Cultivation and Optimization of Saline Microalgae BG0011 for Production of Biofuels and Bioproducts

Yingxiu Zhang
Advisor: Dr. Pratap Pullammanappallil
Dr. Spyros Svoronos; Dr. Edward Phlips
Agricultural&Biological Engineering
University of Florida
May, 2015

Why Algae?

- Does not compete with food resources
- Can be cultivated on marginal lands to save arable lands
- Grow faster than traditional crops

Synechococcus BG0011

Photograph for different cell densities of *Synechococcus* sp. BG0011

- **Species**: Unicellular cyanobacterium, Synechococcus sp.
- **Find location**: Isolated from epiphytic samples collected in the Florida Keys

Unique Characteristics:

- Nitrogen fixation
- High salinity tolerance (10-70psu)
- Secrete exocellular biomaterial (ECB)

An attractive candidate for production of biofuels and bioproducts

Objectives

- **To optimize algal growth by changing several factors**, such as light intensity, CO_2 concentration, phosphorous concentration.
- **To minimize economic input** by replacing the expensive buffer 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES) to some cheap alternatives(e.g. $NaHCO_3$).

Methods

Four PBRs for algae batch cultures

Light intensities (unit:µmol photon m^{-2} s^{-1}):

- 1) Low light: 20 vs. High light:438 (sparged with air or air+1% CO_2)
- 2) Five different light intensities (sparged with air only)

CO_2 concentration:

1) air; 2) air+1% CO_2; 3) air+5% CO_2

K_2HPO_4 concentration:

1) 0.012 g/L; 2) 0.024 g/L; 3) 0.05 g/L; 4) 0.1 g/L

Changing HEPES buffer to $NaHCO_3$ buffer

Results

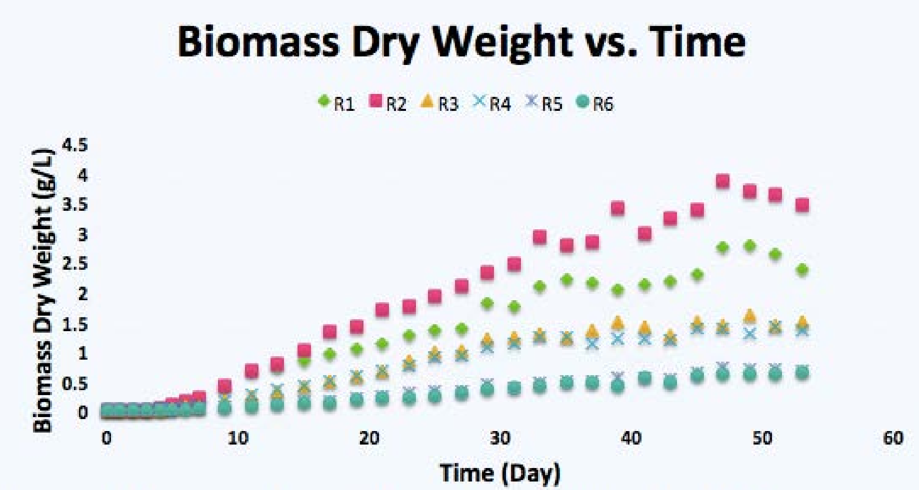

Figure 4. Biomass dry weight under air (2 L/min) at light intensity (μmol photon m^{-2} s^{-1}) of 315 (R1, R2), 241 (R3), 183 (R4), 139 (R5) and 106 (R6).

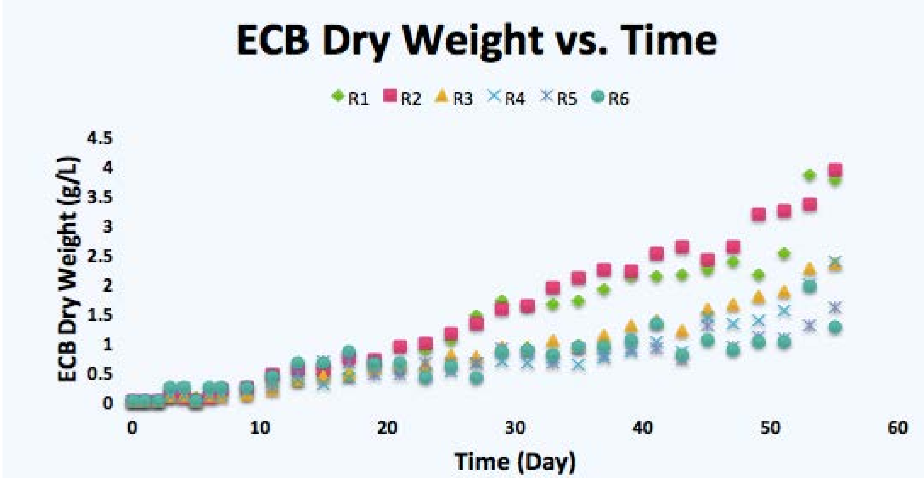

Figure 6. ECB dry weight under air (2 L/min) at light intensity (μmol photon m^{-2} s^{-1}) of 315 (R1, R2), 241 (R3), 183 (R4), 139 (R5) and 106 (R6).

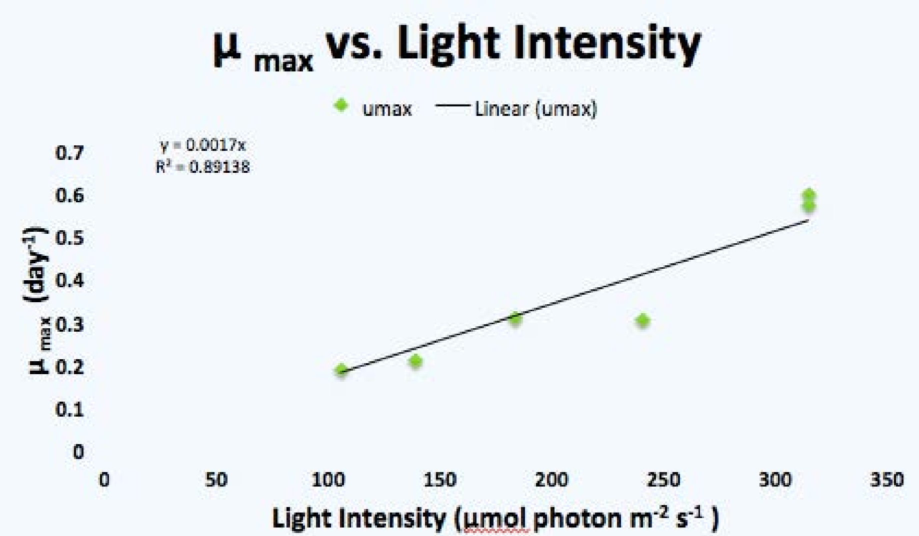

Figure 5. Relationship between μ_{max} and light intensity.

- Increasing light intensity increased algae cell density and maximum specific growth rate(μ_{max}). Before reaching the light intensity saturation point, μ_{max} is proportional to the light intensity.

Conclusion

- **Light experiment:** Increasing light intensity increased algae cell density and maximum specific growth rate(μ_{max}). Before reaching the light intensity saturation point, μ_{max} is proportional to the light intensity.
- **CO_2 experiment**:Under high light, enriched with 1% CO_2 content of air does improve cell density. However, μ_{max} was not affected. Cell density was not improved at 5% CO_2 compared to 1% CO_2.
- **P experiment** : As phosphorous concentration increases, cell density increases but ECB content does not increase appreciably.
- **Buffer Experiment**:From long term cultivation, $NaHCO_3$ buffer can be used to instead of HEPES buffer.
- A total **8 g/L** of organic matter is obtained which can be used as feedstock for biofuels and bioproducts.

Email: yzhang88@ufl.edu