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Production of P(3HB-co-3HV) in non-axenic two-stage continuous culture.

Duration: 2019-2022

Background

To address the overwhelming negative environmental issues of plastic packaging and to enter the virtuous loop of circular economy, it is urgent and crucial to mitigate the negative burden of packaging resources and packaging waste management. Furthermore, despite extremely dynamic researches and developments on biobased and biodegradable materials, commercially available biopackaging does not yet properly meet the huge market and society demands. Among them, PHAs (PolyHydroxyAlkanoates) are the more promising due to their inherent full biodegradability and are fully synthesized by a great diversity of microorganisms. In particular, the copolymer poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (P(3HB-co-3HV)) is very interesting due to its thermomechanical properties which allow a great processing window. In this context, this thesis purpose is to develop a non-axenic process of production of P(3HB-co-3HV) from agro-industrial residues.

The main challenges in PHA production using mixed microbial cultures (MMC) relates to selection of a culture with high PHA-storing capacity and able to obtain a biopolymer with reliable properties matching the commercial demand. Some instances have been recorded in the literature in which selection in one-stage continuous culture on a dual phosphorus and carbon limitation led to the dominance of stable MMC with PHB production capacity. This process has been applied with success using acetate or a mixture of acetate and butyrate as substrate. Depending on the dilution rate applied, a two-stage process should be carried out in order to reach a high cell content in the intracellular PHA biopolymer. This selection/production system remains to be studied. Moreover, the use of propionate to get P(3HB-co-3HV) production has not been yet investigated.

Objectives

The objective of this work was to evaluate the effects of the extent of phosphorus growth limitation and of the nature of the carbon source on PHA over-producers selection and on the PHAs production performances in an open two-stage continuous culture system.

In addition, VFA production from potato peels by anaerobic digestion have been investigated.

Methodology

- Lab and pilot scale experiments of P(3HB-co-3HV) production in CTSR (5L)
- Data compilation and statistical analysis
- Innovative characterization methods
- Mathematical modelling

Keywords

Microbial selection, P(3HB-co-3HV) production, Dual-limited continuous culture, Propionate effects

Partnership:

This thesis is part of the LOOP4PACK research program, supported by the French national research agency, which seeks to develop sustainable bioplastics from agroindustrial wastes to close the packaging loop. Two laboratories (IATE & TBI), a technology resource center (CRITT-Bio-Industry), a large company (McCain) and a competitiveness cluster (MATIKEM) will join forces in LOOP4PACK to develop a viable whole chain.