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Editorial

Microbial Technology and Bioplastics

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Introduction

With the question, can we clean the world from "Fossil Fuel" Plastic to Bioplastic? we need to review the current uses of plastic and the needs therein and determine if bioplastics would be able to meet these needs. To evaluate this question, let's evaluate the observations, experiments, and potential conclusions for this work.

Observations

Fossil fuel-based plastics have a significant impact on the environment and are difficult to degrade biologically in the environment. In 1950, 1.5 million metric tons of plastics were produced worldwide, whereas in 2019, 368 million metric tons of material was produced [1]. The use of plastics is anticipated to quadruple by 2050, according to the World Economic Forum and their document, "The New Plastics Economy, Rethinking the future of plastics" [2]. The use of single use plastics and other non-biodegradable sources of plastic that are not adequately recycled can add up as adverse environmental effects- such as microplastics [3]. New sources of bioplastics that are not made from fossil fuels may have less of an impact and should be evaluated [4].

Question to research

Can the world meet 100% of its plastic needs with bioplastics?

Experiment

Scientists first calculated the likely global demand for plastic in the years 2030 and 2050 using government projections. They then examined the current outputs and limitations of plastic technologies and selected those that were technically and commercially proven and established. Because Microbial Bioplastics is more efficient than plant-based plastics, they chose to propose only microbial plastic technologies [5]. Microbial plastics come from biopolymers such as polyhydroxyalkanoates (PHAs) that are natural biodegradable polyesters produced by bacteria [5]. PHAs have similar properties to common plastics, however, currently the ability to mass-produce PHAs is affected by higher production costs. There, however, are many pluses with this technology and much like when a new technology such as flat screen tvs enters the market, after a while, the technology advances and they become less expensive to produce. In addition to the production, there needs to be a consumer or government backing.

In terms of technical and commercially relevant areas, there are a few different ways to create plastics that can have a two-fold benefit- reducing wastes through converting it to something else, and limiting the use of non-biodegradable petroleum based plastics. Com-

mon ubiquitous bacteria can store and accumulate PHAs and can use a variety of substrates to produce PHA. For instance, El-malek., *et al*. identified many renewables sources such as agricultural residuals, and industrial wastes that may have needed to be disposed of in alternative ways as seen below.

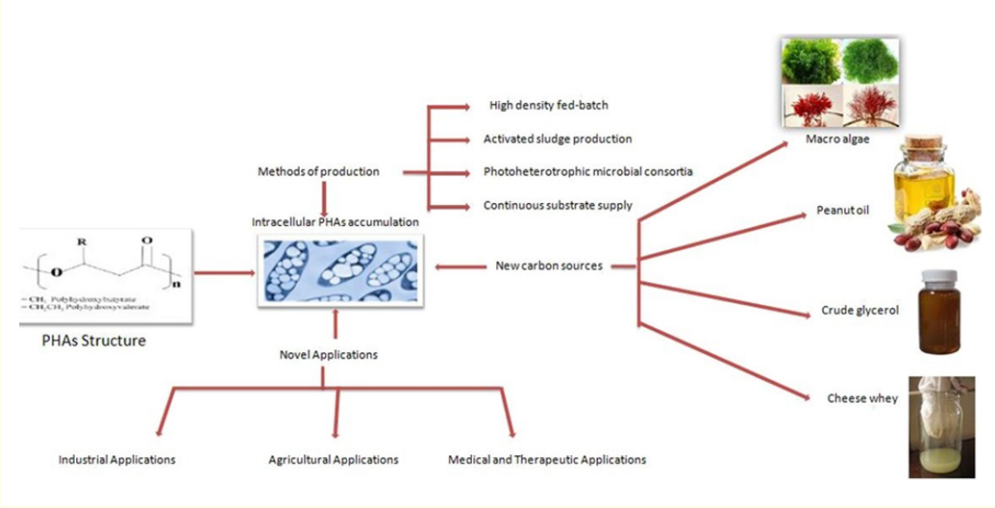

Figure 1: *Microbial Bioplastics production and carbon sources (El-malek., et al).*

For instance, one study used paper mill wastewater to create bioplastic [6]. In this case study, using an actual agro-industrial waste stream and determined that PHA was able to be enriched in the waste stream as an integrated part of the treatment process. Using PHA forming bacteria, they were able to accumulate PHAs in the industrial waste stream.

Bioplastics that are derived from food wastes also allow for a commercially and technical approach to create bioplastics, however, consumer acceptance has been a bit low according to studies [7]. The study by Scarpi., *et al*. indicated that consumers had a lack of understanding and awareness of bioplastics, indicating that education and government programs may be necessary to educate and advance the technology. Also, a good marketing program would likely be necessary to make the public accept the bioplastics. While the general population may not understand how plastics are made, using terms such as microbially derived bioplastics or bioplastics from food-waste, may not appeal to the public. To meet a goal of most of the world's plastics being produced from bioplastics by 2050, this aspect must be noted to be successful.

To accomplish the plan of global bioplastics by 2050, significant upgrades to plastic manufacturing would be necessary. Additional infrastructure would likely be necessary, however, once these industrial hurdles are overcome, it should be relatively straightforward to adjust the manufacturing of plastics with non-fossil fuel sources, and potentially with waste streams like those in paper mill wastewater that would allow for a two-fold benefit.

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