Characterization of a Marine Algae for Bioremediation and Bioproduction from Wastewater

Nathan O'Neil*, Ryan Lam, Chloe Ballin, Ethan Yeh, Pratap Pullammanappallil, Ana Martin-Ryals

Agricultural and Biological Engineering, UF

Introduction

Microalgae, including cyanobacteria, can play a critical role in remediating wastewater pollution and supporting a circular bioeconomy. Integration of microalgae cultivation as a posttreatment for anaerobic digestion effluent (ADE) can provide a mechanism for nutrient removal and the production of high value bioproducts. To do so, the microalgae employed must be able to tolerate the high levels for ammonia, salinity, and potentially toxic ADE byproducts.

Research Aim

Characterize growth, nutrient removal, and phycocyanin yield of a novel Cyanothece BG11 strain grown on the products of anaerobic digestion.

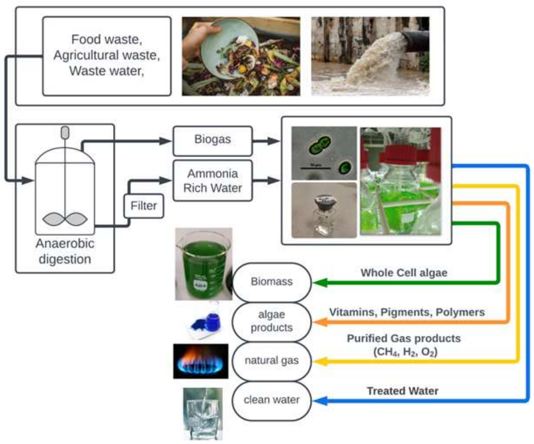

Figure 1: Systems overview diagram

Experimental Design

- Batch culture experiments with increasing concentrations of anaerobic digester effluent (ADE) and biogas
- Biomass growth measured by Optical Density at 680 nm
- Assessment of biogas content by Gas Chromatography
- Standard water quality measurements done with HACH kits.
- Phycocyanin assessed via freeze-thaw extraction and nanodrop

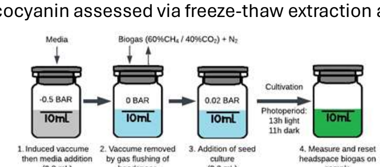

Figure 2: Sample cell bioreactor method diagram

Biomass Growth

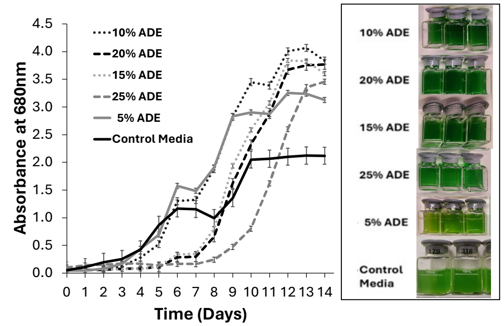

Figure 3: Optical density absorbance readings by day over 14 days

Nutrient Removal Efficiency

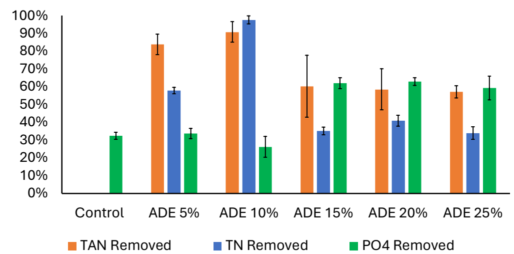

Figure 4: Total Nitrogen (TN), total Ammonia (TAN) and total Phosphate (PO4) removed after 14 days

Biogas CO_2 Removal Efficiency

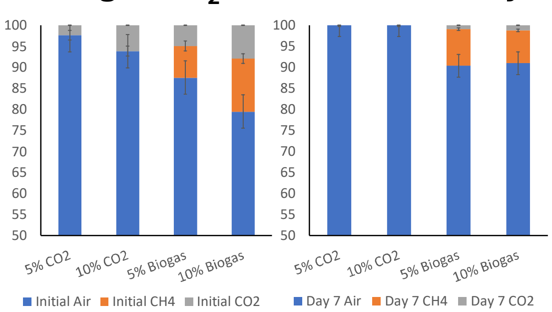

Figure 5: Variable headspace gas content after 7 days of batch culture

Phycocyanin Product Yield

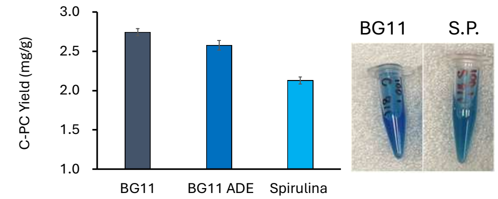

Figure 6: Phycocyanin protein extraction by algae dry weight

Results

- Observed growth across all conditions with highest biomass yield observed in the 10%,20%, 15% v/v ADE loading.
- Prolonged lag phase observed with increasing ADE concentrations.
- BG11 effectively removed 47% 53% and 75.3% total nitrogen, ammonia and phosphate, respectively.
- Biogas results good indicate a tolerance for feed biogas (60% CH_4, 40% CO_2) concentrations up to 10% CO_2 in the headspace before significant impact on growth rate and optimal nutrient removal occurs after established biofilm growth.
- CO_2 is reduced to below detectable limits by the end of 7 days, and 1.2% percent in highest biogas tested
- While lower than expected, C-Phycocyanin extracted from cyanothece meets levels found in industry standards like spirulina within the same extraction method. Growth on ADE did lower extracted content.

Conclusions

- Cyanothece BG11 performs nominally to other applied cyanobacteria within literature and serves as an excellent candidate for future anaerobic digestor system testing.
- Exploration for the impact of the excreted EPS on nutrient removal efficiencies
- While methods for extraction need to be refined to improve overall yields, growth on ADE did not negatively impact or improve yield for currently desired protein extraction

Supported by:

USDA-NIFA Hatch: FLA-ABE-006128

*Corresponding Author: noneil@ufl.edu