Evaluating the Effectiveness of Microalgae in Wastewater Treatment Coupled with Carbon Dioxide Sequestration

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Abstract

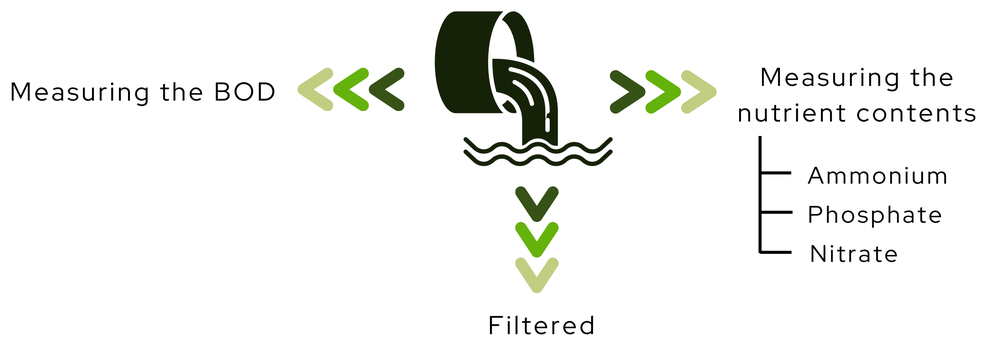
Microalgae play a crucial role in wastewater treatment due to their ability to absorb pollutants such as nitrogen, phosphorus, and heavy metals. Additionally, they can capture carbon dioxide through photosynthesis. *Chlorella* spp. has gained interest in wastewater treatment due to its high growth rate and tolerance to various environmental conditions. This study evaluated the efficiency of *Chlorella* sp. AARL G049 in wastewater treatment while simultaneously capturing carbon dioxide. The alga was cultivated in wastewater from a coffee factory and a mulberry paper factory under different carbon dioxide concentrations : control (air), 5%, and 10%. Wastewater analysis revealed that coffee factory wastewater contained higher initial nutrient levels than mulberry paper factory wastewater, supporting microalgal growth until day 12. There were no statistically significant differences in chlorophyll *a* content, dry weight, and carbon dioxide fixation rate among the different CO_2 concentrations for cultivation in coffee factory wastewater. However, the highest values were observed at 5% CO_2 : 6.511 $mg \cdot g^{-1}$ DW, 0.92 $g \cdot L^{-1}$, and 0.0271 $g \cdot d^{-1}$, respectively. Large-scale experiments in the 10-liter bioreactor, along with further analysis of the fatty acid composition of *Chlorella* sp. AARL G049, are currently in progress.

Introduction

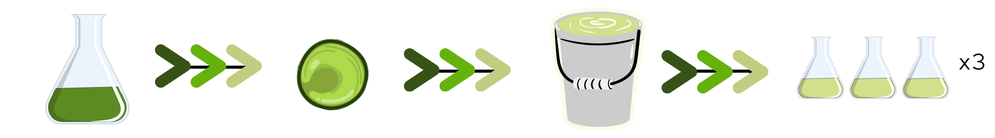
Due to the world's growing population, the rapid expansion of the agricultural and industrial sectors has resulted in a significant rise in urban wastewater production. Organic and inorganic pollutants, along with various contaminants such as micro-pollutants, heavy metals, and excess nutrients, are released from industrial, agricultural, and household activities. Wastewater contains large amounts of organic and inorganic nutrients, which can disrupt ecosystems due to high biological oxygen demand (BOD) and Chemical Oxygen Demand (COD). Excess nutrients in water can also lead to eutrophication. Microalgae are microorganisms that play a crucial role in wastewater treatment due to their ability to remove pollutants such as nitrogen, phosphorus, and heavy metals. They can also capture carbon dioxide through photosynthesis. *Chlorella* spp. has gained attention in wastewater treatment because of its high growth rate and resilience to various environmental conditions.

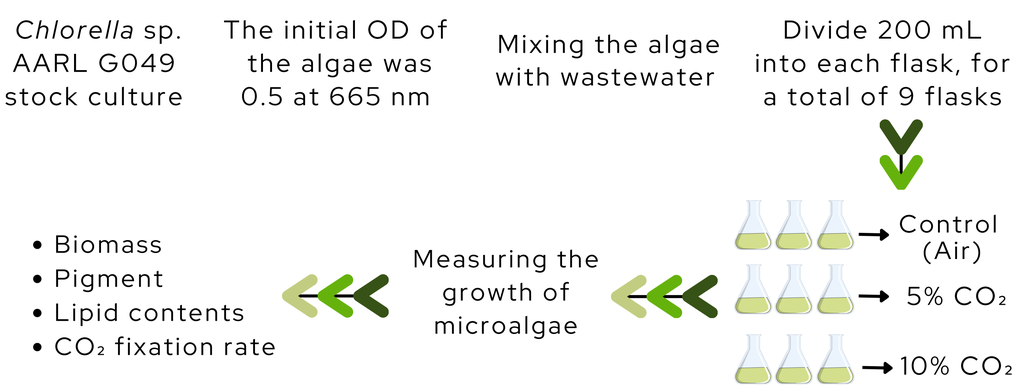
Materials and Methods

- **Assessment of wastewater quality**



- **Cultivation of *Chlorella* sp. AARL G049 in wastewater**





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References

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- Plohn, M., Spain, O., Sirin, S., Silva, M., Escudero-Onate, C., Ferrando-Climent, L. and Funk, C. (2021). Wastewater treatment by microalgae. *Physiol Plant*, 173(2), 568-578.

Results

- Nutrients in wastewater and after co-cultivation with *Chlorella* sp. AARL G049

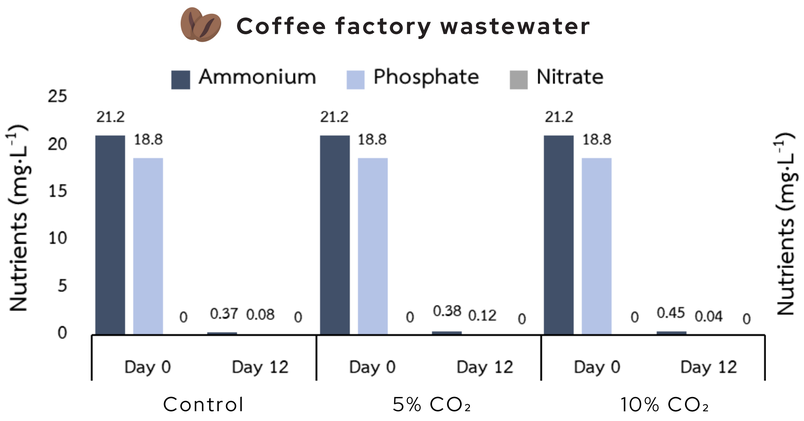

Figure1: The reduction of nutrients in coffee factory wastewater

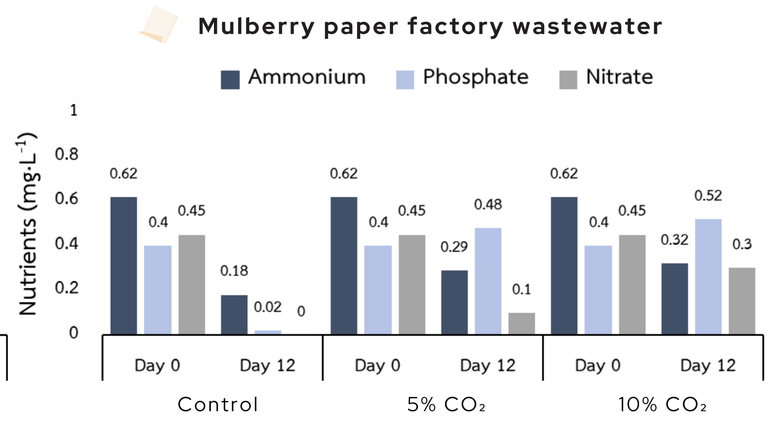

Figure2: The reduction of nutrients in mulberry paper factory wastewater

- The measurement of growth

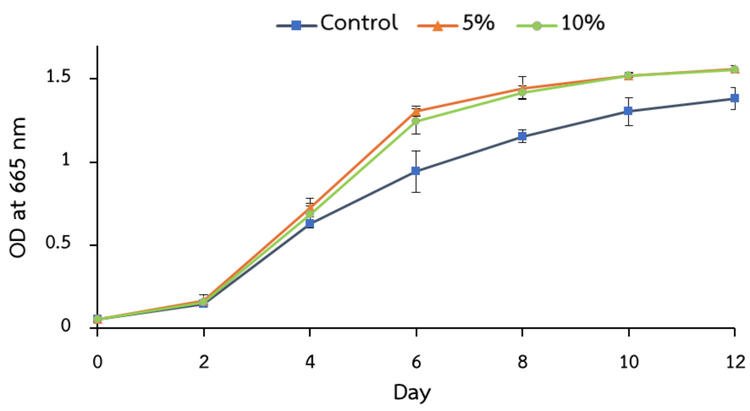

Figure3: Absorbance at 665 nm of microalgae cultivated with coffee factory wastewater

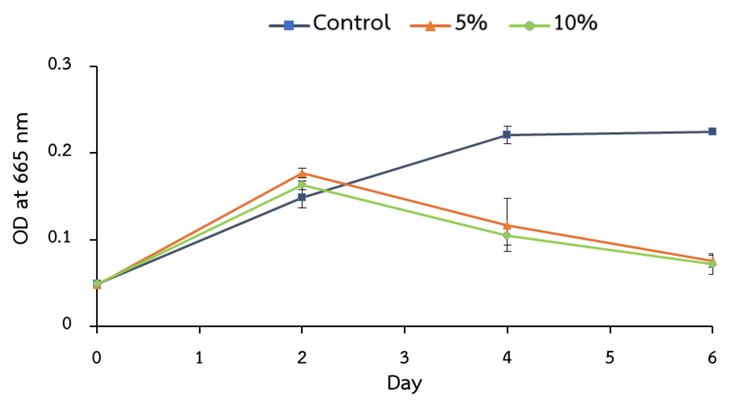

Figure4: Absorbance at 665 nm of micoalgae cultivated with mulberry paper factory wastewater

- CO_2 fixation rate

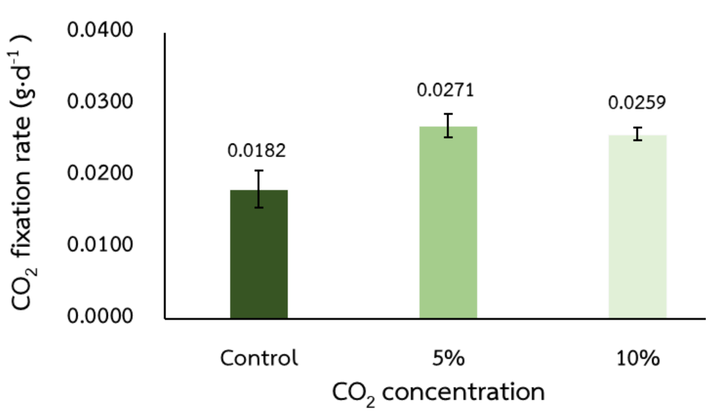

Figure5: CO_2 fixation rate of microalgae cultivated with coffee factory wastewater

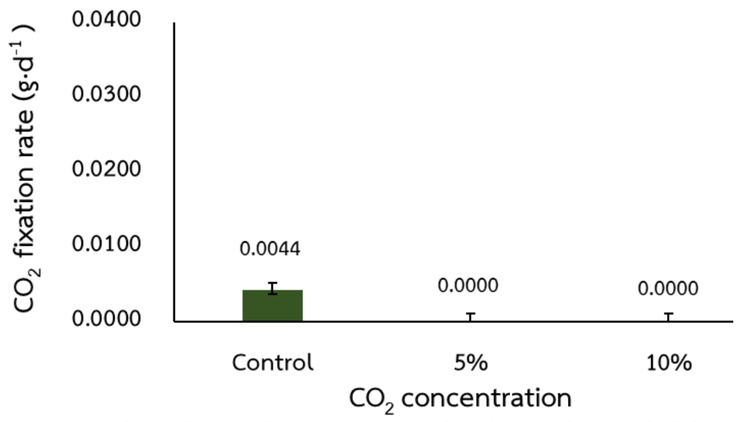

Figure6: CO_2 fixation rate of micoalgae cultivated with mulberry paper factory wastewater

- Biological oxygen demand (BOD)

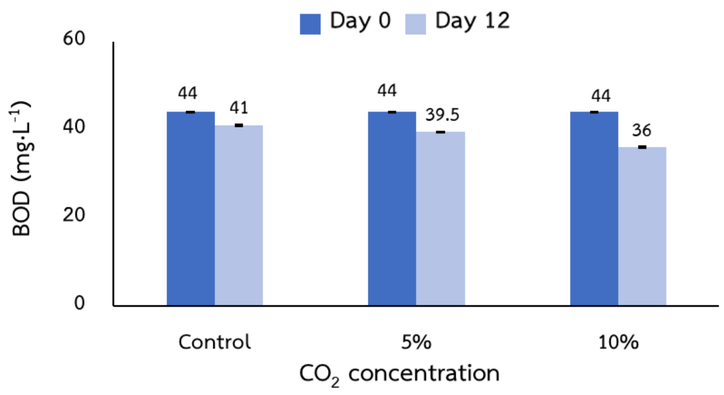

Figure7: BOD levels after cultivating microalgae with coffee factory wastewater

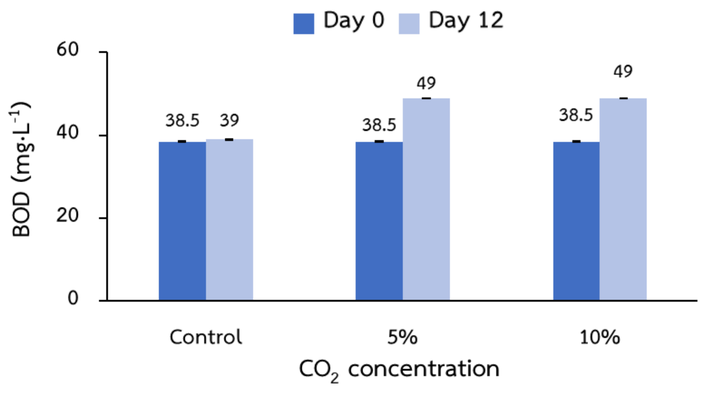

Figure8: BOD levels after cultivating microalgae with mulberry paper factory wastewater

Conclusions

The cultivation of microalgae in combination with wastewater and carbon dioxide, in nutrient-rich wastewater with an optimal concentration of carbon dioxide, allows algae to thrive, leading to efficient nutrient removal from wastewater. The potential of microalgae for carbon dioxide sequestration depends on their growth and the availability of nutrients as an energy source for carbon dioxide fixation.