Sociotechnical Synthesis

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Plastic is literally found everywhere in our day to day lives. However, over the years plastic pollution has gotten worse and worse. Every year, more than 380 million tons of plastic are produced globally (Ritchie & Roser, 2018). Bioplastics have been the solution to the plastic crisis of heavy usage of renewable bio-based sources instead of petroleum based (*The Truth About Bioplastics*, n.d.). Polyhydroxy butyrate (PHB), which is a non-toxic and biodegradable plastic, has been gaining considerable attention as an alternative to petroleum plastics. It is naturally produced in microbial organisms and can be degraded microbially or in proper composting facilities which can really reduce the plastic pollution in our environment (Atiwesh et al., 2021). However, there are currently several factors that are hindering the transition to bioplastics such as: high production cost, lack of proper composting and recycling infrastructure, and lack of consumer education.

My technical work was on improving the PHB production process in hope to reduce the production cost by performing gene edits to maximizing intracellular concentration of acetyl-CoA in *E.coli* bacteria. Acetyl-CoA is a precursor molecule to produce PHB. Therefore, the more acetyl-CoA the bacteria has then the more PHB it can produce. The gene edits are done by performing a recombiner process of CRISPR-Cas9 and Lambda red to knockout the acetyl-CoA kinase (ackA) and phosphate acetyltransferase (pta), which are collectively known as the Pta-AckA pathway. The genomic model of our project confirmed that the knockout would lead to a decrease in acetyl-CoA concentration. Our lab data showed that the acetyl-CoA concentration was lowered in the modified bacteria compared to wild type and showed viability of this knockout. However, the reason for this can be attributed to our limitations and some

future next steps would be to further investigate other proposed methods of gene edits to increase intracellular concentration of acetyl-CoA.

My thesis observed the current feasibility to transition to bioplastics by looking at the existing composting and recycling infrastructure. To make the bioplastic industry efficient, there would need to be a more efficient way of letting bioplastics break down. In proper composting and recycling facilities, bioplastics would take around 3 months to degrade (Rech et al., 2020). This research investigates the current plastic recycling facilities existing and how much the company emphasizes sustainability. My analysis investigates the current hindrances that exist and how current recycling facilities are approaching and viewing this plastic crisis.

To have a circular life cycle of plastic to solve this plastic crisis and to truly keep all plastics in loop, it is important to genuinely understand how to improve the end-use of plastics. Though the production and start of using bioplastics is crucial but if these bioplastics are not being properly composed of then it is not meaningful. The importance of consumer education of plastic disposal, recycling, and composting infrastructure are factors that decision makers and companies need to take into consideration. Being able to have a perspective on both production and end-use side will allow a closer step to transitioning to a close loop bioplastic industry.

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Citation:

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