N°487 / OC
TOPIC(s) : Waste valorization / Polymers

Polyhydroxyalkanoates production through microbial conversion of forest wastes: a three-step process.

AUTHORS

Paulo C. LEMOS / LAQV-REQUIMTE, FCT/NOVA, DEP. OF CHEMISTRY, CAMPUS DE CAPARICA, CAPARICA
Luisa S. SERAFIM / CICECO - AVEIRO INSTITUTE OF MATERIALS, DEPARTAMENTO DE QUÍMICA, UNIVERSIDADE DE AVEIRO,, AVEIRO

PURPOSE OF THE ABSTRACT

The environmental concern about plastic pollution encourages the investment in new processes for its replacement/mitigation. Several bioplastics are available nowadays but its market share is still small. The ones that are also biodegradable constitute just a few being polyhydroxyalkanoates (PHA) one of them. Polyhydroxyalkanoates are intracellular carbon/energy reserves with physical-chemical properties that make them suitable as biodegradable and biocompatible thermoplastics. These PHAs are promising candidates for petrochemical plastics replacement. Strategies to decrease the production cost of these polymers involve the use of renewable carbon sources/waste streams as well as the use of mixed microbial cultures (MMC). When those streams are rich in short-chain organic acids (SCOA) the process consists of two steps: microbial culture selection and maximization of PHA production. When high sugar-content is present in the substrate, an additional pre-fermentation step is required to enrich the feed in SCOA (three-step process) [1].
Forest residues/wastes can be a potential source of biopolymers. Its thermochemical conversion to pyrolysis bio-oil makes the carbon sources present in the lignocellulosic material more easily accessible to microbial consumption, as those will be present in the liquid phase [2]. The valorization of forest residues, using pinewood wastes converted to bio-oil as fermentation substrate for PHA by MMC in a three-step process is here proposed.
Lignocellulosic based bio-oils apart from easy convertible substrates (sugars, organic acids, ?) are often composed of high contents of furans and phenolics compounds. The utilization of such bio-oils can be challenging for fermentative processes. To be used as substrate bio-oil needs to be submitted to several treatment protocols (precipitation/centrifugation/filtration). The treated bio-oil was fed to an anaerobic reactor firstly in a discontinuous operation mode followed by a semi-continuous one. The results revealed the production of several SCOA, such as lactic, butyric, propionic, and valeric acids, with different profiles according to the conditions imposed on the bioreactor. One of the major problems of the reactor operation was the maintenance of biomass inside the reactor and for that immobilization carriers were introduced in the system.
Under investigation are different strategies for bio-oil pre-treatment such as the use of activated carbon, diananofiltration and enzymatic approaches that could increase phenolic compounds removal allowing a stable fermentation process with higher conversion rates.
At the same time, unfermented bio-oil was fed to a second reactor operated under aerobic dynamic feeding in order to select an MMC able to store PHA. Such a strategy was mostly directed to adapt the MMC for such a complex substrate, although sugars would be present in the feed stream and would not be utilized for PHA production. Upon a stable and efficient operation of the anaerobic reactor is achieved both systems will be coupled, using the produced SCOA to fed the selection reactor.
Several discontinues batch reactors were operated in order to maximize PHA production, collecting biomass form the selection reactor and feeding them with different fermented streams composition, in order to observe the impact of such stream in polymer quantity and quality.

FIGURES

FIGURE 1 **FIGURE 2**

KEYWORDS
Forest wastes | Biopolymers | Polyhydroxyalkanoates | Short-chain organic acids

BIBLIOGRAPHY

[1] Serafim, L.S. et al. In: Recent Advances in Biotechnology: Microbial Biopolyesters Production, Performance and Processing; Microbiology, Feedstocks and Metabolism (vol. 1). pp. 226-264; 2016; Ed. M Koeller, Bentham Science (ISBN: 978-1-68108-326-1).

[2] Moita R. et al. J. Biotechnology,2012, 157, 578-583. DOI: 10.1016/j.jbiotec.2011.09.021.