Algae Cultivation: Growth of the Filamentous Alga *Oedogonium* Compared to Microalgae

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Abstract

As the planet faces depletion of its natural resources, alternative and sustainable energy sources are becoming increasingly sought after. Research on the growth of algae has revealed their potential for carbon capture to reduce greenhouse gas emissions and for conversion into a fuel source for bioenergy applications. Filamentous algae have attracted recent attention as an optimal species for cultivation due to their ease of harvest and dominance over other species. To determine the most suitable species for future biomass applications, a 1000-L open raceway pond was inoculated with the freshwater filamentous alga, *Oedogonium*, with the addition of CO_2. An additional two 1000-L raceway ponds with established cultures of microalgae already receiving CO_2 were used as a comparison to the growth of *Oedogonium*.
The pond cultures were harvested weekly to determine culture density/growth (mg VSS/L) and harvest productivity (g VSS/m^2-day). After 3 weeks, *Oedogonium* harvest productivity exceeded both microalgal ponds at 13.7 (± 0.3) g VSS/m^2-day compared to 9.3 (± 0.6) and 9.5 (± 0.5) g VSS/m^2-day for the microalgae. Thus, *Oedogonium* could serve as a suitable species for biomass production due to its higher productivity rates when compared with microalgal growth.

Introduction

- More sustainable methods for energy production are being researched to meet society's demand.
- Algal cultivation could provide an alternative energy source as well as many other environmental benefits.
- The filamentous alga, *Oedogonium*, is gaining attention for its relative dominance over other species and the potential ease of harvesting long filaments compared to the small cells of microalgae [1].

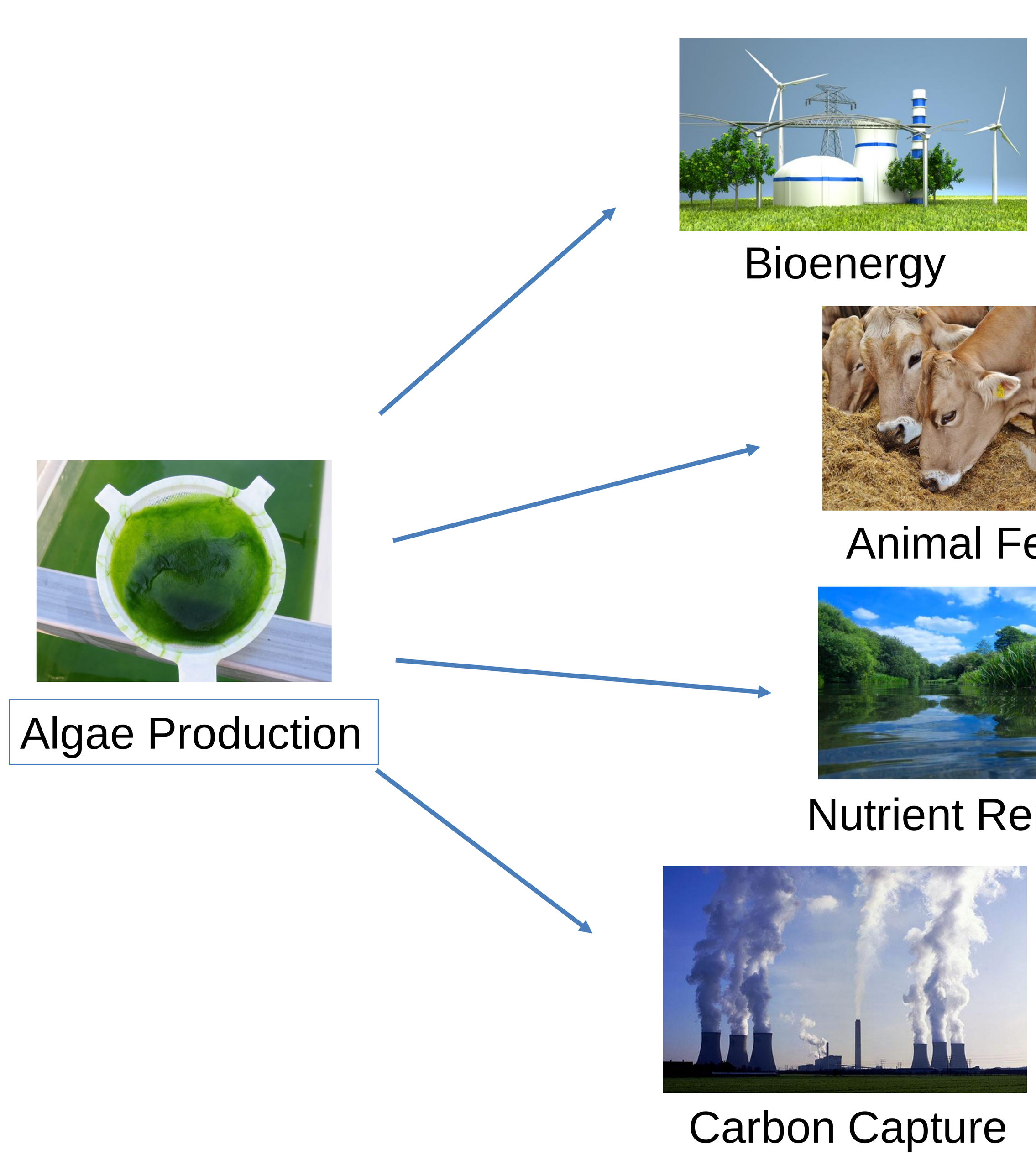


Figure 1. Benefits of Algae Production

Objective

The objective of the current study was to assess the harvest productivity and culture density of *Oedogonium* with the addition of CO_2 and compare it to the growth of different polycultures of established microalgae already receiving CO_2. This will determine the most suitable species of algae for carbon capture and future biomass production.

Methods

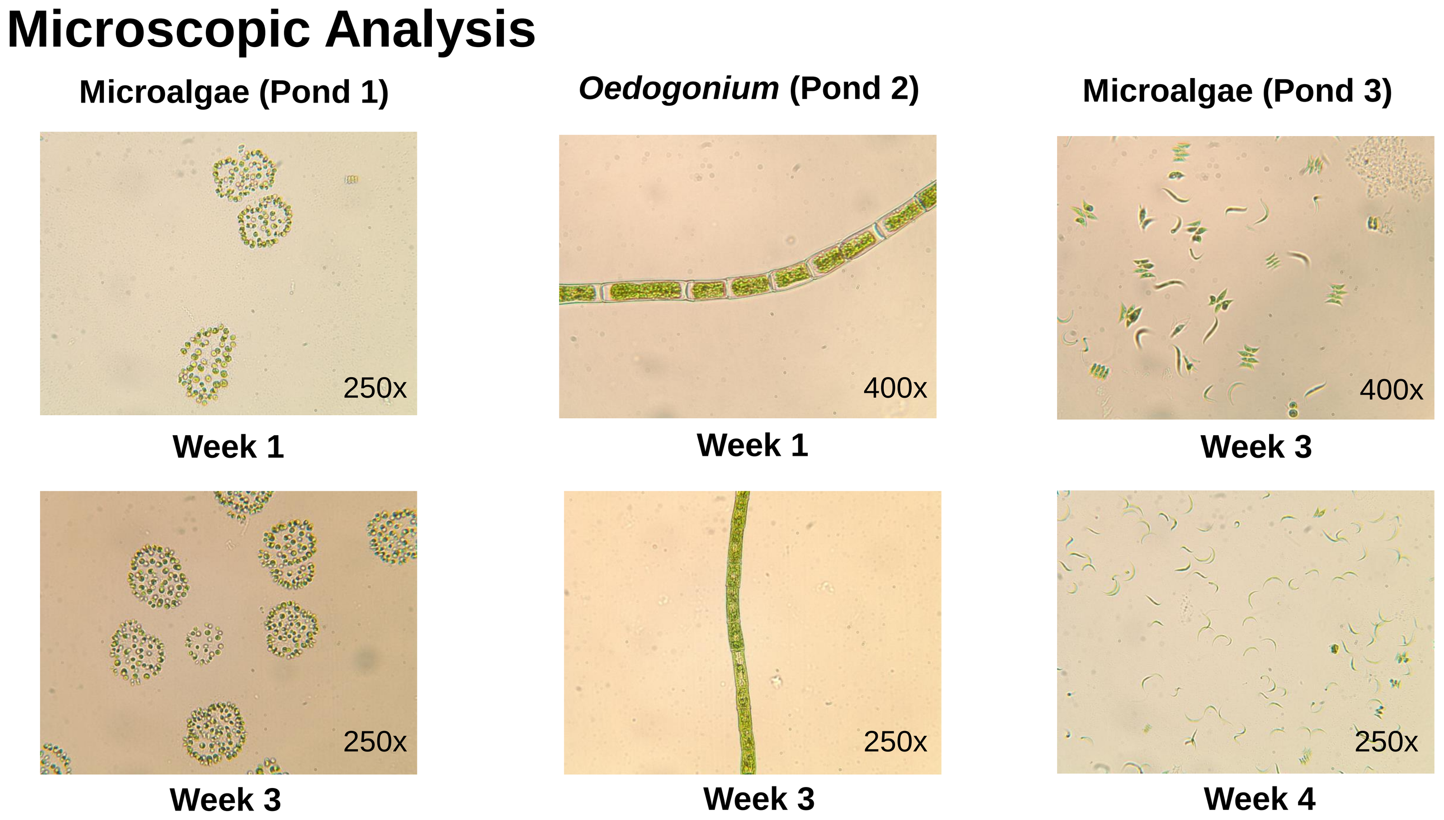
- A 1000-L open raceway pond (Pond 2) in Gainesville, Florida was inoculated with a local culture of the filamentous algae, *Oedogonium*.
- An additional two 1000-L raceway ponds (Ponds 1 & 3) with local polycultures of microalgae (*Scenedesmus*, *Dictyosphaerium*, *Ankistrodesmus*, and others) that were already established and receiving CO_2 were used as a comparison to the growth of the freshwater alga, *Oedogonium*.
- Each pond was supplied with CO_2 on demand to maintain a set pH of 8.0.
- Each week, pH and temperature readings were monitored with a HACH meter and recorded.
- Ponds were raised to full volume (25cm) if evaporation had occurred and pre-harvest samples were obtained.
- Ponds were harvested to half volume (12.5cm) and brought back to full volume with tote water. Post-harvest samples were taken.
- Samples were blended and filtered in triplicate, dried in an oven at 105 °C for 1 hour, and weighed to determine total suspended solids (TSS). Samples were placed in an oven at 550 °C for 2 hours to determine volatile suspended solids (VSS).
- Culture density and harvest productivity were determined weekly.
- Each culture was analyzed under a microscope to identify physical changes in algae.
- Ponds were fertilized at a rate of 41.6 g/week with N-P-K: 30-10-10.

Figure 2. Algae Sampling

Figure 3. Filtered Samples

Results

Microscopic Analysis



During week 1, *Oedogonium* filaments were a dull green color with cell components aggregated towards the center, away from the cell walls. After three weeks, cell components dispersed, filling the entire capacity of the cell wall. The filaments appeared more robust with a brighter green color.

Culture Density/Growth

Table 1. Weekly algal culture growth

	Microalgae Pond 1 (mg VSS/L)	*Oedogonium* Pond 2 (mg VSS/L)	Microalgae Pond 3 (mg VSS/L)
Week 1	64.8 ± 3.9	14.4 ± 3.9	66.2 ± 12.0
Week 2	202.6 ± 8.3	130.0 ± 7.2	213.3 ± 2.3
Week 3	265.3 ± 18.0	382.0 ± 8.0	260.0 ± 13.9
Week 4	141.1 ± 17.4	248.2 ± 12.6	175.4 ± 6.2

Data are means ± standard deviation (n=3).

Initially, the established microalgal ponds had higher increases in culture density than the *Oedogonium* pond. During week 3 of the experiment, *Oedogonium* had the highest increase in culture density, 382.0 (± 8.0) mg VSS/L.

Harvest Productivity

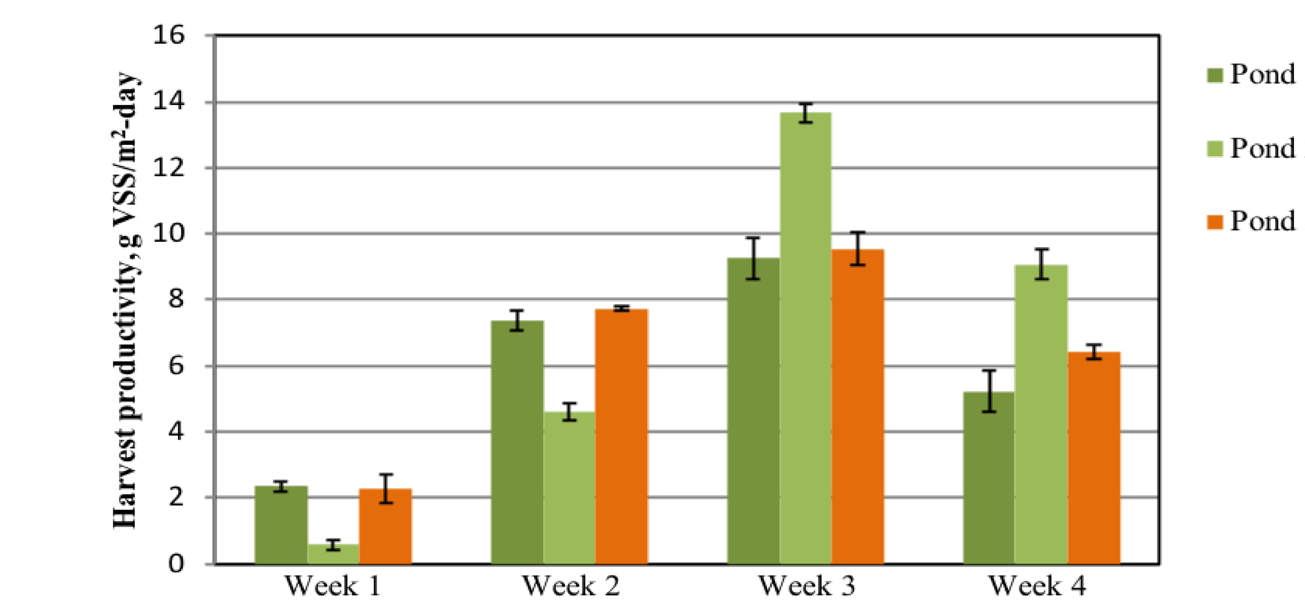


Figure 4. Harvest productivity of *Oedogonium* (Pond 2) and microalgae (Ponds 1 and 3). Data are means ± standard deviation (n=3).

After the four week experiment, *Oedogonium* in Pond 2 surpassed the harvest productivity of microalgae in both Ponds 1 and 3 (Figure 4). During week 3, *Oedogonium* reached a peak of 13.7 (± 0.3) g VSS/m^2-day compared to 9.3 (± 0.6) and 9.5 (± 0.5) g VSS/m^2-day for the microalgae in Ponds 1 and 3, respectively.

Discussion

- *Oedogonium* outperformed both microalgal ponds in terms of harvest productivity by the end of the experiment.
- Culture growth and productivity during week 4 likely decreased due to a large rain event that brought 4.9 inches of rain, causing the ponds to overflow and spill some of the biomass.
- In an Australian study of the *Oedogonium* species by Cole et al. (2014), peak harvest productivity reached 8.33 (±0.51) g DW (dry weight) m^{-2}-day when adding CO_2 to maintain a pH of 7.5 [2]. Productivity in the current study peaked slightly higher at 13.7 (± 0.3) g VSS/m^2-day.
- *Oedogonium* appears to be a suitable species to use for biomass production purposes. Not only did it outperform other genera, the filaments can be harvested easily with a net, and it appears to be quick at adapting to culture conditions to obtain high biomass productivities.

Acknowledgements

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