to be 0.3376 cells/day. For nutrients media 2 with MSM as nutrient, the concentration tested is 40mM and 50mM. Where, 40mM of $NaHCO_3$ was found to be optimum for the growth of algae. The growth rate is found to be 0.13722 cells/day.

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