Algae Cultivation from Heterotrophic Growth with Hydrothermal Aqueous Product of Dairy Manure

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Overview

- Algae has the potential to be utilized as livestock feed because of it high protein content
- Challenges to algae as livestock feed include
  - Fluorescent lighting cost
  - Media culture costs
  - Sunlight can be unreliable
- Heterotrophic algal growth on the hydrothermal aqueous product (HAP) from the hydrothermal carbonization (HTC) of dairy manure may create a sustainable livestock feed

Introduction

Heterotrophic Growth

- Conventional algae grow photoautotrophically (sun + CO_2)
- *Spirulina maxima* has been reported to grow mixotrophically (organic carbon or CO_2)

HAP as Growth Medium

- HAP from dairy manure is rich in nitrogen, phosphorous, and organic carbon
- Provides nutrients (N and P) needed for all growth types
- May provide carbon source for heterotrophic growth

Project Objective

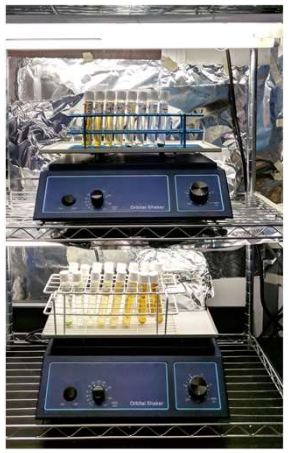
- Determine the optimal HAP concentration and lighting conditions for *S. maxima* growth for maximized biomass productivity

Methodology

Experimental Setup (Fig. 1)

- Six concentrations of sterile HAP evaluated
  - 1, 2, 3, 5, 7, and 10%
  - Negative (DI H_2O) and positive (Spirulina media) controls
- Three lighting (~100 µmol $m^{-2}s^{-1}$) conditions evaluated
  - Constant darkness (heterotrophic growth)
  - Constant lighting (photoautotrophic growth)
  - 18/6 hours of light/dark (mixotrophic growth)
- 10-mL samples of each media and each lighting conditions were inoculated with *S. maxima* in 12-mL vials and placed on orbital shaker to ensure mixing
- Vials opened every two days to allow gas exchange and to monitored growth using OD_{600}

Methodology



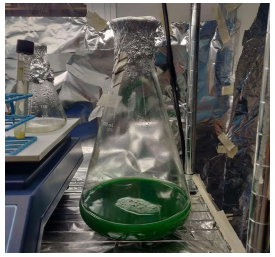


Figure 1: *(left)* Complete algae cultivation system. Constant lighting and constant darkness (in foil) conditions on bottom shelf. Mixed lighting conditions on top shelf. *(above)* Mature culture of *S. maxima.*

Results

- Heterotrophic growth of *S. maxima* not observed with any HAP concentration or with Spirulina media (Fig. 2)
- Photoautotrophic growth of *S. maxima* observed with Spirulina media, 1% HAP, and 2% HAP (Fig. 3)
  - HAP cultures have lower biomass than Spirulina medium cultures
  - HAP cultures die off after ~17 days
- Mixotrophic growth of *S. maxima* had highest biomass and longest sustained growth (Fig. 4)
- 2% HAP outperforms all other HAP concentrations for heterotrophic, autotrophic, and mixotrophic growth

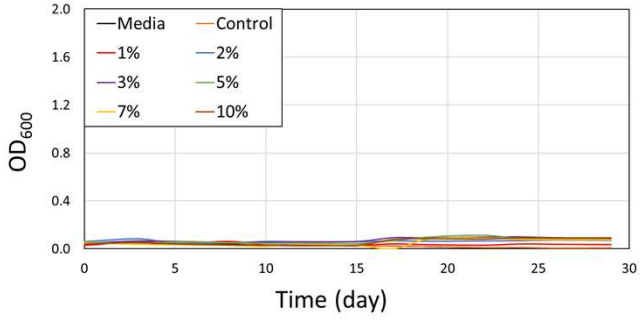


Figure 2: OD_{600} versus time constant darkness conditions

Results

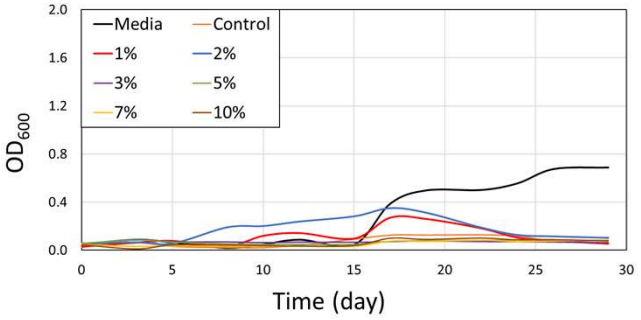


Figure 3: OD_{600} versus time for constant lighting conditions

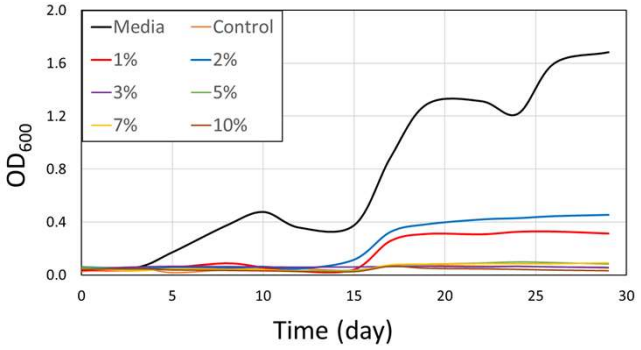


Figure 4: OD_{600} versus time for light/dark lighting conditions

Future Work

- Determine whether HAP growth media can be reused after harvesting algae
  - Quantify phosphorous and nitrogen content
  - Repeated growth cycles with *S. maxima*
- Evaluate *Chlorella vulgaris* as potential heterotrophic algae for growth on HAP

Acknowledgements

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