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The Green Solution: Optimizing productivity of bi-substrate microalgae cultures

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The Green Solution
Optimizing productivity of bi-substrate microalgae cultures

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Background

Glycerol is a waste generated from biodiesel production. We can capitalize on its low-cost and availability by utilizing it as a carbon source for cultivating *Chlorella Protothecoides,* an algae strain known for thriving under heterotrophic conditions. Microalgae is often employed for CO_2 capture, biofuel production and most importantly, it can be processed for antioxidants and lipids. These products are often found in health supplements and food additives, with a current market value of US$2.1 billion.

Goal

Determine:
- Feasibility of recycled biodiesel glycerol as an alternative carbon substrate to glucose in microalgal biomass production
- The effect of changing glycerol to glucose ratios in achieving an optimal condition for maximizing biomass production (100:0, 25:75, 50:50, 25:75, 0:100)
- Interplay of nitrogen deficiency on optimal glycerol to glucose ratio (10:1, 40:1, 80:1,120:1)

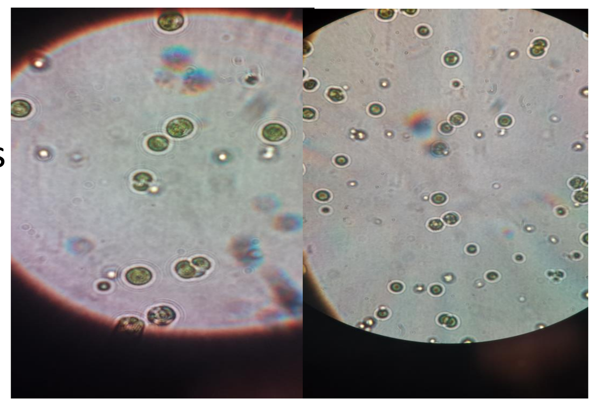
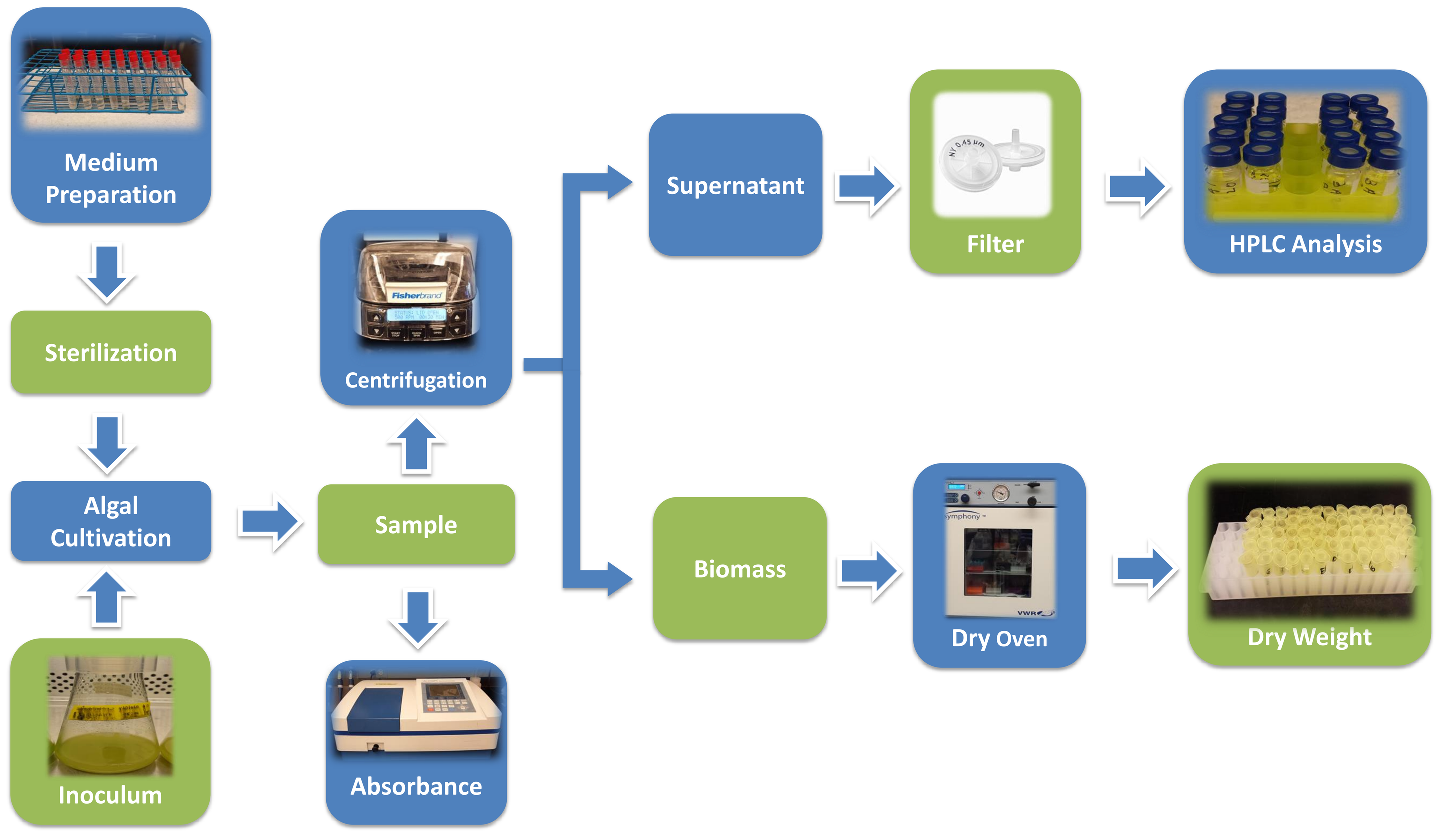


Figure 1: *Chlorella protothecoides*

Materials and Methods



Results

Growth Rate

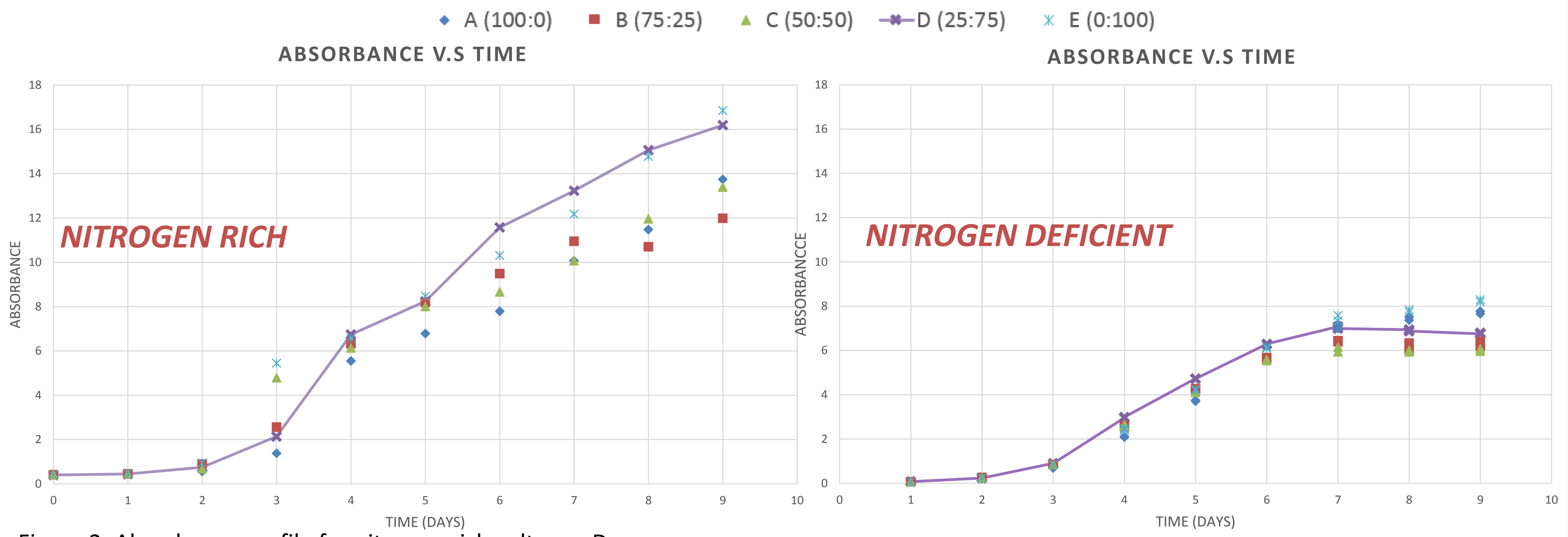


Figure 2: Absorbance profile for nitrogen-rich cultures. D (25:75) Culture exhibits high productivity during exponential phase and stagnation phase

Figure 3: Absorbance profile for nitrogen-deficient culture. D (25:75) exhibits high productivity during exponential phase only

Substrate Consumption

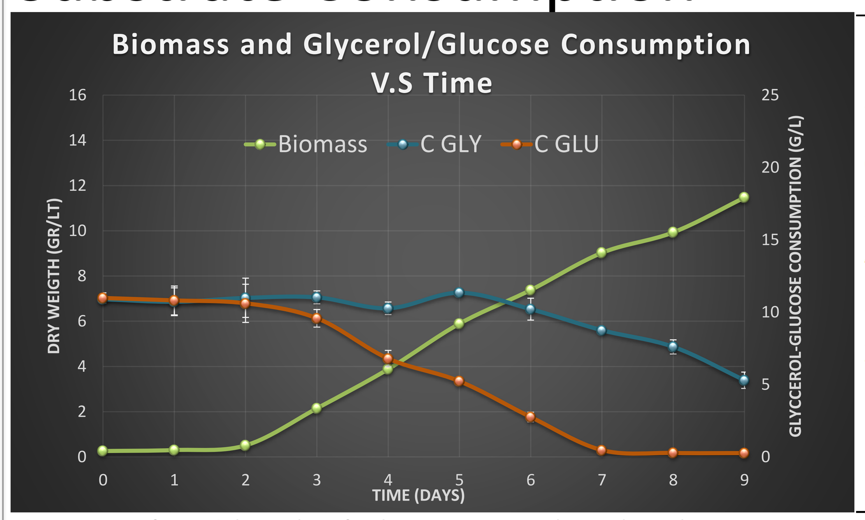


Figure 4: Preferential uptake of substrate, 50:50 Glycerol to Glucose

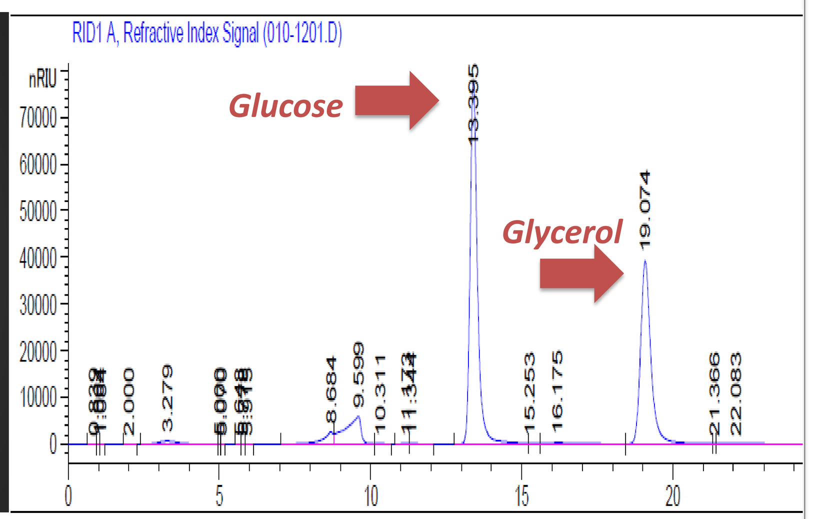


Figure 5: Liquid Chromatograph of medium supernatant

Biomass and Antioxidant

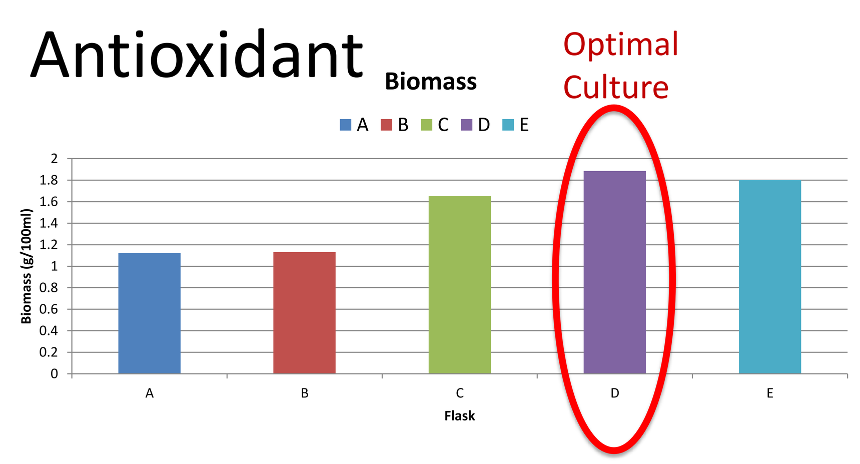


Figure 6:Biomass 25:75, C to N 80:1 Trial

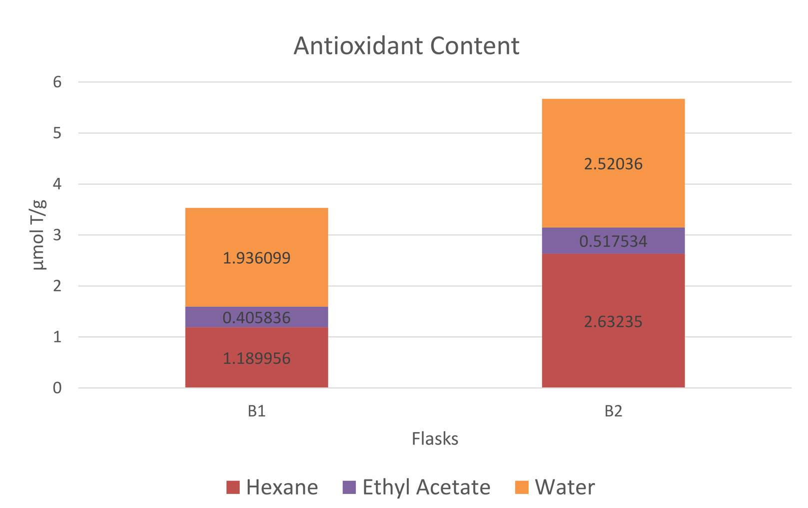


Figure 7: Antioxidant content for Glucose/Glycerol 25:75, C to N 80:1 Trial

Figure 8: Top (Day 3), Bottom (Day 9)
Variation in Chlorophyll content as a function of Glycerol to Glucose ratio.

Conclusions

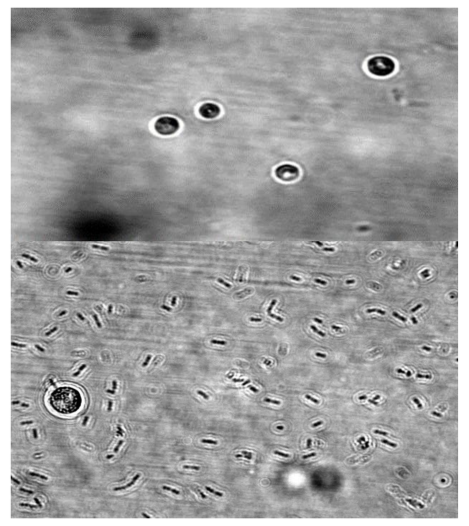


Figure 9: (Top) Healthy culture vs. (Bottom) Contaminated culture

- Optimal ratios are 25:75 Glycerol to Glucose, 10:1 Carbon to Nitrogen
- 25:75 Glycerol to Glucose exhibits highest productivity rate
- Nitrogen deficiency results in Biomass reduction
- Glycerol maintains Chlorophyll pigment within *Chlorella protothecoides*
- Glycerol rich cultures are more resistant to contamination

Future Work

- Evaluate Antioxidant, Chlorophyll-A, Chlorophyll-B and lipid compositions of extractable biomass
- Characterize and create Kinetic model of optimal ratio between substrates and nitrogen
- Additional trials to confirm finding and recalibrate results

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Acknowledgements

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