WORLD WATER DAY

"GREENHOUSE GAS SEQUESTRATION BY CO_2 CAPTURE VIA SPIRULINA PLATENSIS MICROALGAE CULTIVATED IN PHOTOBIOREACTOR"

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INTRODUCTION

Background

- CO_2 is the primary GHGs which are emitted through human activities or produced directly naturally in the atmosphere and consequently contribute to climate change.
- The quantity of CO_2 that 1 kg of dry Spirulina can absorb is 1.83 kg of CO_2.
- Spirulina has high photosynthesis rate and cell wall containing without cellulose, thus its simpler degradable for biogas production.

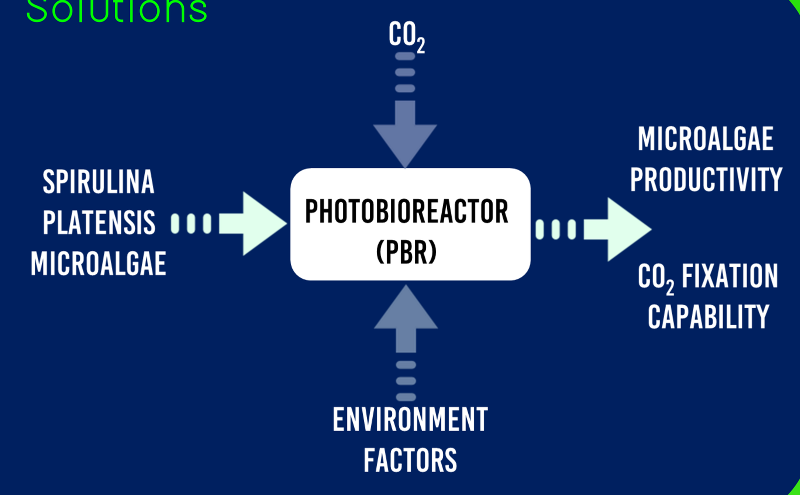
Problem Statement

Figure out how to acquire maximum CO_2 fixation of cultivate Spirulina Platensis microalgae in photobioreactor and assessing the feasibility to apply algae biomass byproducts for bioenergy.

Project objectives

The experiments carried out to decide the relationship between adjusting in the flow rate of CO_2 in Spirulina cultivation in photobioreactor to the growth of microalgae cells and determine CO_2 fixation capability.

Solutions



LITERATURE REVIEW

- Specific Growth Rate; μ (d^{-1})

$$\mu = \frac{lnX_2 - lnX_1}{t_2 - t_1} \quad \text{Eq. (1)}$$

Where: X_1 and X_2 are biomass concentrations at time intervals t_1 and t_2

- Biomass Productivity Rate; P (mg L^{-1} d^{-1})

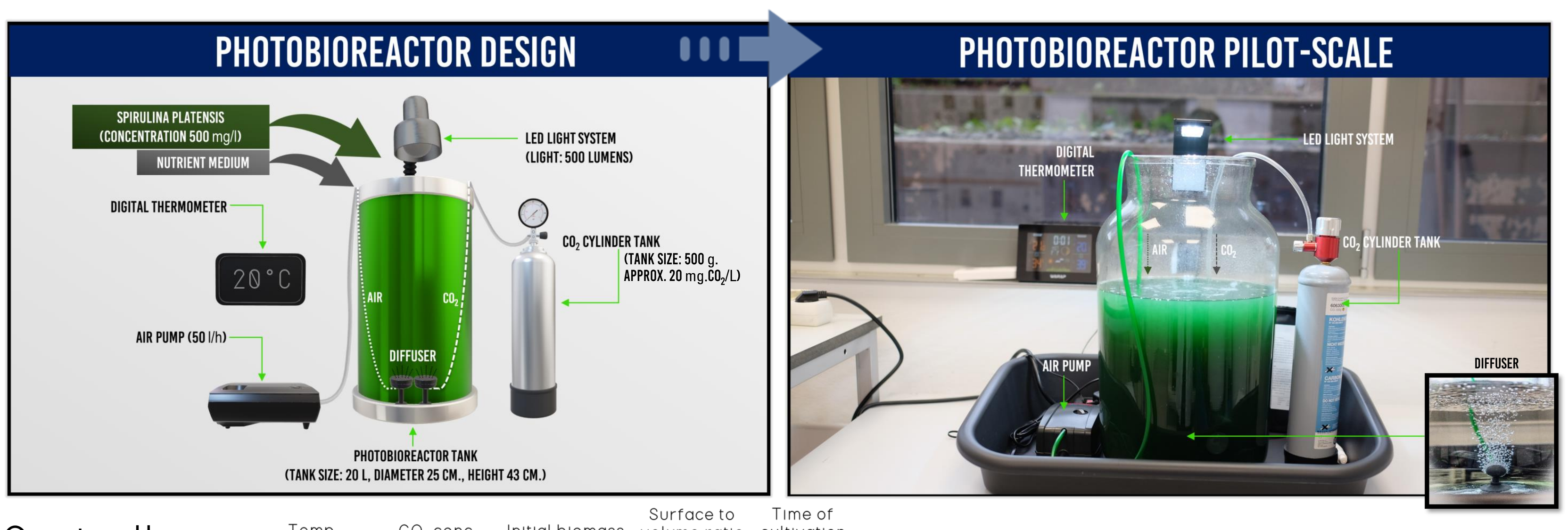
$$P = \frac{X_t - X_0}{t - t_0} \quad \text{Eq. (2)}$$

Where: X_t is biomass concentration (mg/L) at t (day)
X_0 is biomass concentration at inoculation

- CO_2 Fixation Rate; P_{CO2} (mg L^{-1} d^{-1})

$$P_{CO_2} = 1.88 \times biomass\ productivity \quad \text{Eq. (3)}$$

MATERIALS AND METHODS



Controller Parameters

- Temp 20-22 °C
- CO_2 conc. 0-20%
- Initial biomass Algae 500 mg/L
- Surface to volume ratio 20 m^{-1}
- Time of cultivation 14 days
- pH 8.5-10.5
- Light intensity 500 lumens, 6500K daylight (time: 24 hrs.)
- Air conc. 0-50 l/h
- PBR material Glass (transparency & acid/base resistance)
- Nutrient Sodium, chloride, nitrogen, phosphorus, potassium, etc.

Independent Variables: pH, temp, light Air, CO_2 Conc.

Dependent Variables:
- Microalgae biomass byproduct volume
- Cell density
- CO_2 removal

Methods:

I. Algae inoculation into photobioreactor
II. Inject air flow: 0 l/h (day 1-6), 50 l/h (day 7-14)
III. Inject CO_2 concentrations: 0% (day 1-6), 50% v/v (day 1-7)
IV. Measure pH, DO, and temp with Multimeter
V. Measure Biomass concentration with dry weight measurement

- ✓ The experiment was run for **14 days** and the biomass measurement was recorded every **24 hrs.**
- ✓ A **volumetric pipette** was used to withdraw **40 ml sample** from the growing media.
- ✓ Biomass was then separated from the sample using **filtration equipment.**
- ✓ The concentrated biomass was collected using **qualitative filter paper** with a diameter of 11 cm. and the pore size of 20-25 µm.
- ✓ In every sample, the filter paper was weighed using a **3 digits Precision Balance** to record initial weight and then placed in **Glass Desiccator** to dry the biomass for 24 hrs.
- ✓ Then, the final weight was recorded.
- ✓ The average biomass on a daily basis was calculated to compare the values

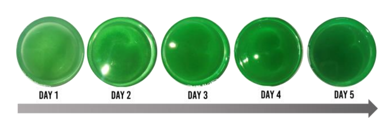


Fig. 1: Spirulina sample of the growing media from day 1-5

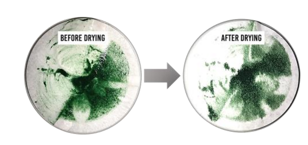
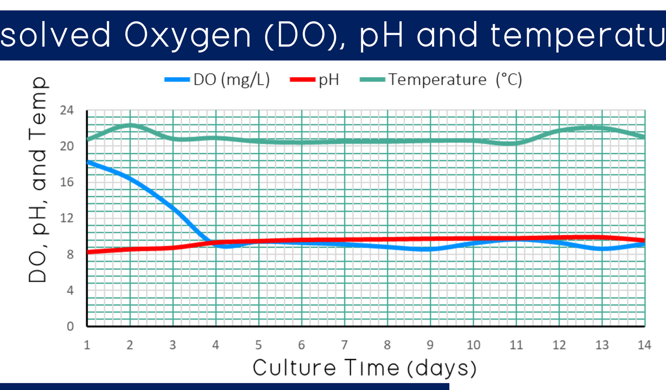


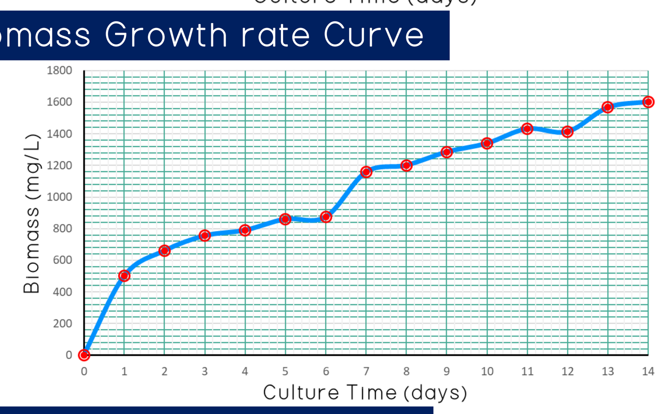
Fig. 2: Spirulina biomass before and after drying

RESULTS

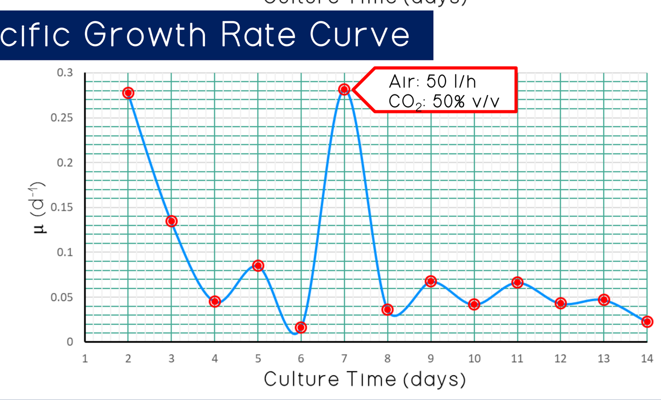
A Dissolved Oxygen (DO), pH and temperature



B Biomass Growth rate Curve



C Specific Growth Rate Curve



D Biomass Productivity and CO_2 Fixation Rate

- ✓ Maximum Biomass Productivity Rate; P = 284 mg L^{-1} d^{-1}
- ✓ Maximum CO_2 Fixation Rate; P_{CO2} = 533.92 mg L^{-1} d^{-1}

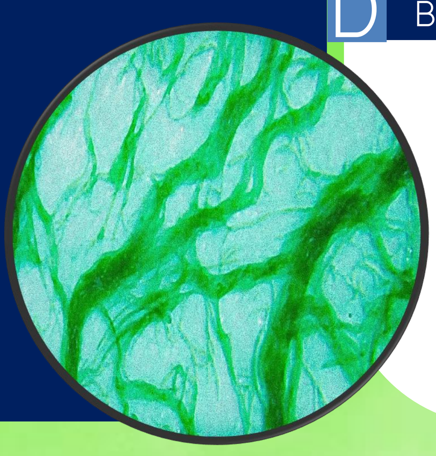


Fig. 3: Microscopic observations of Spirulina

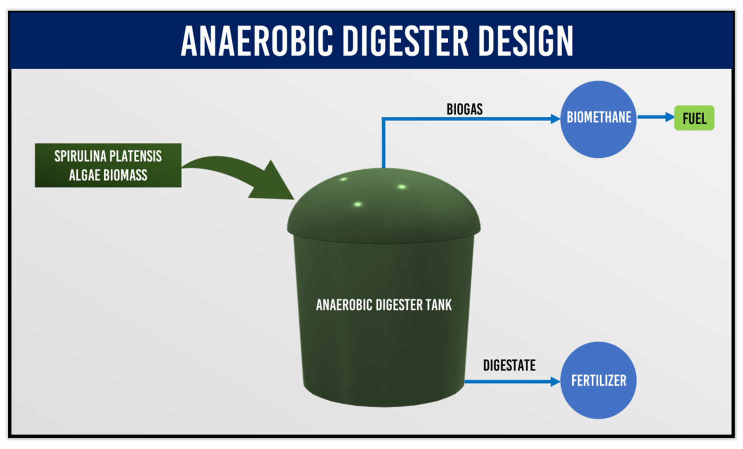
DISCUSSION

- During the 14-day experimental period, the water quality parameters of the growth medium varied.
- The initial of DO is dramatically decreasing. Then, a small variation was observed in the DO because of a continuous supply of the air to the reactor.
- The pH of the sample was recorded at 8.30 at the beginning. After that, it gradually increased in the range of 8.61-9.92.
- The temperature of roughly 20 °C is suitable for the growth of this Spirulina microalgae. As a consequence, the temperature in the PBR was controlled by a heater in range of 20-22 °C
- The algal biomass concentration was initially 500 mg/L. As the number of algal cells was rapidly increased, a continuing growth in biomass was noticed.
- Because of increased air and CO_2 concentration, rapid expansion can be detected on day 7, with biomass increasing up to 2 times its initial volume.
- Until day 14, the maximum biomass weight was determined at 1,603 mg/L.

CONCLUSIONS

- ✓ The increased CO_2 concentration affects the growth of microalgae cells.
- ✓ The amount of CO_2 absorbed by microalgae cultivated in photobioreactor for 14 days with a flow rate approx. 20 mg.CO_2/L shown that the maximum CO_2 fixation rate was 533.92 mg L^{-1} d^{-1}.

FUTURE RESEARCH



- ✓ Anaerobic digestion is a promising application of algal biomass for producing bioenergy while allowing recovery of inorganic nutrients (nitrogen and phosphorus) for reuse.
- ✓ Methane yield from Spirulina sp. have been reported at 260–320 L/kg VS. [1]

REFERENCES

[1] F. Bux and Y. Chisti (eds.) (2016). Algae Biotechnology, Green Energy and Technology, Springer International Publishing Switzerland.
[2] Katuwal, Sarmila. (2017).Designing and Development of a Photobioreactor for Optimizing the Growth of Micro Algae. South Dakota State University.
[3] P. Dyah Prinajati (2021). Analysis of Reducing CO_2 Emissions Using Spirulina Microalgae. Journal of Community Based Environmental Engineering and Management, Vol. 5, No. 1: 47-56

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