Optimization of Nutrient Medium for Permeate Remediation

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Introducing Permeate

- Leachate from the SW Archer Landfill must be treated or remediated before it can be discharged
- Reverse Osmosis is a high pressure membrane filtration method
- Currently, leachate requires two stages of Reverse Osmosis filtration before meeting FDEP GWCL Target Levels (2005)
- Primary permeate still has roughly 100 to 120 ppm of Ammonia (2.8 ppm for GWCL)

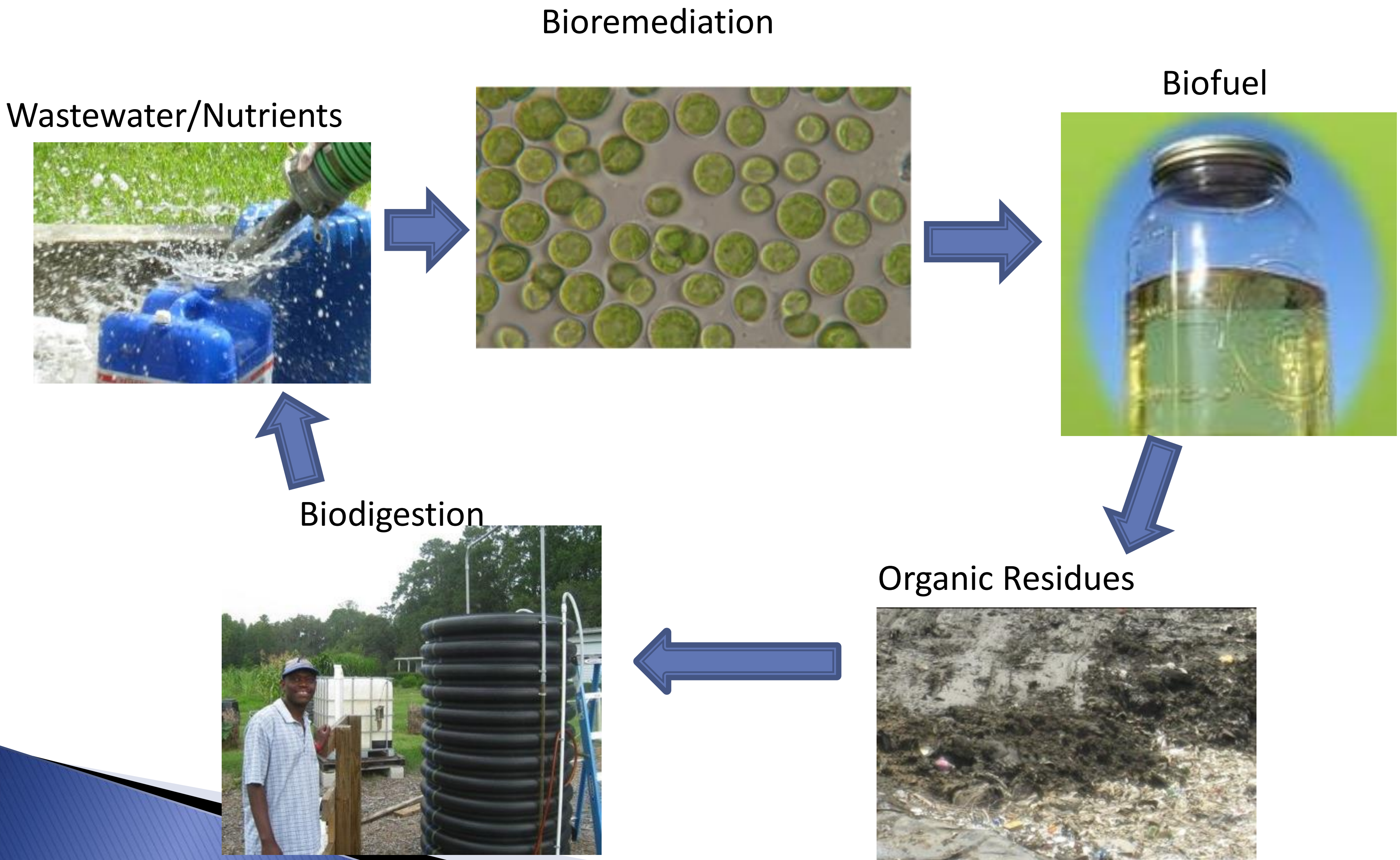
Archer Landfill

Phycoremediation

- Algae can utilize the ammonia content of primary permeate

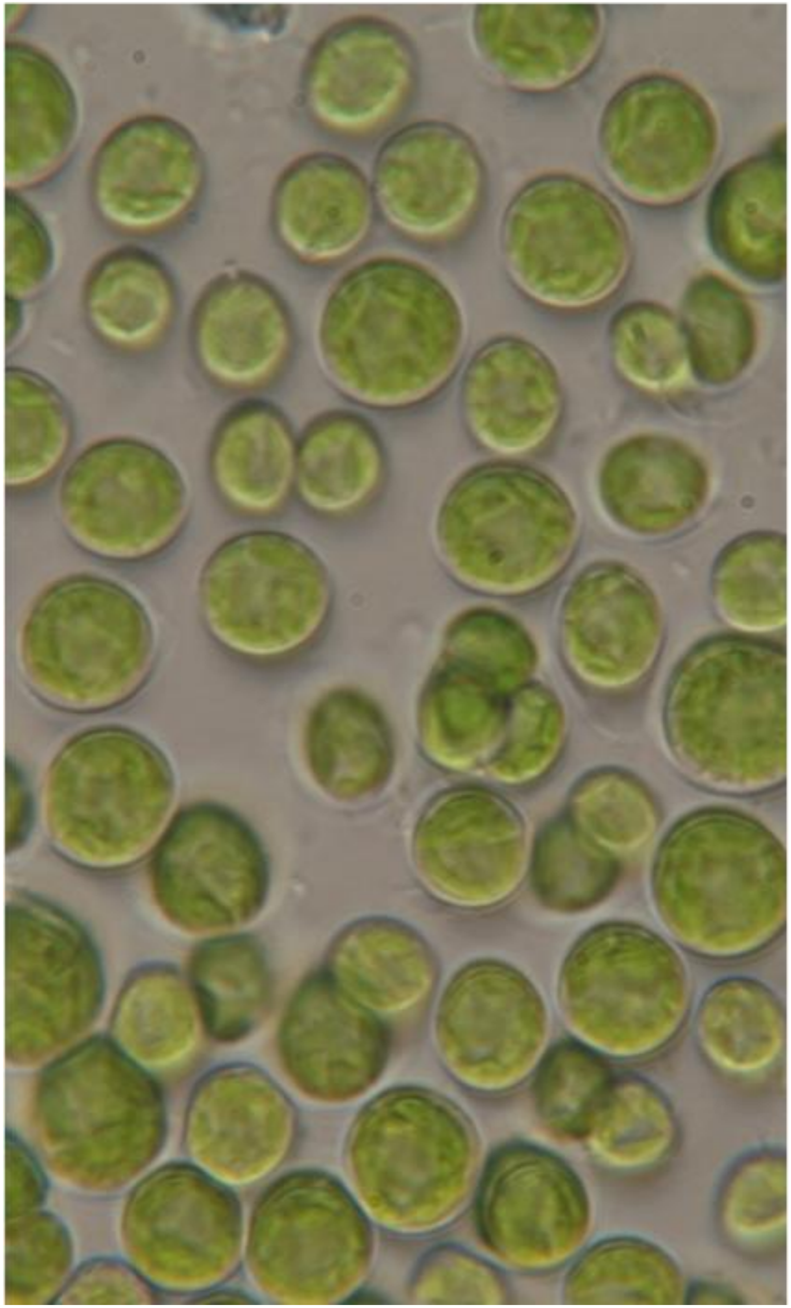
- Using algae to remediate would provide:
    - Clean Water
    - Savings in Energy and Equipment
    - Highly Valuable Algal Biomass
    - Oxygen
    - Carbon Sequestration

Algal Resource Cycle



Scenedesmus

- Genus of photosynthetic microalgae capable of quick growth in wastewaters
- Biomass can be used for lipid content (biofuel) or biodigestion
- Isolated from SW Archer landfill



Objectives

- Experimentally determine the concentrations of nutrients which will result in the highest algal growth and remediation in permeate

- Provide a complete nutrient medium for future studies and applications in permeate remediation

Theoretical Optimized Permeate

- Hypothesis:
  - An effective macronutrient supplement can be derived from the elementary composition of *Scenedesmus* as provided by Krauss & Thomas (1954), based on the amount of algal biomass producible from the concentration of ammonia in permeate
  - This Theoretical Optimized Permeate (TOP) would allow the algae to remediate ammonia as quickly as possible, without excess.

The TOP

- From 120 ppm-N in permeate, 1.45 g/L theorized algal biomass

Elementary Composition of *Scenedesmus obliquus* by Krauss & Thomas (1954)	
Element	% Dry Weight
Nitrogen	6.8
Phosphorus	1.42
Sulfur	0.335
Potassium	1.405
Magnesium	0.54

Theoretical Optimal Nutrient Concentrations	
Element	Concentration (ppm)
Nitrogen	120 (0 added)
Phosphorus	20.61
Sulfur	4.86
Potassium	20.39 (0 added)
Magnesium	7.84

A Complete Medium

- A series of experiments were conducted to determine the feasibility of the TOP

- It was found that both macronutrients and micronutrients were necessary for continued algal growth in permeate

Experimental Outline

- Experiment 1: Macronutrients
  - Shows that permeate is macronutrient deficient
- Experiment 2: Micronutrients
  - Shows that permeate is micronutrient deficient
- Experiment 3: Leachate
  - Shows that leachate can be a viable substitute for micronutrient supplementation

Methods: Macronutrients

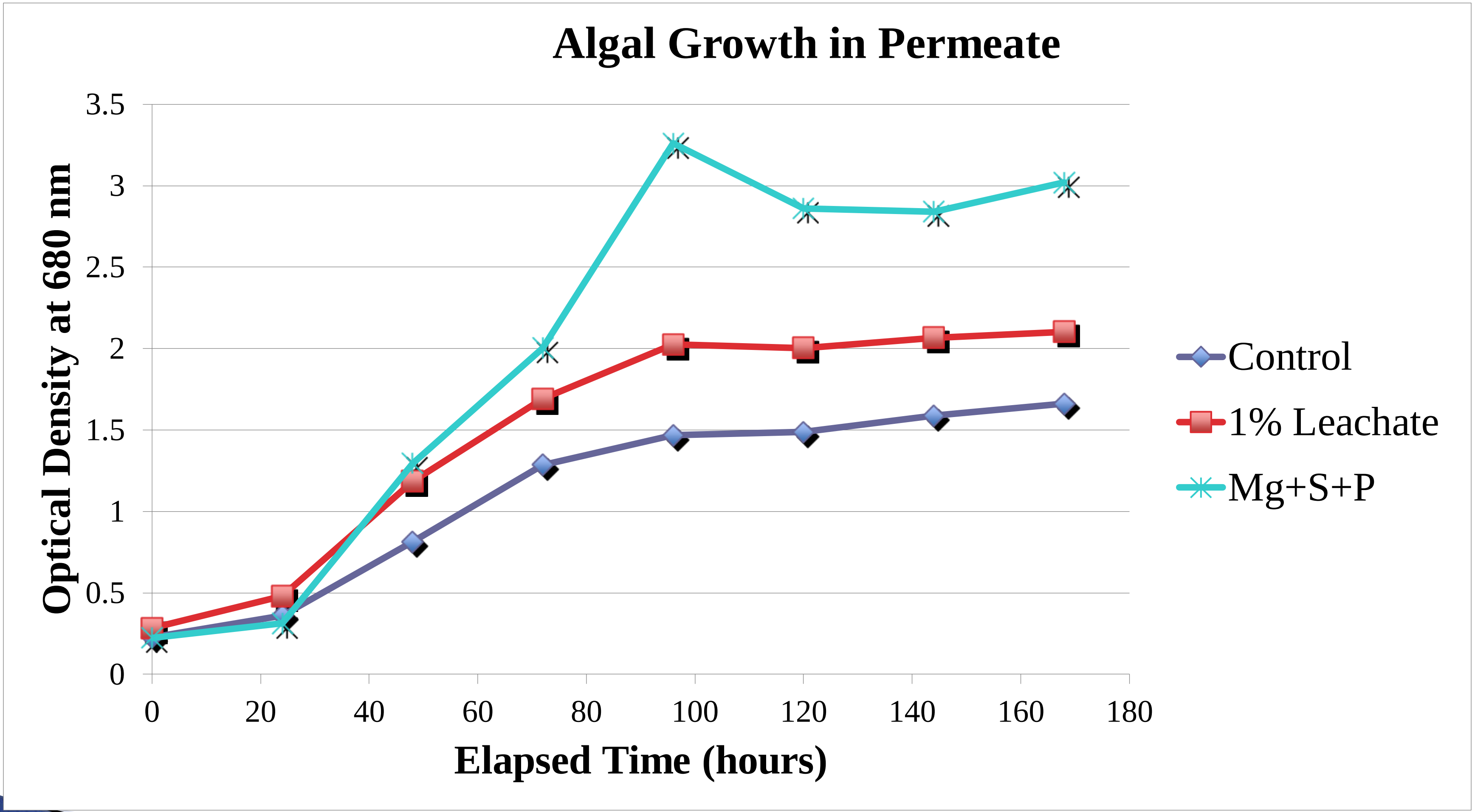
- Growth measured as optical density at 680 nm using spectrophotometer
- Used 400 mL cultures in 500 mL Erlenmeyer flasks
- 20 hour/day lighting
- Atmospheric aeration
- Control group with 90% permeate, 10% algae (volume)
- Experimental groups with 1% Leachate, Mg+S+P

Design: Macronutrients

Day 1

Day 4

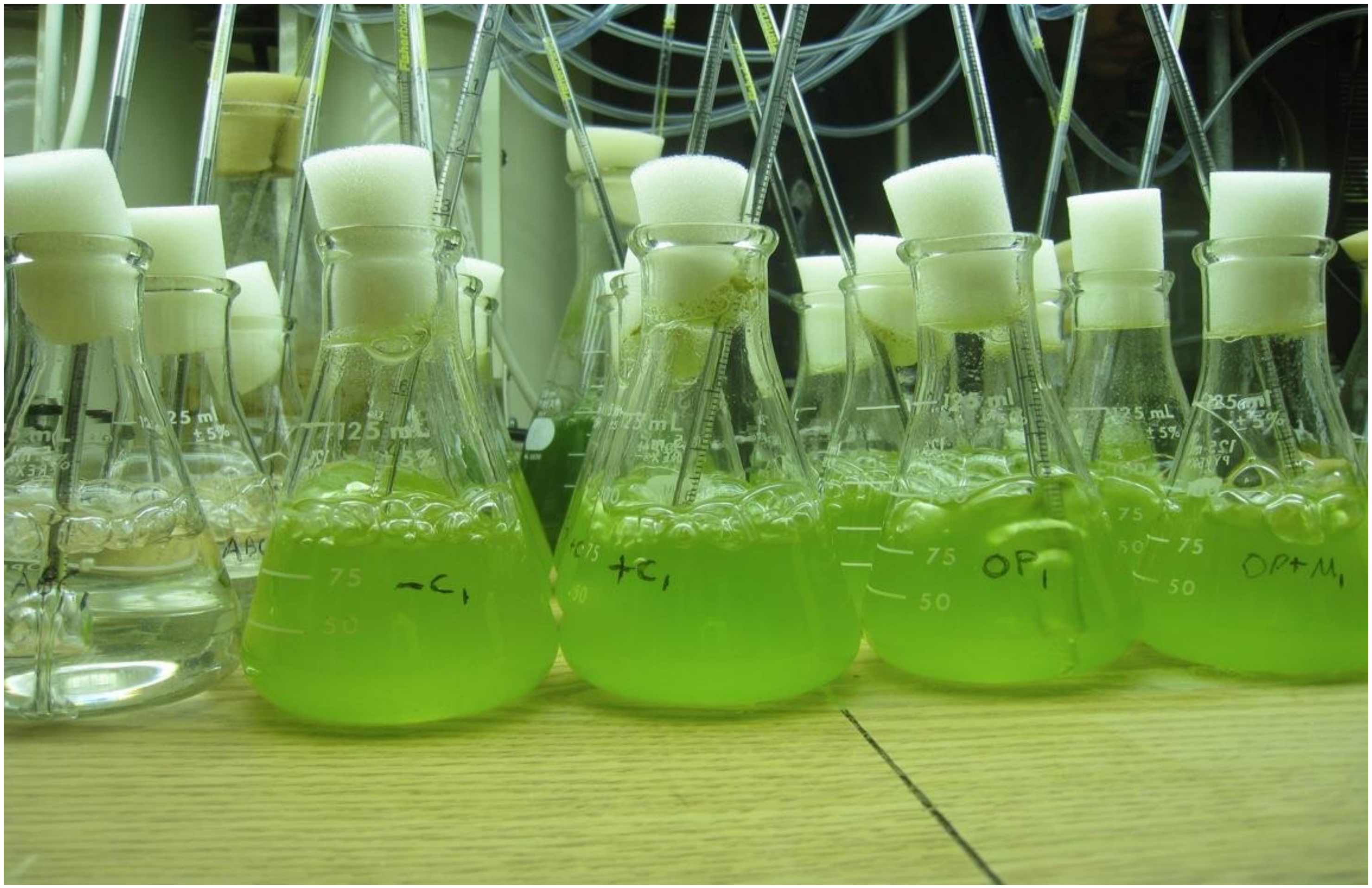
Results: Macronutrients



Methods: Micronutrients

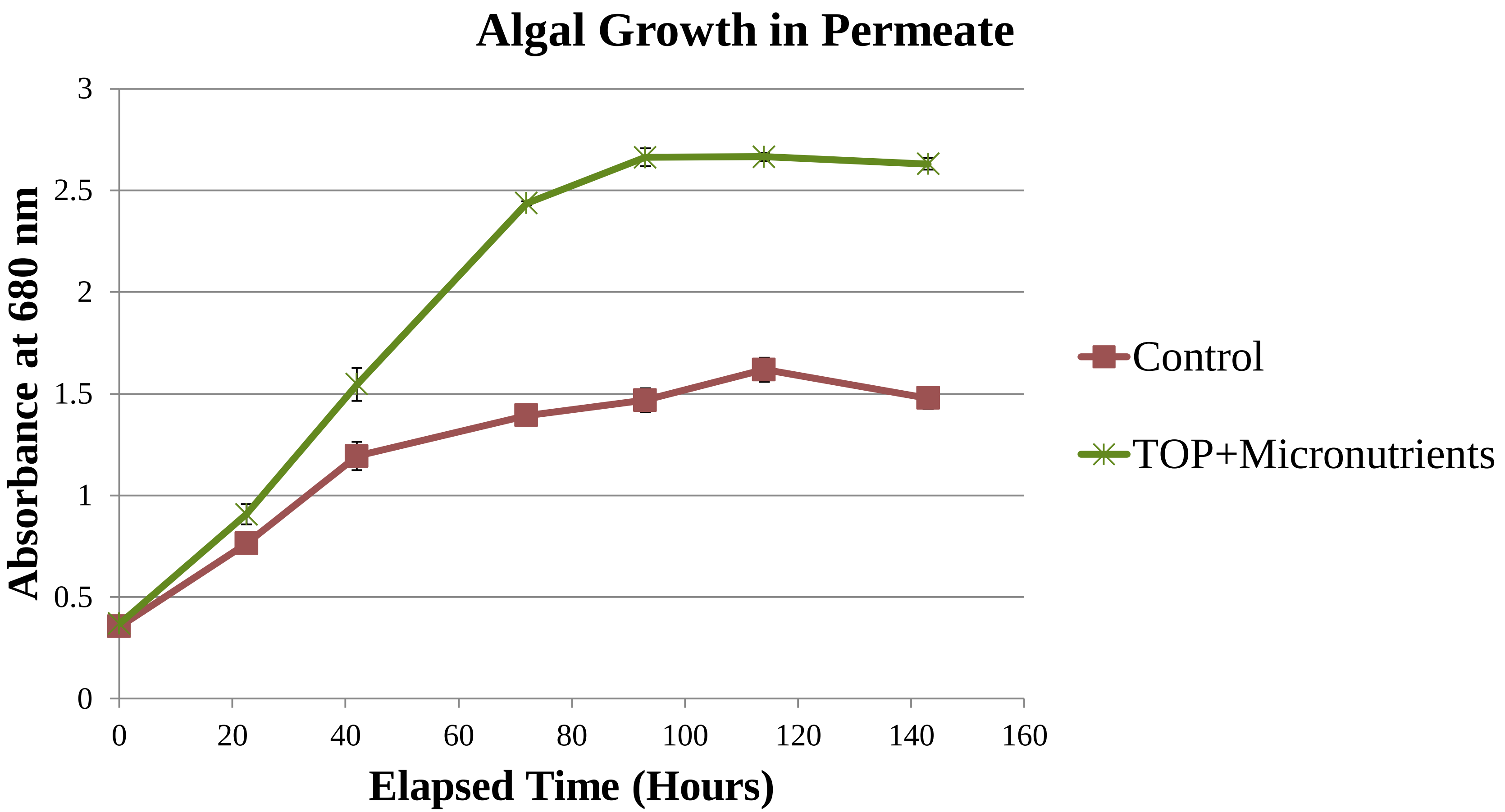
- 100 mL triplicate cultures in 125 mL Erlenmeyer flasks
- 20 hour/day lighting
- Atmospheric Aeration
- Control Group: RO permeate
- Experimental Group: RO permeate + TOP with Micronutrients

Design: Day 1



Day 3

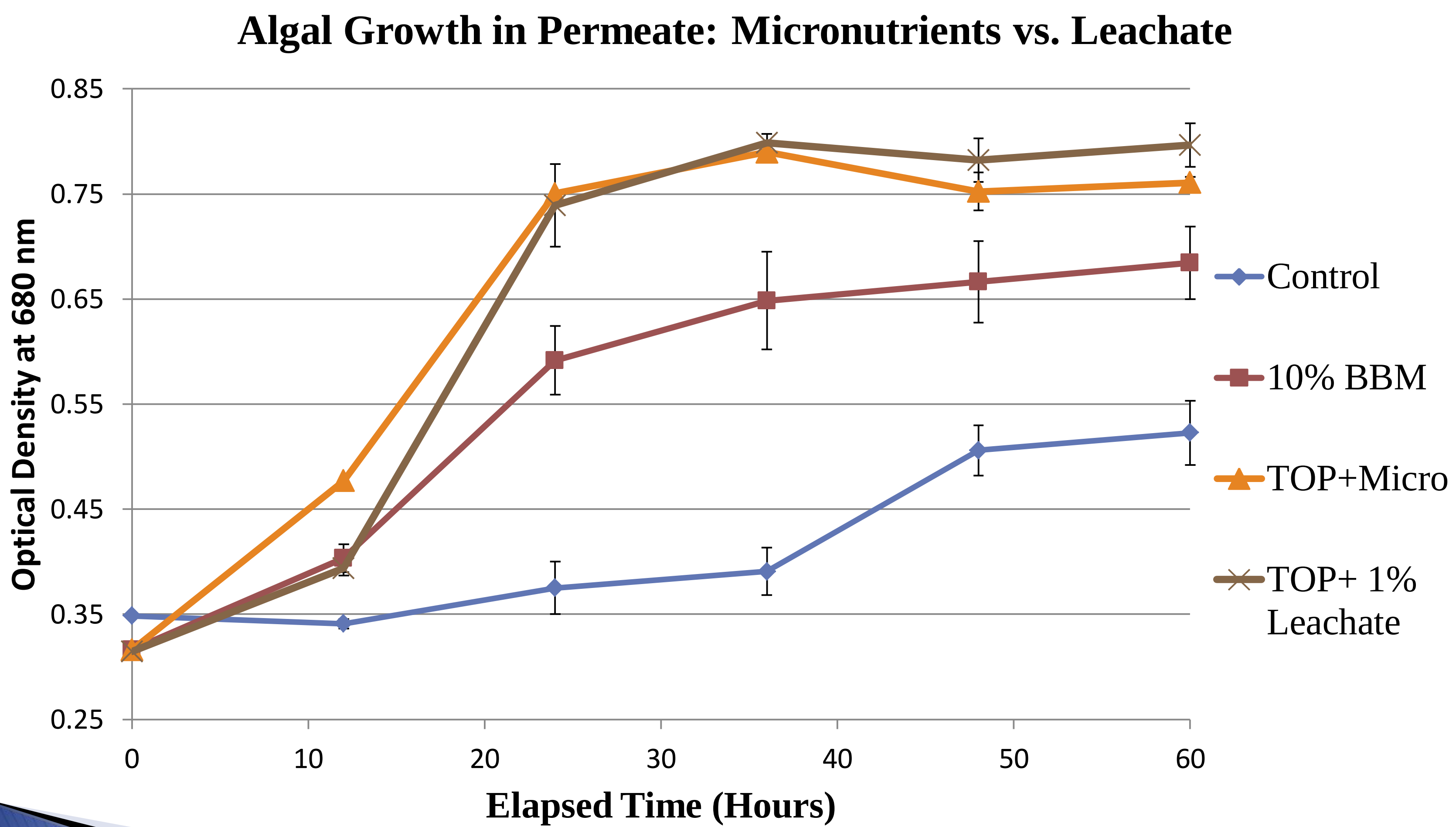
Results: Micronutrients



Assessing Leachate as a Micronutrient Source

- Can leachate can be used as a source of micronutrients?
- Reducing the need for adding trace metal solution

Results: Assessing Leachate



Conclusions: Benefits of the TOP

- Provides a complete medium
- Uses 66% less Phosphate than Bold's Basal Medium, potentially less after further testing
- Has no Boron
- Has no added Calcium
- Has no added Potassium
- Has no EDTA (Ethylenediaminetetraacetic acid)
- Has no NO3, NaCl, H2SO4, KOH
- Provides excellent growth in permeate

Future Studies/Applications

- Using the TOP, more research can focus on reactor designs and large scale growth on permeate, on-site applications
- Future modifications may include more precise determination of elemental concentrations

References

- APHA (2005) Standard Methods for the examination of water and wastewater. 20th ed. American Public Health Association, Washington, D.C.

- FDEP (2005) Technical Report: Development of Cleanup Target Levels (CTL's). Florida Department of Environmental Protection, Chapter 62-777, F.A.C.

- Krauss, R. W. & W. H. Thomas (1954) The Growth and Inorganic Nutrition of *Scenedesmus Obliquus* in Mass Culture. *Plant Physiology* 29:3 205-214

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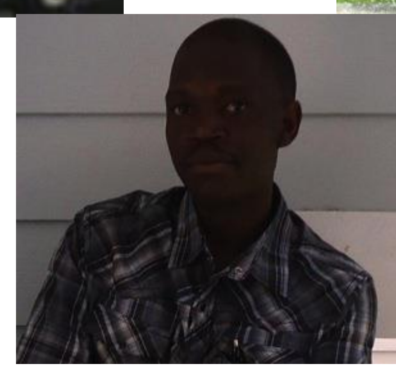

Questions?

Thank you!