MICROBIAL PRODUCTION OF BIOPLASTICS

Editorial

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Abstract

Current article focus over review of biopastic such as PHA, PLA from lactic acid. However microbial production is more safer and can save money time and labor wih maximum purity.

Keywords: *PHA, LACTIC ACID,*

1.1 Introduction:

The term bioplastics was coined by European Bioplastics, a European umbrella organisation for bioplastics. Bioplastics are biodegradable, bio based or both (European Bioplastics, 2016)

Chemically *unrelated products that are created by microorganisms (or a portion of them) under various environmental circumstances are included in the category of "***biomaterials." The bioplastics** *family is a significant group of biomaterials.*

Currently, only around 1% of the annual plastic production in the world is bioplastics which is 300 million tons.(Sabbah and Porta 2017).

These polyesters have physico-chemical characteristics similar to petrochemical plastics and are found abundantly throughout nature. They build up intracellularly in microorganisms in the form of storage granules. Typically, these polymers are created from **hydroxy-acyl-CoA derivatives using several metabolic processes.** *The monomer composition, macromolecular structure, and physical characteristics of bioplastics vary depending on their microbial source. They are all largely biodegradable and biocompatible, which is really intriguing from a biotechnological perspective.*

1.2 Microbial production of bioplastics

is an innovative and sustainable approach to produce biodegradable plastics using microorganisms.

Bioplastics are a type of plastic derived from renewable biomass sources, in contrast to traditional petroleum-based plastics that are non-renewable and contribute to environmental pollution.(Rujnić-Sokele and Pilipović 2017).

1.3 Classification

Bio-based plastics are further classified into three categories: Modified natural polymers, synthesized bio-based polymers from synthesized bio-based monomers and bioplastics from waste.

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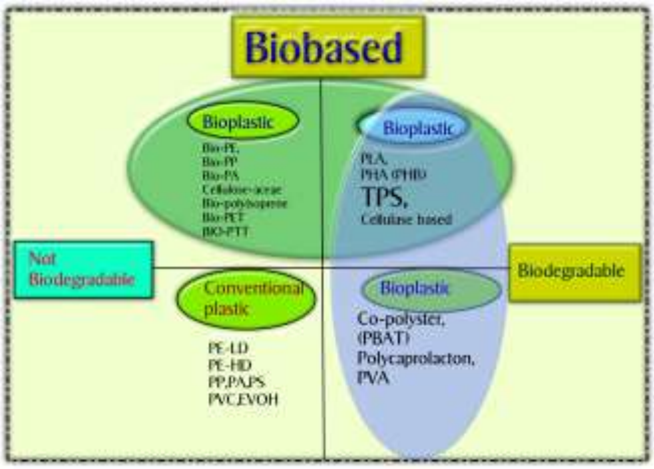

Material coordinate system of bioplastics (European Bioplastics, 2011; UK National Info Point, 2014): EVOH: ethylene vinyl alcohol; PA: polyamide; PBAT: polybuthylene dipate terephthalate; PE: polyethylene; PE-HD: high density polyethylene; PE-LD: low density polyethylene; PET: poly(ethylene terephthalate); PHA: polyhydroxyalkanoate; PHB: polyhydroxybutyrate; PLA: polylactic acid; PP: polypropylene; PS: polystyrene; PTT: polytrimethylene terephthalate; PVA: polyvinyl alcohol; PVC: polyvinyl chloride; TPS: thermoplastic starch.

The five most common types of bioplastics include:

1. **Starch-Based.** *Simple bioplastic derived from corn starch. (Iyer et al. 2023; Waldrop 2021)*
2. **Cellulose-Based.** *Produced using cellulose esters and cellulose derivatives. (Sabbah and Porta 2017).*
3. **Protein-Based.** *Produced using protein sources such as wheat gluten, casein and milk.(Pooja et al. 2023).*
4. **Bio-derived Polyethylene.** *bio-derived monomers monoethylene glycol. (Rosenboom, Langer, and Traverso 2022).*
5. **Algae based. E.g. spirulina** *(Iyer et al. 2023).*
6. **Aliphatic Polyesters.** *Bioplastic can be produced from various plan pars. (Thomas 2023).*
7. **Polybutylene Succinate (PBS)** *(Barrino et al. 2023).*
8. **Microbial production of bioplastics** *typically involves the use of microorganisms, such as bacteria or fungi, to convert simple carbon sources into polymer compounds. (Filiciotto and Rothenberg 2021)*

The two main types of bioplastics produced through microbial processes are:

1.4 Polyhydroxyalkanoates (PHA):

Polyhydroxyalkanoates are a group of biodegradable polyesters that are synthesized and accumulated by certain microorganisms as intracellular carbon and energy storage materials. PHAs have properties similar to conventional plastics and can be used in various applications, such as packaging materials, disposable items, and agricultural films. The most common PHA-producing bacteria are Cupriavidus necator (formerly known as Ralstonia eutropha) and various species of Pseudomonas.

1.5 Polylactic acid (PLA): *Polylactic acid is a biodegradable and bioactive thermoplastic derived from renewable resources, such as corn starch or sugarcane. Poly lactic acid (PLA), one of a variety of biodegradable plastics, is not only generally accessible but also secure to degrade after use without harming the environment. In terms of several qualities suited for industrial use, including as mechanical, physical, biocompatibility, and processability, PLA is also on par with other common polymers like PP and PET. As a result of these qualities, PLA has emerged as the biopolymer most frequently utilized in a variety of sectors, including packaging, agriculture, and the automobile industry. The global PLA market has steadily increased thanks to its greater demand. In reality(Taib et al. 2023). One of the biodegradable and renewable thermoplastic biopolymers is polylactic acid (PLA), which is compostable. Producing fibers, flexible nonwovens, strong and durable materials (100,000 Da or above) can be done using high-molecular-weight PLA. The techniques used for food packaging, food industry waste, biopolymers' classification, the synthesis of PLA, the significance of PLA attributes for food packaging, and technologies for processing PLA in food packaging*

Microbial fermentation processes *involve converting sugars derived from these renewable sources into lactic acid, which is then polymerized to form PLA. The bacteria Lactobacillus and Lactococcus are commonly used for PLA production.*

The process of microbial production of bioplastics involves the following steps:

Substrate selection:

Microorganisms require a carbon source to produce bioplastics. Common substrates include sugars derived from crops or agricultural waste.

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Microorganism selection:

Specific strains of bacteria or fungi are chosen for their ability to efficiently produce the desired bioplastic polymer.

Fermentation:

The selected microorganisms are grown in a bioreactor under controlled conditions, and the carbon source is provided as a feedstock.

Bioplastic accumulation:

During the fermentation process, the microorganisms convert the carbon source into bioplastic, which accumulates within the cells.

Harvesting and extraction:

After a sufficient amount of bioplastic has been produced, the cells are harvested, and the bioplastic is extracted and purified.

Processing:

The extracted bioplastic can be further processed into various forms, such as pellets or films, for use in different applications.

Advantages:

Microbial production of bioplastics offers several advantages, including reduced dependence on fossil fuels, reduced greenhouse gas emissions, and the potential for biodegradability, which can help alleviate plastic waste and pollution problems.

Challenges in bioplastic production

However, challenges remain in terms of cost-effectiveness, scalability, and competing with well-established petroleum-based plastics in the market. Researchers and industries are continually working on improving the efficiency and viability of microbial bioplastic production to make it a more sustainable alternative to conventional plastics.

Bioplastics are plastics derived from renewable biomass sources such as plants, bacteria, and algae. *One common bioplastic is polyhydroxyalkanoates (PHA). The metabolic pathway for PHA production in bacteria involves several steps:*

Substrate Uptake: *The bacteria take up renewable carbon sources, such as sugars or lipids, from the environment. These carbon sources serve as the building blocks for bioplastic production.*

Glycolysis: *In the glycolytic pathway, glucose or other sugars are broken down into smaller molecules, producing energy (ATP) and precursor molecules (e.g., acetyl-CoA).*

Fatty Acid Biosynthesis: *In some bacteria, the acetyl-CoA generated from glycolysis is converted into fatty acids through the fatty acid biosynthesis pathway.*

2. PHA Biosynthesis:

The fatty acids or other precursors are then converted into polyhydroxyalkanoates through a series of enzymatic reactions. This step involves enzymes such as **PHA synthase**, *which polymerizes the monomers to form the bioplastic.*

Inclusion Body Formation: *PHA is accumulated as inclusion bodies inside the bacterial cells. These inclusion bodies can be harvested and processed to obtain the bioplastic material.*

Environmental Factors: *Various environmental factors like nutrient availability, temperature, and pH can influence the efficiency and yield of the bioplastic production process.*

It's important to note that the specific metabolic pathway and the intermediates involved may vary depending on the type of bioplastic being produced and the microorganisms used in the process. Additionally, different bioplastic production methods might involve slightly different pathways or steps.

Lactic acid fermentation

Homofermentative process

Homofermentative bacteria convert glucose to two molecules of lactate and use this reaction to perform substrate-level phosphorylation to make two molecules of ATP:

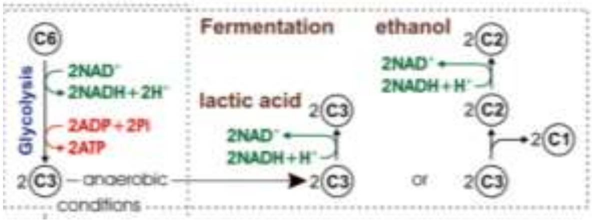
glucose + 2 ADP + 2 Pi → 2 lactate + 2 ATP

Heterofermentative process

Heterofermentative bacteria produce less lactate and less ATP, but produce several other end products:

glucose + ADP + Pi → lactate + ethanol + CO2 + ATP

Examples *include Leuconostoc mesenteroides, Lactobacillus bifermentous, and Leuconostoc lactis.*



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Conclusion

Microbial production of lacic acid has much scope oday and can

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