Post-Harvest Algal Pretreatment using Biological Control

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Abstract

The mass cultivation of algae is a developing field with many potential applications in both industry and agriculture. Algal biomass can be anaerobically digested to produce methane. An effective way to generate a significant amount of biomass is through outdoor open raceway ponds, but these cultures are susceptible to contamination from insects. Efficient pretreatment methods using biological controls may be necessary to obtain the maximum methane generation from pure algal feedstocks. Algae contaminated with insect larvae were harvested from a 1000-L open raceway pond located at the Stanton Energy Center in Orlando, Florida. The insects were identified as midge fly larvae by microscopy. One of the common predators of these larvae are the Giant Danio minnows, which have a primarily carnivorous diet. Two minnows were placed in separate 5.5 gallon fish tanks and fed approximately 136 worms per day in the form of a wet pellet mixture of algae and larvae. The concentration of larvae in the harvested algae was 18 larvae/g of wet biomass. The biological pretreatment resulted in 99% removal of the insect contamination over a 24-hour treatment period. Thus, Giant Danio minnows could serve as a feasible pretreatment method to remove insect larvae from harvested algae.

Introduction

Algae for Bioenergy:

There are many benefits to using algae for bioenergy. Algae consume less water for growth than terrestrial crops, and can be cultivated in saline water, brackish water or wastewater. Thus, they do not compete with food crops. Growing algae can mitigate carbon dioxide emissions and they have a high photosynthetic efficiency in comparison to terrestrial crops [1]. However, mass cultivation of algae often requires a large-scale outdoor setup.

Open Pond Contamination:

Open outdoor cultures are susceptible to contamination from a variety of organisms, including bacteria, other algae, aquatic vertebrates, and insects. Open raceway ponds are often supplemented with nutrients to support algal growth, and these nutrients make these ponds an excellent breeding ground for such contaminants. Contamination by aquatic insects in an open pond system is considered a particularly unavoidable circumstance [2].

Figure 1. 1000-L Open Raceway Ponds

Objectives

- Identify type of insect contamination in harvested algae sample
- Develop strategy and evaluate the effectiveness of using a biological control to remove insect contamination from algae

Contaminated Algae Sample

Methods

Identification:

• Species identified using CK Olympus Tokyo Inverted Microscope

Characterization:

•Characterize solids concentrations of algae samples before and after removal of insects according to Standard Methods [3]

- Total Solids (TS)
- Volatile Solids (VS)

Biological Control:

•Giant Danio minnows selected based on diet

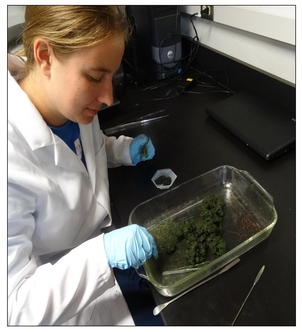
•Number of larvae counted in 11 mL original algal sample in triplicate before exposure to biological control

•Two minnows were evaluated for replication (one per tank)

•Each minnow was fed 75 ml/day of contaminated algal sample over 15 days

Determination of Removal Efficiency:

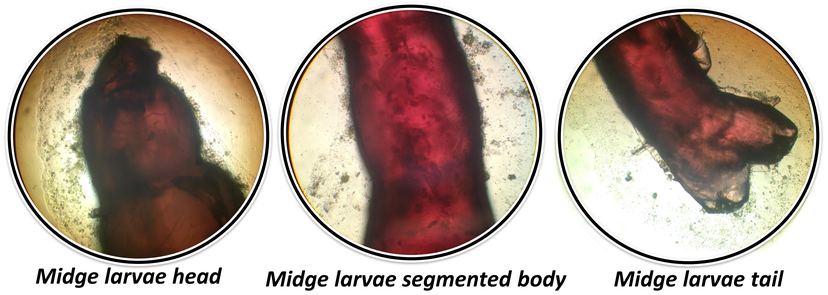
•Number of larvae counted in centrifuged original algal sample in triplicate before and after exposure to biological control



Insect removal by hand

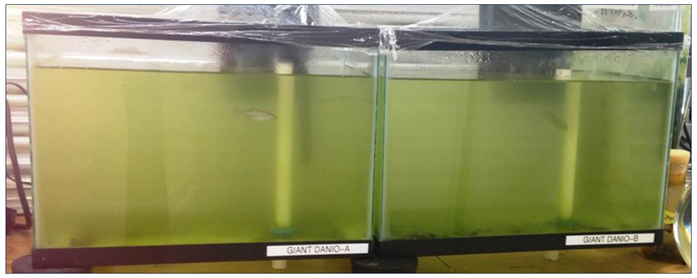
Giant Danio minnow

Results



Midge larvae head ***Midge larvae segmented body*** ***Midge larvae tail***

Figure 3. Identification of Insect Contamination: Midge Fly Larvae



Visual Observations: There was no feeding preference between stages of larvae for the Giant Danios. During feeds, the minnows did not have a preference for either living or dead worms. Tetra BloodWorms were substituted as feed after the end of the experiment and no difference was found in their eating habits.

Table 1. Algae Characterization

SAMPLE	TS (%)	VS (%)	Organic matter (gVS/kg sample)
Algae with larvae	48.0 ± 2.0	27.5 ± 1.0	0.13
Algae	21.5 ± 0.5	71.9 ± 0.6	0.15

Table 2. Contaminant Concentrations and Removal Efficiency

Effective Feed rate	
Algae feed rate	75 ml/day
Concentration of larvae	1.82 larvae/ml algae
Number of larvae fed	136 per day
Removal efficiency	99%

Conclusions

- Giant Danio Minnows are an effective biological control for midge fly larvae contamination and were capable of 99% removal at a feed rate of 136 larvae per day per minnow.
- Algae contaminated with midge fly larvae have essentially the same organic matter concentration as algae without the larvae.

References

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