World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:19, No:04, 2025

Integrating Eucalyptus Bark Valorization and Enzymatic Biopolymer Recovery for the Sustainable Production of Polyhydroxybutyrate

Authors : João Matias, T. Rodrigues, C.A.V. Torres, S. Marques, F. Gírio, M.A.M. Reis, F. Freitas

Abstract : To evaluate the potential of eucalyptus bark enzymatic hydrolysate as a sole feedstock to produce the bioplastic polyhydroxybutyrate, P(3HB), by Burkholderia thailandensis DSM 13276, three hydrolysate samples with distinct physical and chemical characteristics were analyzed and used in bioreactor cultivation assays to assess how substrate variability impacts P(3HB) production and properties. High glucose concentrations (>80 g/L) and elevated molar C/N ratios (160.7), associated with high ammonium content (0.73 g/L), promoted cell growth (CDW = 9.48 g/L) at the expense of P(3HB) accumulation (19 wt%). In contrast, lower glucose levels (~20 g/L) and reduced C/N ratios (41.5) enhanced P(3HB) accumulation (60 wt%), yielding 4.6 g/L of polymer with a volumetric productivity of 1.36 g/(L•day) and a sugar-to-polymer conversion yield of 0.19 g/g. P(3HB) was extracted using both enzymatic and solvent-based methods. The enzymatic method, employing Alcalase under mild conditions, achieved 96% recovery efficiency with exceptional purity (100 ± 3%), producing fine P(3HB) granules, while the chloroform-based method yielded aggregated clumps due to the fast precipitation of the biopolymer in cold ethanol. FTIR analysis confirmed the chemical structure of P(3HB) in all samples, with characteristic peaks for C–H and C=O stretching vibrations closely matching literature-reported spectra. The extracted biopolymer had molecular weight values between 2.77×10^5 and 6.30×10^5 Da, with polydispersity indices between 1.57 and 2.10. The thermal analysis showed that the produced P(3HB) exhibited melting temperatures of 170-175 ºC, and degradation temperatures between 280 ºC and 297 ºC, all aligning with commercial P(3HB) standards. These findings highlight eucalyptus bark as a cost-effective and sustainable feedstock to produce the bioplastic P(3HB), particularly when substrate composition is optimized. The study underscores the feasibility of integrating renewable feedstocks with green recovery methods, namely, enzymatic extraction, to develop high-quality bioplastics and advancing in the goals of a circular bioeconomy.

Keywords : alcalase, burkholderia thailandensis DSM 13276, eucalyptus bark, Polyhydroxybutyrate
Conference Title : ICBE 2025 : International Conference on Bioengineering
Conference Location : Lisbon, Portugal
Conference Dates : April 10-11, 2025