Optimizing Conditions to Maximize Algae Growth for Biodiesel Production

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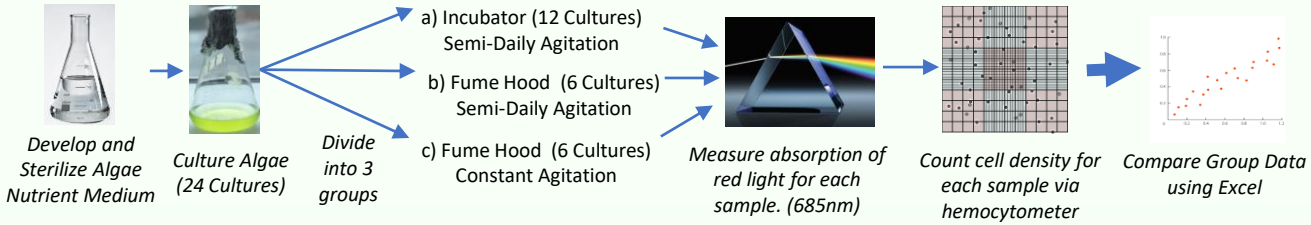
Abstract

Select subspecies of microalgae are considered to be the most promising candidates for third generation renewable resources of biodiesel. Algae not only ingest excess carbon emissions from the atmosphere, they also convert it into energy-dense lipids which can be harvested, and then transformed into biodiesel. However, before the fuel industry can adopt algae farming as a realistic alternative to fossil fuels, the process of harvesting algal lipids must be optimized further. Our research aims to make algal lipid extraction more realistic by determining the ideal growing conditions of the algae species Chlorella Vulgaris. Our research this semester focused on two objectives: The first objective was to generate a standard plot which relates Absorbances of algae cultures to their cell densities. A standard plot would then replace cell-counting and hemocytometer usage, saving us many hours per semester. The second objective was to determine the highest algae growth rates between three groups: a) incubation with semi-daily agitation, b) fume hood with semi-daily agitation, and c) fume hood with constant agitation. Our resulting standard plot shows a direct linear relationship between absorbance and cell density with a R squared value of 0.8629. Group c had the slowest growth rate, while groups a and b had similar growth rates which were nearly double that of group c. Our data suggests that constant agitation is not an ideal condition for algal growth.

Methods



Results

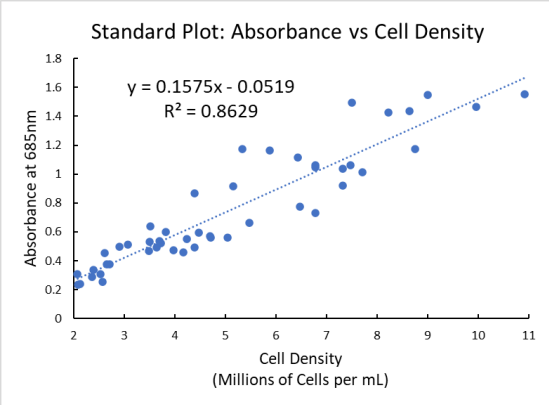


Figure 1 (left): Standard Plot Relating Absorbance of Culture to Cell Density. One goal of our study was to determine whether a standard plot may serve as a future tool to quickly determine the cell density of any given culture by simply measuring the culture's absorbance, rather than spending hours counting cells with a hemocytometer. Absorbance values were measured using 1.00cm polystyrene cuvettes in a Varian Cary 50 UV-Vis Spectrophotometer. Cell Density values were determined by taking microscope photographs of a Bright-Line hemocytometer, and then counting the individual cells in the photo. Data was acquired from the even numbered algae cultures (6, 3, and 3 from groups a, b and c respectively).

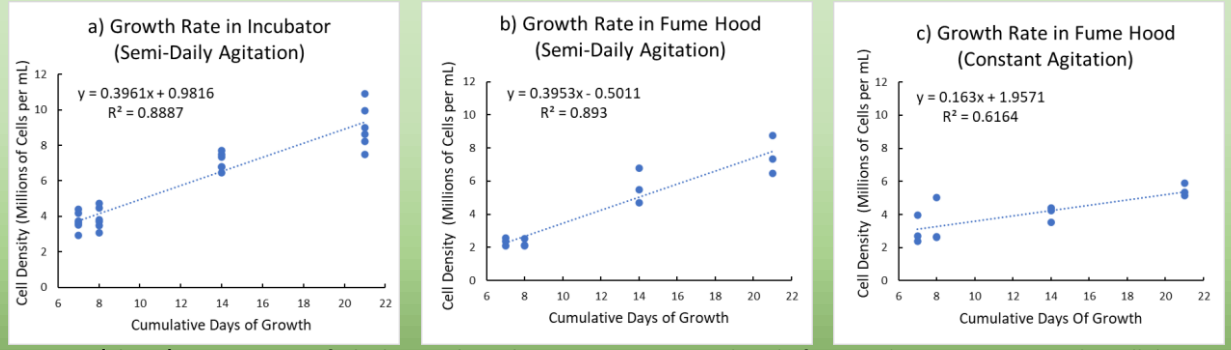


Figure 2 (above): Comparison of Algal Growth in Three Groups. A second goal of our study was to compare the cell density growth rates between cultures exposed to different environmental stressors. **Group a)** 6 algae cultures grown in an incubator at 22.6 deg C, stirred once every other day by hand. **Group b)** 3 cultures grown in a fume hood at roughly 20 deg C, stirred once every other day by hand. **Group c)** 3 cultures grown in the same fume hood as group b, stirred constantly (day and night) by a magnetic stir rod.

Discussion

In **Figure 1,** the standard plot yielded a linear relationship with a higher-than-anticipated R squared value of 0.8629. While still not ideal, these promising results demonstrate that a standard plot may serve as a future shortcut for determining cell density as opposed to manually counting cells one-by-one using a microscope and hemocytometer. This outcome motivates us to further optimize our procedure in hopes to have higher correlation in future semesters. In the short term, the equation from **Figure 1** can be used to approximate the growth of algae cultures next semester.

In **Figure 2**, relative growth rates of the three groups can be compared by observing the linear slopes of each group. The value of the slope indicates "millions of new cells per day". Therefore, Group C has the slowest growth rate, while groups A and B have nearly identical growth rates which are more than double the rate of group C. Note that each group started out with the same cell density at day zero. Our data suggests that constant agitation may hinder the proliferation of Chlorella Vulgaris. In the future, our group would like to increase the validity of our results by imposing more constant variables to the groups, such as light intensity, and temperature.

Future Directions:

- Genetically modify to increase lipids
- Investigate growth rate of cultures being stirred at regular time intervals, rather than constantly.
- Utilize wastewater as a source of nitrogen for algae growth
- Expand cultivation to the E-Garden
- Cultivate different algae strains to maximize lipid yield and decrease contamination (*ex. Dunallella*)

A very special thank you from our group to the Geneseo Foundation, the SUNY Geneseo Student Association, the eGarden of Geneseo, and the Chemistry Department of SUNY Geneseo. Our project would not be possible were it not for them.