Effect of Abscisic Acid on *Chlorella vulgaris* Growth and Lipid Yield

Gary Jones[1] and Ann C. Wilkie[2]

[1] Department of Microbiology and Cell Science, College of Agricultural and Life Sciences

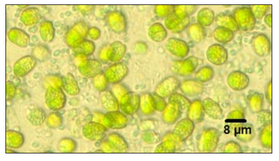
[2] Faculty Mentor, Soil and Water Science Department, University of Florida-IFAS, Gainesville, Florida

Abstract

Photosynthetic algae can produce carbon-neutral fuel through lipid transesterification and can be farmed without competing with food crops. Commercial-scale use of algae for biofuel production is dependent on high lipid yields and efficient extraction. The purpose of this research was to evaluate the effect of exogenous plant hormones, specifically abscisic acid (ABA), on algal biomass growth and lipid content. ABA plays an important role in plant responses to environmental stress. *Chlorella vulgaris*, a microalgae strain capable of lipid production, was grown in BG-11 standard growth media. Cultures were illuminated at 300 µmol photons/m^2/s on a 12:12 photoperiod. ABA was added in various concentrations from zero (control) to 20 ppm, and all treatments were performed in triplicate. Biomass growth rate was measured by spectrophotometry at 680 nm. Lipid content was determined using nuclear magnetic resonance and presence of lipids was confirmed qualitatively using Nile Red staining. Compared to the control, there were no significant changes in biomass growth rate or dry biomass yield. Although ABA did not appear to elicit cell growth, the average lipid yield of all treatments exceeded that of the control. Further studies are warranted to precisely determine the effect of ABA on microalgae growth and lipid content.

Introduction

Microalgae grow rapidly and can be used to create biodiesel from lipid production. Lipid content varies depending on the algal species[1]; *Chlorella vulgaris* can range from 18-40% lipids depending on culture conditions[2]. One challenge facing commercial-scale algae production is ensuring the presence of high lipid content in harvested algae[3]. The use of phytohormones may be a way to induce phenotypic changes in microalgae[4].



***Chlorella vulgaris* (40x)**

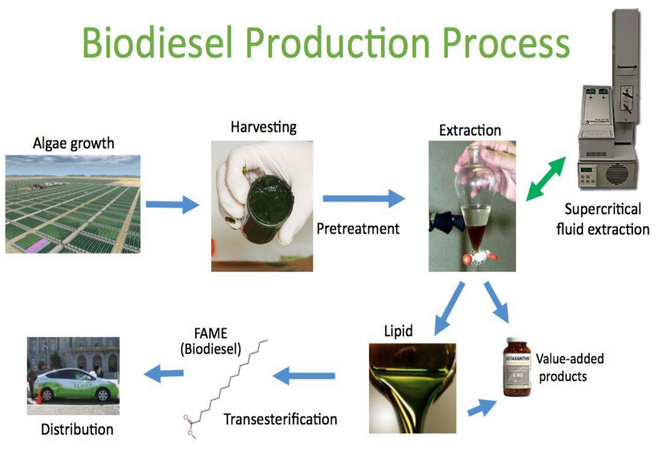


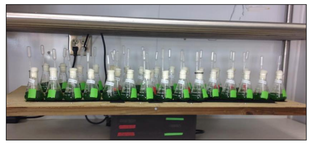
Figure 1. The conversion of algae to biodiesel

Objective

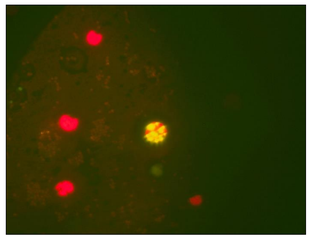
To determine the biomass yield and lipid content of *Chlorella vulgaris* at varying concentrations of abscisic acid (ABA).

Methods

- **Sample Preparation:**
  - *Chlorella vulgaris* inoculum cells were obtained from the Bioenergy and Sustainable Technology Laboratory and cultivated in standard BG-11 Medium.
  - Subcultures with 10% inoculum were grown in BG-11 medium with ABA concentrations of 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 ppm, in triplicate.
  - Algae were cultivated at 25°C over 10 days.
  - Light intensity was 300 µmol photons/m^2/s on a 12:12 photoperiod.
  - Cultures were agitated with an orbital shaker at 100 rpm.
- **Cell Growth:**
  - Optical density was measured over 10 days using spectrometry at 680 nm.
  - pH was monitored daily.
- **Algal Biomass Dry Weight:**
  - Samples were filtered and dried at 105°C for one hour.
- **Lipids:**
  - Nuclear magnetic resonance (NMR) was used to determine lipid content.
  - Nile Red staining was used to detect lipids by fluorescence microscopy.



Experimental setup



Nile Red lipid detection

Results

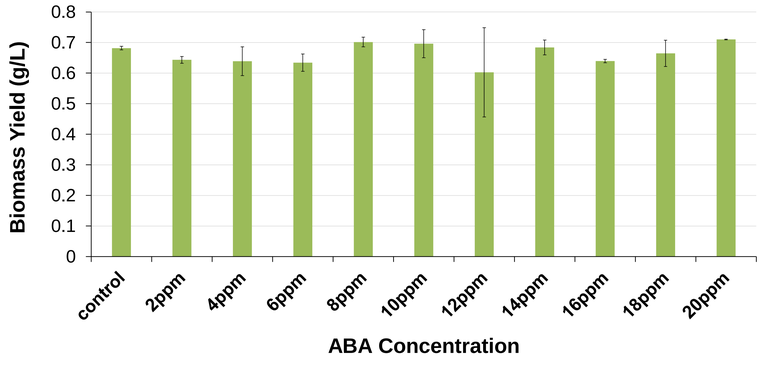


Figure 2. Average biomass yield of Chlorella vulgaris for varying ABA concentrations

There was no significant correlation between ABA concentration and the measured biomass yield for *Chlorella vulgaris*.

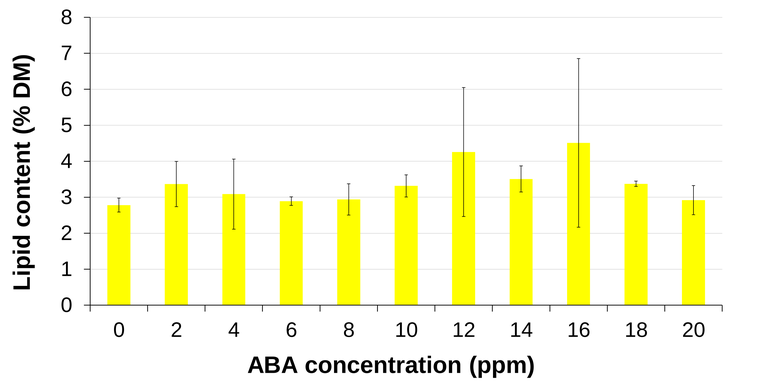


Figure 3. Average lipid content of Chlorella vulgaris for varying ABA concentrations

All ABA concentrations exhibited higher average lipid content than the control.

Conclusions

- ABA concentrations ranging from 2 to 20 ppm had minimal influence on cell growth rate and biomass yield of *Chlorella vulgaris*.
- Average lipid content was higher with the presence of ABA relative to the control.
- ABA can be utilized as a resource to stimulate lipid production in *Chlorella vulgaris*.

Future Work

- Investigate the effect of ABA on nitrogen-deprived *Chlorella vulgaris* cells with respect to cell biomass yield and lipid content.

References

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