Scale up of Bioplastic (PHB) Production from Algae Based Media

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ABSTRACT

As crude oil consumption continues petroleum reserves are being depleted, driving up energy and fuel prices as well as the cost of producing synthetic plastics. The non-biodegradability of synthetic plastics has led problems with pollution and the significant buildup of synthetic plastic material in landfills. An alternative to the use of petroleum based plastics is the use of biodegradable plastics that are produced using raw materials that are biologically derived. One class of biodegradable plastics is polyhydroxyalkanoates (PHAs), of which polyhydroxybutyrate (PHB) is the most studied. PHB is biopolymer that is synthesized by many organisms and is naturally produced in certain organisms as an energy storage molecule. PHB has properties similar to traditional plastics such as polystyrene and polypropylene. However, PHB is not produced at commercial scales due to the cost associated with processing and producing large quantities of PHB. The focus of this project has been to scale up the production of PHB by utilizing a novel strain of E. coli capable of secreting PHB, making use of waste material, specifically from algae biofuels processing, and different extraction techniques to aid in lowering PHB production and processing costs.

INTRODUCTION & BACKGROUND

Microalgae can be a significant source of renewable biomass for the production of various bio-products including biofuels and bio-based materials. As algae grow they take up nutrients such as nitrogen and phosphorous, compounds that require removal from wastewaters such as municipal wastewater. Therefore, coupling wastewater remediation with the production of algal biomass has tremendous potential to generate large quantities of renewable biomass. This biomass can be grown and harvested using rotating algal biofilm reactors, a technology developed at Utah State University. Once harvested the algal biomass can be processed, using an Utah State University procedure also developed to produce feedstock material for the production of various bio-based products.

PHB PRODUCTION AND EXTRACTION

Production of PHB using recombinant E. coli was quantified using gas chromatography. E. coli grown on various media and scales was harvested and evaluated for the amount of PHB produced. In addition to measuring the amount of PHB generated by the bacteria, several methods were also tested to extract and collect the PHB contained in the E. coli biomass. Chloroform is the most commonly used solvent. However, chloroform is toxic and difficult to scale up. Therefore, additional methods that were tested that have potential for scaling.

SUMMARY OF PROJECT

Growth of E. coli has been achieved at various scales using different medias, including the algae aqueous phase. Extraction of PHB from the harvested biomass has also been performed at various scales. However some methods evaluated were not scalable or were not feasible to scale up.

FUTURE WORK

In moving forward with this project there are a number of areas that require further attention to improve the production of PHB from E. coli grown in algae based media:

- Continue to characterize/analyze and optimize the aqueous phase media for bacterial growth.
- Improve PHB yields from the secreting strain E. coli via genetic improvements.
- Optimize and continue to scale up extraction process of PHB, specifically the Propylene Carbonate method.
- Submit research paper as peer reviewed academic publications.

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