Study of Microalgae Biofixation for Carbon Capture and Utilization (CCU)

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Background

- Human activities have significantly increased the global CO_2 level (>400ppm) resulted in global warming and extreme climate change.
- Microalgae has been applied for nutrients nitrogen (N) & phosphate (P) removal in wastewater treatment. Removal of CO_2 by microalgae biofixation has also been proposed due to its higher growth rate.
- Microalgae biomass can be converted into biofuel for electricity generation, thus fossil fuel consumption can be reduced.

Objectives

- To optimize different growth conditions such as medium pH, nutrients N & P levels required for marine microalgae; *Tetraselmis* sp.
- To study the critical effects of different carbon sources (i.e. CO_2 or HCO_3^-) in *Tetraselmis* sp. culture.
- To determine the pH change and dry biomass weight of culture medium with different levels of CO_2.

Materials

- Shaking incubator: for cultivation of marine microalgae; *Tetraselmis* sp. with agitation, light-dark cycle and temperature control.
- 100 mL culture medium (seawater with Guillard's f/2 or BG-11 medium).

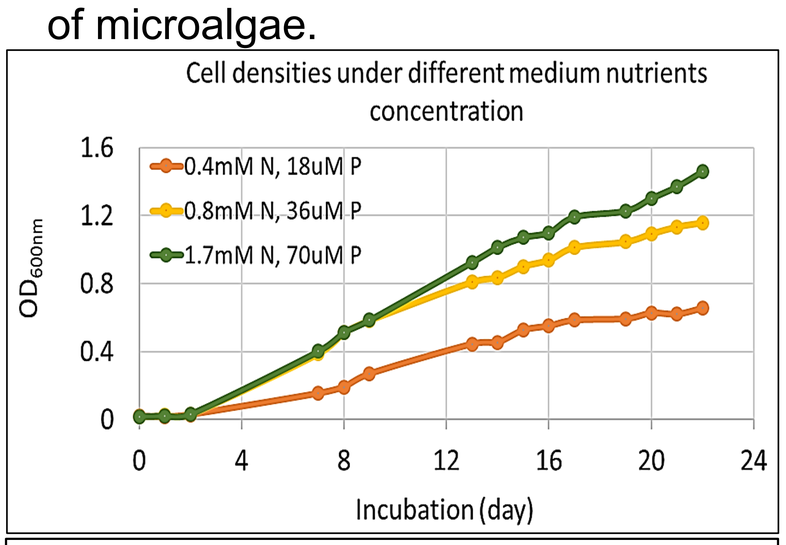
- Spectrophotometer: for cell density measurement (OD_{600nm}).
- Centrifuge (6000rpm): for collection of microalgae cells.
- Dry biomass weight determined using an oven at 105°C.
- Microscope and haemocytometer: for cell counting and observation.

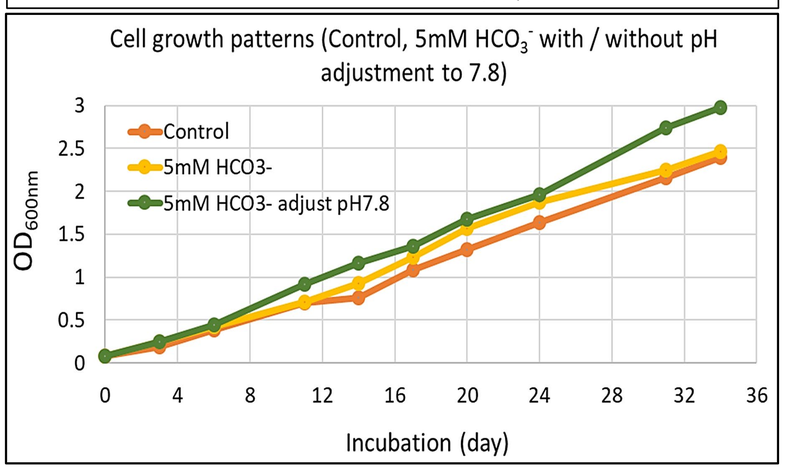
Method

- Microalgae were cultivated at 25°C, 150 rpm at pH 7.8 with 16:8h light dark cycle for 7-28 days. Samples were collected for cell density measurement (OD_{600nm}) and direct cell counting.
- Collected samples were centrifuged, washed & dried to obtain dry biomass weight which can be used to estimate the amount of CO_2 removed by microalgae biofixation, also the culture medium pH was measured during incubation.
- The effects of nutrients N & P were investigated to optimize the growth of *Tetraselmsis* sp. Trials of adding HCO_3^- with & without pH adjustment (to 7.8) along incubation was compared. The effect of CO_2 level on microalgae growth was studied by feeding different amount of pure CO_2 gas into culture medium.

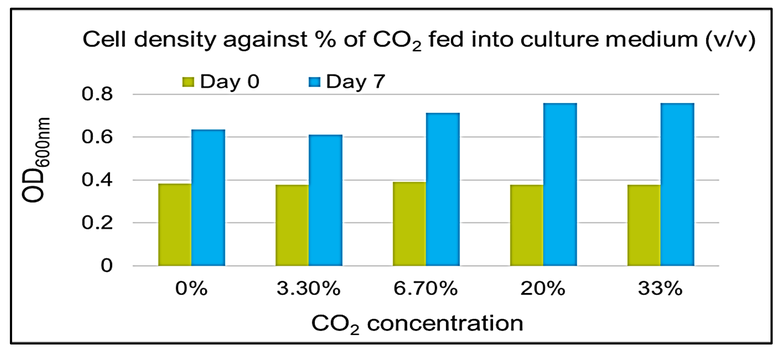
Results: microalgae growth

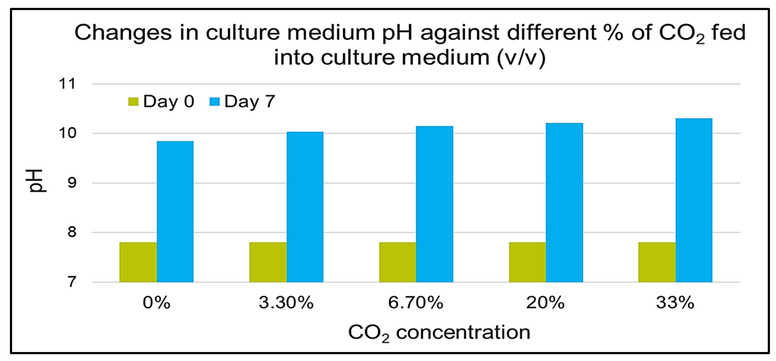
- Through optimization of medium N and P concentrations, highest growth of *Tetraselmis* sp. was observed at 0.8mM-N & 36μM-P
- Significant growth enhancement was not observed at high nutrient levels
- Extra carbon source (i.e. 5mM HCO_3^-) enhanced cell growth; high pH in prolonged incubation affected growth of microalgae.

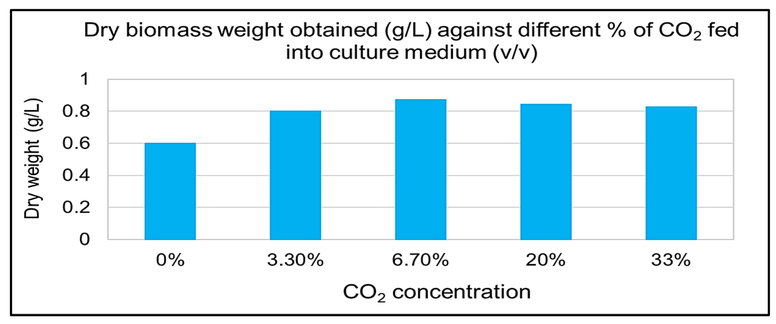




Result: effect of $[CO_2]$







Day 7 (0%, 3.30%, 6.70%, 20% and 33% CO_2)

- Dose of CO_2 above atmospheric level (i.e. 0.04%)(v/v) showed faster growth rate of *Tetraselmis* sp. Also, a higher dry biomass weight obtained from higher CO_2 feeding can be used for biofuel production.
- Feeding CO_2 at 6.7%-20% can achieve higher CO_2 removal through microalgae biofixation.

Conclusion

- In addition to wastewater treatment for nutrients removal, microalage biofixation using *Tetraselmis* sp. at optimized pH can be promptly applied for CO_2 removal from different flue-gas emission sources such as fossil-fuel combustion in power plants.

Acknowledgment

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