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Carbon Dioxide Utilization for Fast Algae Cultivation

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1. Introduction

Algae are photosynthetic organisms commonly used due to the valuable compounds in their composition and exhale oxygen. It can be an alternative resource for ensuring food, fuel, and sustainable human civilization.

Challenges:

- ❑ Operating and maintenance cost
- ❑ Initial high costs construction
- ❑ Large scale fast algae cultivation

Research approach:

- ❑ Using CO_2 for fast growth of algae
- ❑ Closed photobioreactor system cultivation

This research related directly to six and indirectly ten Sustainable development goals 2020.

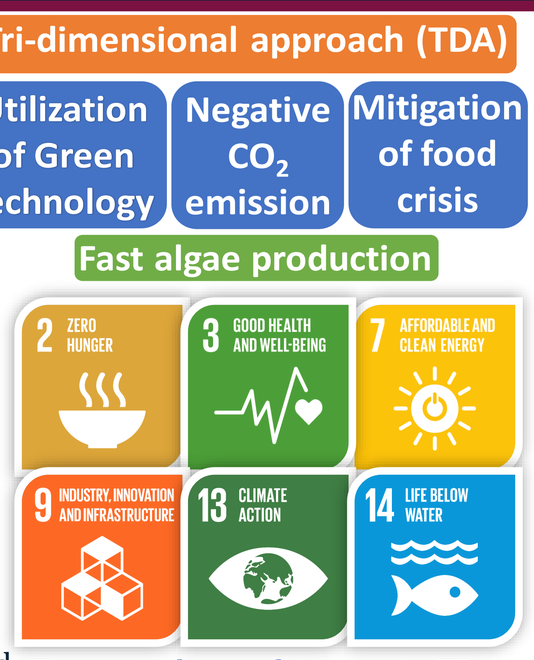

Figure 1 Algae cultivation in TDA approach and sustainable development goals 2020

2. Background

- ➢ Microalgae can be cultivated in both open systems and closed photobioreactors. It is a significant challenge to design closed photobioreactors that are economically potential for large scale cultivation. We used carbon di-oxide from the powerplant to reduce the production cost, contamination chance and increase productivity.
- ➢ It ensures high value products, such as nutraceuticals, beta carotene, cosmetics, biofuels, fish and animal feed, and many industrial applications.
- ➢ It does not require arable land and fresh water.

Open system	Closed system
1. Low productivity	1. Less CO_2 losses
2. High contamination	2. No contamination
3. High CO_2 losses	3. High productivity
4. Not hygienic	4. Reproducible
5. Difficult to collect biomass	5. Intact food quality
6. Low operating cost	6. Easy to predictability
7. Weak control	7. Good control
8. Very high water loss	8. Low water loss

(b)

Figure 2 Algae cultivation in (a) closed system (b) comparison of open and closed photobioreactor system

3. Methodology

- ❖ High dissolved gas dissolution (HDGD) technique has been applied to cultivate Spirulina species for the first time. This new technique is better than any other conventional gas mixing system.
- ❖ It is possible to dissolve gases at normal temperature in contained or seawater.
- ❖ To make a prototype for fast algae cultivation with some customization of the current model and choose promising microalgae strain for collect data.
- ❖ To test the algae cultivation data and compare it with the prior standard results for maximizing productivity with minimal cost.

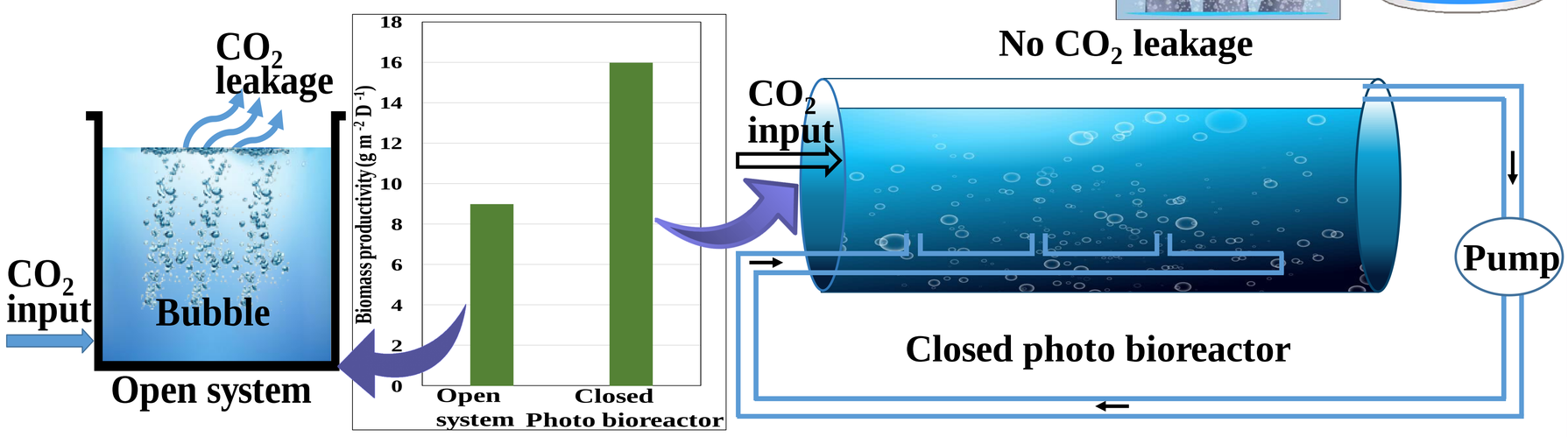

Figure 3: HDGD technique and Biomass productivity in open system and without CO_2 leakage in closed photobioreactor

4. Results & future plan

- ❖ In our experiment, the biomass of Spirulina platensis increases 1.7 times in 10% CO_2 enriched seawater (CSW_{10}) more than natural seawater (NSW).
- ❖ For the first 2 days the growth rate of algae is almost the same.
- ❖ To maximize the effective parameters for microalgae cultivation, we simulate this system by using numerical analysis as well as kinetics modeling (logistics equation) and find the predicting values.

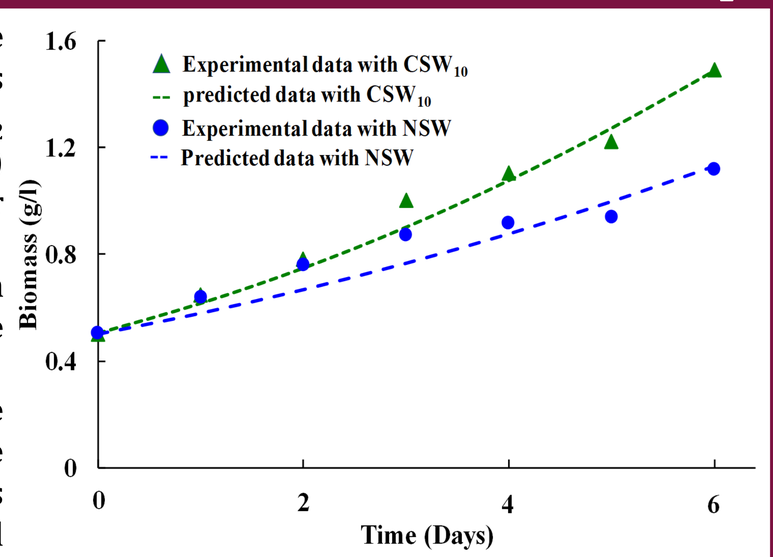

Figure 4 Cultivation of Spirulina platensis: 10% carbon dioxide enriched seawater (CSW_{10}) and natural seawater (NSW)

Table: Vision of fast microalgae cultivation and negative CO_2 emission

Target area	2 years	5 years	10 years
Productivity	Double than present yield	Triple	More than 6-fold
Negative emission of CO_2	1 ton/year	3-fold	10-fold
Scalability	300 litres of water used for cultivation	The pilot system app. 20-ton water will be used	Large scale production of seaweed

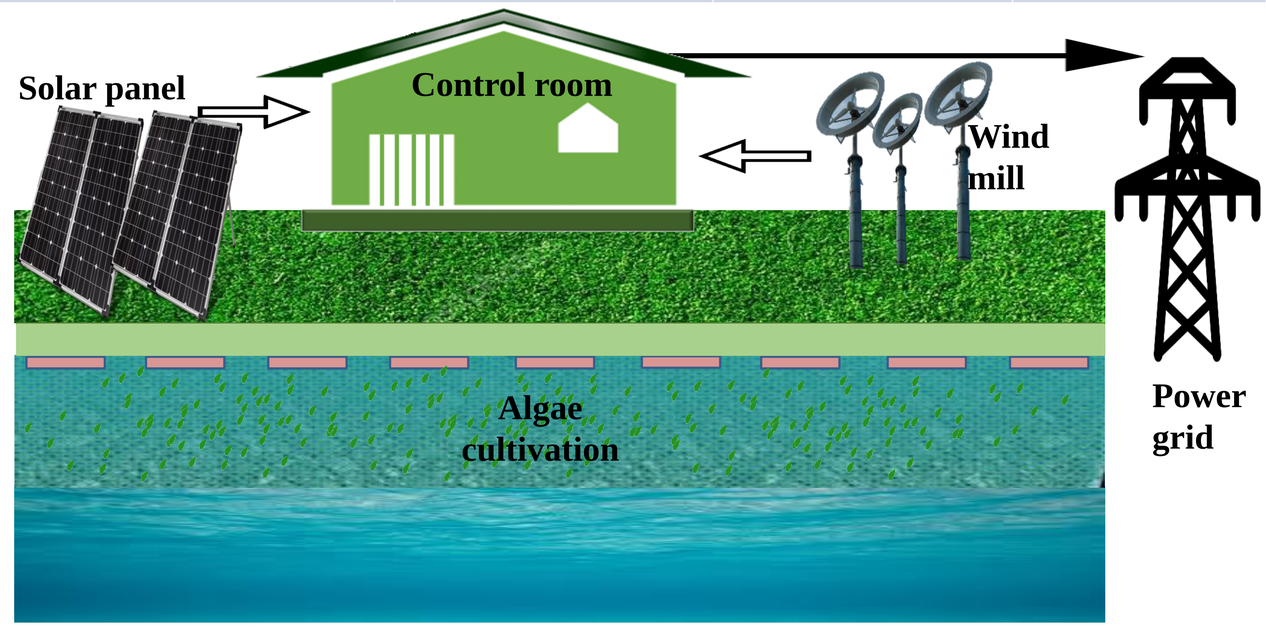

Figure 5: Large scale cultivation of microalgae for reducing negative CO_2 emission

5. Summary

- ❑ Microalgae is the most alternative promising resource for ensuring functional foods (human, animal diets of fish food), finance, and fuel security.
- ❑ A closed photobioreactor system reduces the leakage of carbon dioxide and ensures hygienic issues for algal cultivation.
- ❑ High dissolved gas dissolution (HDGD) system is an innovative technique for dissolving various gases on to water where approximately 100% dissolution is possible. Using the HDGD system, captured CO_2 can be dissolved on to water without any risk of exposing greenhouse gas into the air.
- ❑ In a lab-scale experiment, it is observed that algae absorb carbon-di-oxide and increase the production of biomass.

References

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