Effect of Potassium and Phosphate Concentrations from Biodiesel Wastewater on *Chlorella protothecoides* Growth and Nutrient Uptake

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Introduction

- The Searle Biodiesel Lab produces 75-80 gallons of Biodiesel Wash Water (BWW) per batch of fuel (2,000 annually) during final fuel refining.
- BWW has been identified as a nutrient rich water that is a suitable media for algae based on their ability to absorb large quantities of nitrogen, potassium, and sodium (Herrera).
- By studying the algae growth patterns in response to the amount of BWW a culture receives, we can optimize the conditions for maximum nutrient redemption.
- The species *Chlorella prothecoides* was chosen for its hardiness and ability to withstand the harsh conditions of the BWW

Methods

- 9 *Chlorella vulgaris* cultures- 3 controls received media, 3 cultures received the slow treatment, and 3 cultures received the fast treatment.
- Treatment periods lasted approximately 2 weeks while culture were under controlled light, temperature, and air flow.
- 5 mL samples were taken and filtered at the beginning and end of each treatment.
- Water samples were analyzed using Ion Chromatography for phosphate and potassium uptake.
- Nitrate uptake was measured using a Vernier Nitrate Ion-Selective Electrode.
- Algal samples were measured for biomass change over the two week treatment period.

Treatment Period	Fast Treatment		Slow Treatment	
	Media	TN-BWW	Media	TN-BWW
Pre-experiment	100%	0%	100%	0%
1st	88%	12%	94%	6%
2nd	76%	24%	88%	12%
3rd	64%	36%	82%	18%
4th	52%	48%	76%	24%
5th	40%	60%	70%	30%
6th	28%	72%	64%	36%
7th	16%	84%	58%	42%
8th	4%	96%	52%	48%

Table 1 (top): Percentage of Media and Treated, Neutralized-BWW (TN-BWW) each culture received during each treatment period.

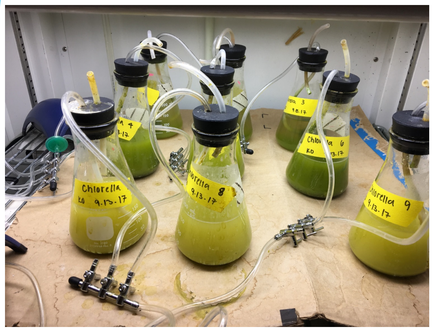
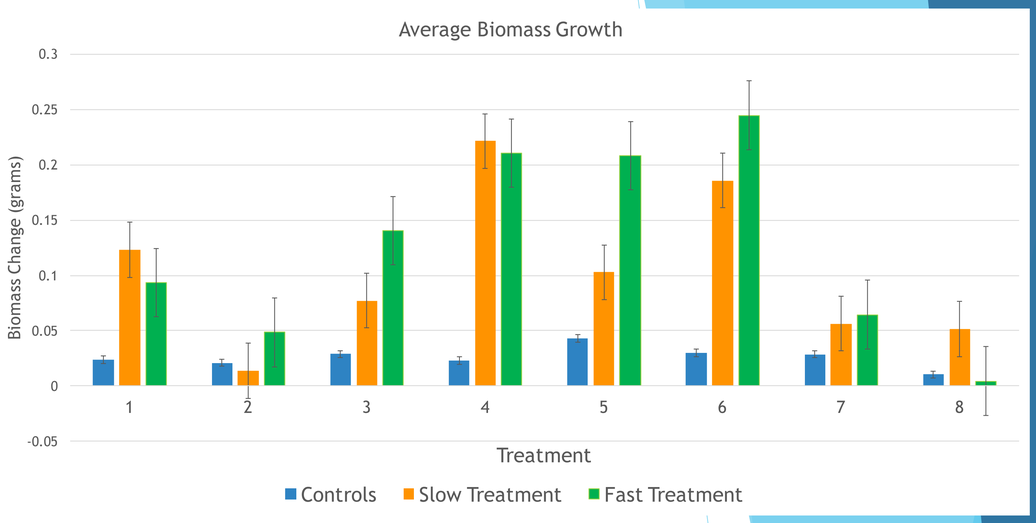
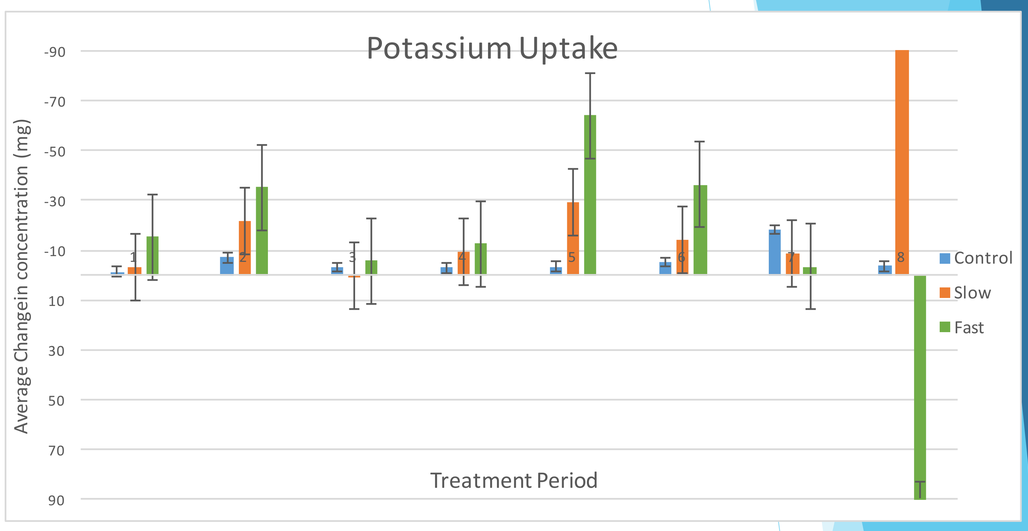


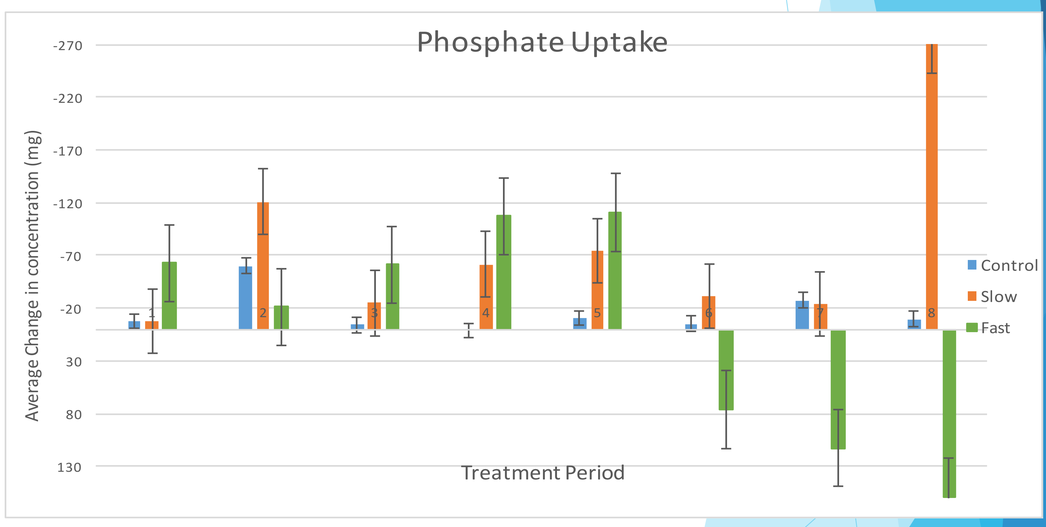
Image 1 (left): Algae culture experiment set up.



Graph 2: Average biomass growth of the 3 treatment replicate cultures during the treatment period.

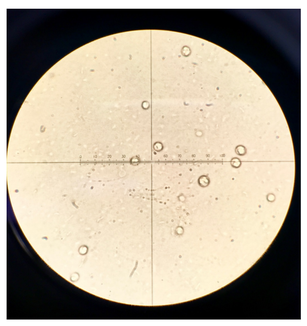


Graph 3: Average Uptake of Potassium over 8 treatment weeks

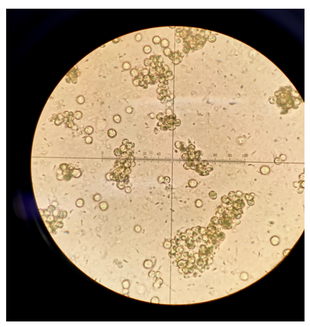


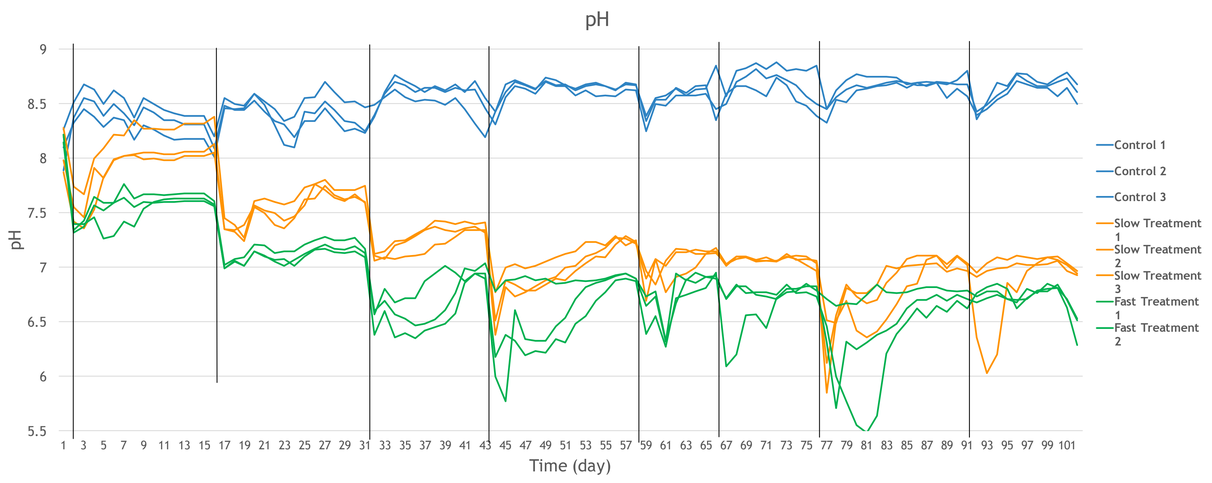
Graph 4: Average Uptake of Phosphate over 8 Treatment Periods

Result & Conclusions



Right: Culture 6 (slow treatment); Left: Culture 8 (fast treatment) at the end of treatment 8





Graph 1: Daily pH measurements of 9 *Chlorella vulgaris* cultures throughout the experiment. Vertical lines indicate change in treatment period.

Discussion

- Nutrient uptake of potassium and phosphate correlate to the biomass grot pattern over the eight weeks
- Nitrate uptake over the 8 treatment periods was inconclusive
- After treatment 5, the fast treatment cultures rapidly declined to complete culture death. This is supported by decreased biomass growth, nutrient absorption, little pH respiration response, and no living cells observed under microscopic analysis.
- At the beginning of Treatment 7, the fast cultures contained 84% BWW which raised the potassium concentrations close to 400 ppm.
- Slow treatment cultures also experienced a decline after treatment 6. As no algal death was observed, nutrients were still being absorbed, and biomass growth remained positive, the culture experienced this as a result of constraints due to the culture conditions.
- As the cultures became very dense, they would compete for nutrients, space, light, and air. This is supported in the microscopy showing healthy cells.

Citations: Herrera, Daniella. Growing Algae in Biodiesel Wash Water for Waste Water Remediation. IES Climate Change Poster Session. Loyola University Chicago. March, 2017.
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