CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)	Project Number
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Project Title

Optimizing Cultivation of Chlorella vulgaris in Various Photobioreactor Systems and Municipal Wastewater Concentrations

Abstract

Objectives/Goals

Among the scientific community, there is growing agreement that microalgal photobioreactors are among the most effective systems for biomass generation and carbon capture to lower atmospheric carbon dioxide levels. However, further optimization of growth is required to provide more effective solutions. Current literature mostly focuses on closed photobioreactor systems with carbon dioxide bubbling and, if utilizing wastewater, pure wastewater as a nutrient source. This study aims to investigate the ideal type of photobioreactor and wastewater concentration to maximize microalgae growth in small-scale municipal wastewater filtration systems.

Methods/Materials

The green microalgae Chlorella vulgaris was cultured in four 30-liter photobioreactor systems: closed and open-air, with and without carbon dioxide bubbling and pH monitoring. Periodically, turbidity was recorded and Guillard's formula was added. Separately, C. vulgaris was cultured in seven 300-milliliter samples of various concentrations of distilled water and treated municipal wastewater from the Hyperion Water Treatment Plant. The turbidity and pH of each sample were collected and recorded regularly.

Results

The system that yielded the most biomass was the open photobioreactor with carbon dioxide bubbling and pH monitoring, generating a turbidity value of 180 NTU after 21 days. The wastewater sample microalgae grew sinusoidally, with considerable asymptotic variation after an initial period of similar growth. The optimal wastewater concentration for culturing was the 83% concentration, with an asymptotic turbidity value of 763 NTU.

Conclusions/Discussion

The results show algal growth dominance in photobioreactor systems with an additional carbon dioxide source and installed degassing mechanism. In addition, the data support a culturing concentration of around 80-85% municipal wastewater over 100% wastewater or distilled water. Hence, developing and implementing algal photobioreactor systems in water treatment plants can take advantage of these discoveries both to capture carbon and to purify wastewater, lowering levels of atmospheric carbon dioxide and mitigating the potential risks of marine algal blooms caused by wastewater pollution.

Summary Statement

This study concluded that photobioreactor microalgae growth may be optimized with a regulated degassing mechanism, an additional carbon dioxide source, and, in systems utilizing wastewater, continuous replacement of diluted wastewater.

Help Received

Dr. Ochan Otim aided me in collection of the wastewater from the Hyperion Water Purification Plant, obtaining instrumental analysis of the treated wastewater, and reviewing experimental procedure. He also gave me access to the lab. My parents helped in driving and gathering necessary materials.