Culture condition optimization for extremophile microalga *Asterarcys quadricellulare*

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ABSTRACT

In recent years, biomass production from microalgae has attracted industrial and commercial interest, leading to studies aimed at improving cultivation efficiency. *Asterarcys quadricellulare* is a fast-growing, thermotolerant green microalga with promising commercial potential and the ability to grow in alkaline environments. In this study, *A. quadricellulare* was isolated from a natural hot spring and identified using morphological and molecular characteristics. The strain showed good growth at 32–37°C, higher than commonly reported for most green microalgae. The effects of key physical factors, including pH, carbon dioxide (CO_2) concentration, light intensity, temperature, and aeration, were examined. Algae cultures were maintained in BG-11 medium for 14 days. Growth was determined by measuring optical density at 750 nm and dry weight. The results showed that optimal growth and biomass production were obtained at pH 8–9 and 37°C. The microalga grew well under CO_2 concentrations of 5–10% and light intensities of 100–200 µmol m^{-2} s^{-1}. The highest biomass productivity (0.1157 g L^{-1} day^{-1}) was achieved at 5% CO_2. In addition, aeration using an air pump improved biomass production. These results suggest that *A. quadricellulare* can grow under relatively high CO_2 concentrations and low light conditions, indicating its potential for CO_2 bio-fixation. Its ability to tolerate elevated temperatures may also help reduce energy requirements for temperature control in large scale cultivation. The results provide fundamental information for the design and scale-up of biomass production systems.

INTRODUCTION

Microalgae are photosynthetic microorganisms with high potential for biomass production and carbon dioxide sequestration. However, cultivation of microalgae in tropical countries such as Thailand often faces challenges due to high temperatures that can affect the growth of many species. Isolation of microalgae from hot spring environments can provide thermotolerant strains capable of growing under high-temperature conditions. Therefore, this study investigates the growth of *Asterarcys quadricellulare* isolated from a hot spring to determine suitable cultivation conditions for biomass production under Thailand's tropical climate.



Figure 1. *A. quadricellulare* (adapted from Morsi, H., Eladel, H.,& Maher, A. (2021).)

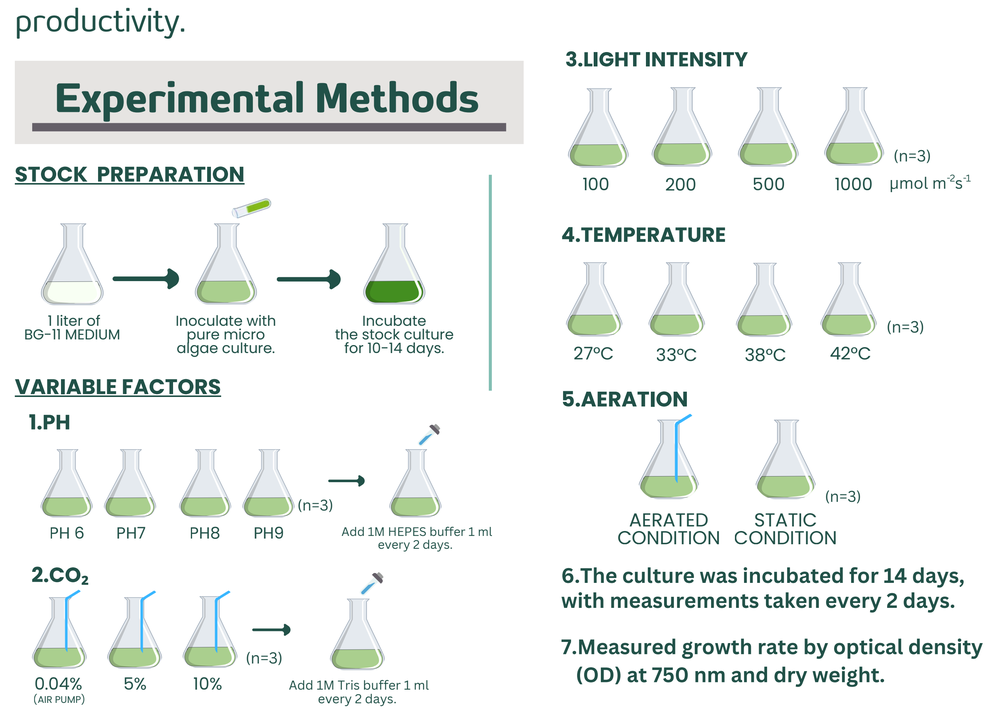


Figure 2. Cultivation of *A. quadricellulare* in Erlenmeyer flasks under different experimental conditions.

OBJECTIVE

To study the effects of pH, temperature, carbon dioxide concentration, light intensity, and aeration on the growth rate of *Asterarcys quadricellulare* and identify the optimal cultivation conditions for maximizing biomass productivity.

Experimental Methods



6.The culture was incubated for 14 days, with measurements taken every 2 days.

7.Measured growth rate by optical density (OD) at 750 nm and dry weight.

RESULTS

1.pH

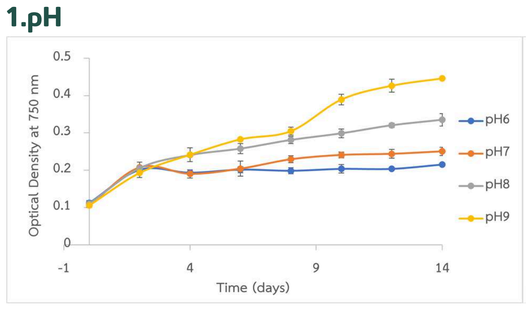


Figure 3. Growth curves of *A. quadricellulare* at different pH levels measured as OD_{750} over 14 days.

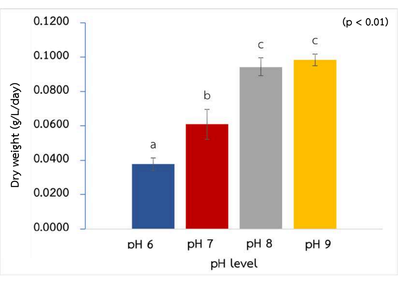


Figure 4. Dry weight of *A. quadricellulare* at different pH levels after 14 days.

4.Temperature

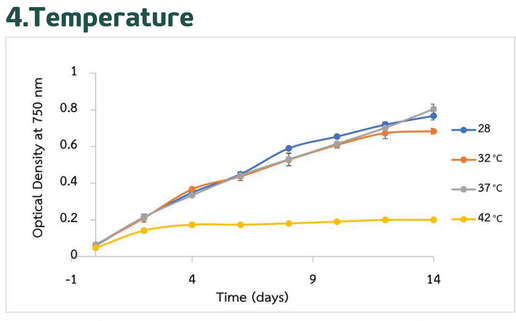


Figure 9. Growth curves of *A. quadricellulare* at different temperature measured as OD_{750} over 14 days.

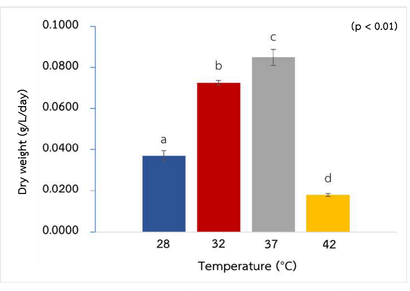


Figure 10. Dry weight of *A. quadricellulare* at different temperature after 14 days.

2.CO_2

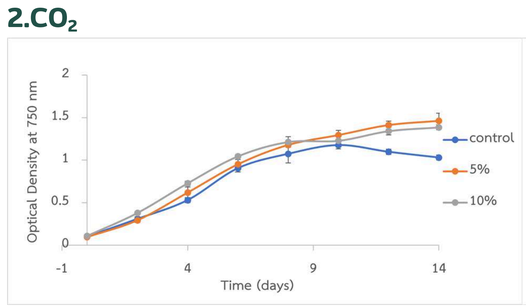


Figure 5. Growth curves of *A. quadricellulare* at different CO_2 levels measured as OD_{750} over 14 days.

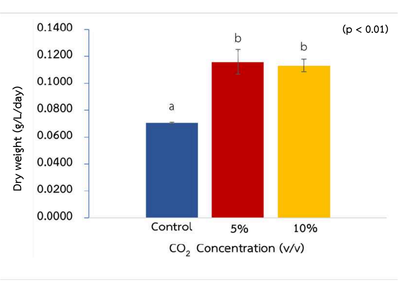


Figure 6. Dry weight of *A. quadricellulare* at different CO_2 levels after 14 days.

5.Aeration conditions

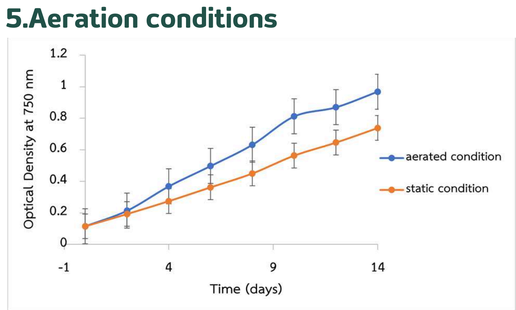


Figure 11. Growth curves of *A. quadricellulare* at different conditions measured as OD_{750} over 14 days.

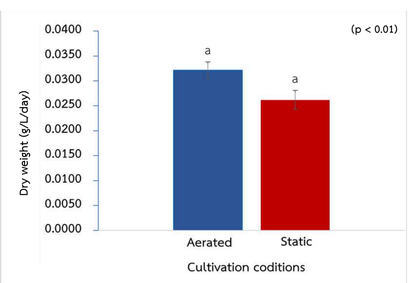


Figure 12. Dry weight of *A. quadricellulare* at different conditions after 14 days.

3.Light intensity

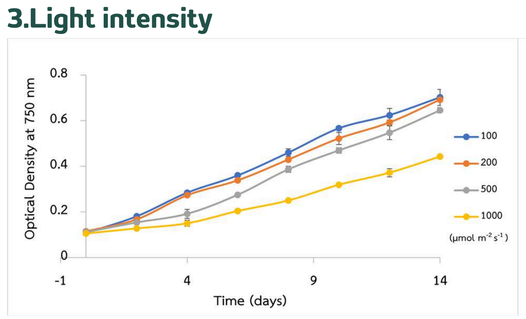


Figure 7. Growth curves of *A. quadricellulare* at different light intensity levels measured as OD_{750} over 14 days.

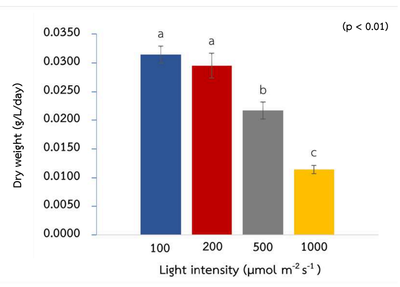


Figure 8. Dry weight of *A. quadricellulare* at different light intensity levels after 14 days.

Results showed that the microalga grew well at pH 8–9 and the highest growth at pH 9 (Figure 3,4). Supplementation with 5 to 10% CO_2 produced higher biomass than normal aeration, with the highest value of 0.1157 g/L/day at 5% CO_2 (Figure 5,6).

The optimal light intensity was 100–200 µmol m^{-2} s^{-1}, while higher light intensity caused photoinhibition (Figure 7,8). And optimal temperature for growth was 37°C, whereas growth significantly decreased at 42°C (Figure 9,10). In addition, aeration enhanced biomass production compared to static conditions (Figure 11,12).

CONCLUSION

Asterarcys quadricellulare, a thermotolerant microalga isolated from a hot spring in Thailand, showed the ability to grow under a range of environmental conditions. The results indicated that better growth was obtained under alkaline pH, elevated CO_2 levels, and suitable light intensity. In addition, the strain was able to tolerate relatively high temperatures, suggesting its potential for biomass production in tropical environments such as Thailand.

References

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- Varshneya, P., Beardall, J., Bhattacharya, S., & Wangikar, P. P. (2018). Isolation and biochemical characterisation of thermophilic green algae tolerant to high CO_2 and NO. Algal Research, 30, 28-37.

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