Name(s)

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Project Number

S1117

Project Title

Developing Compostable and Water-Soluble Algal Bioplastics by Repurposing Waste Products of Algal Biofuel Production

Abstract

Objectives

Plastic pollution is becoming an environmental crisis, with over 40% of the ocean being covered in floating plastic. The purpose of this research was to determine the sustainability of algae-based bioplastics as alternatives to conventional petroleum-based plastics. The ultimate goal was to develop an algal bioplastic recipe using byproducts of algal biofuels that was compostable, water soluble, and exhibited similar physical properties in strength to conventional plastics.

Methods

The research consisted of three parts. In Phase I, four species of algae (T. suecica, N. oculata, H. droebakensis, and C. vulgaris) common to biofuel production were cultured in a homemade photobioreactor. Cell counts were taken daily using hemocytometry. The algae species were then harvested, and lipids were separated from the algal biomass and converted to biodiesel via mechanical extraction. The resulting biomass was used to create bioplastics.

In Phase II, various percentages of algal biomass to pure starch ratios were tested in the bioplastic recipe. The plastics were tested for strength.

In Phase III, the potential environmental impacts were tested and the bioplastics of various starch to biomass ratios were tested for biodegradation in soil, water solubility, and ability to increase plant growth as a natural fertilizer.

Results

Results indicated that C. vulgaris was the optimal species for bioplastic production due to fast proliferation and stronger bioplastics. When comparing various ratios of algal biomass in the recipe, higher starch contents yielded stronger bioplastics. In tests for environmental impact, trends between starch and biomass ratios were identified. Data suggests that higher percentages of algal biomass resulted in faster water dissolution, increased biodegradation in soil, and taller plant heights. Bioplastics with 25% biomass performed best in testing, supporting 633 grams, losing 19.2% mass in water (7 days), losing 97.5% mass after composting (7 days), and increasing plant heights by 46% and 28.5% in pea and radish plants respectively (12 days).

Conclusions

Results suggest that environmental impacts and strength can be manipulated with adjustments to the starch/biomass ratios. Algae-based bioplastics show promise as sustainable alternatives to petroleum-based plastics, specifically single use plastic items.

Summary Statement

I used algae biomass (a typical waste product in biofuel production) to create plastic that was compostable in soil, water soluble, a natural fertilizer, and exhibited similar physical properties to conventional petroleum-based plastics.

Help Received

None. I designed, built, and performed the experiments myself.