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BIOBASED FEEDSTOCK VALORISATION THROUGH POLYHYDROXYALKANOATE PRODUCTION: FROM EXCESS CHEESE WHEY TO ECO-EFFICIENT BIOPLASTICS

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Abstract

The focus of this study was the development of a 3-stage process for cheese whey valorisation through polyhydroxyalkanoate (PHA) production by a mixed microbial culture selected under Feast and Famine conditions. The goal was to investigate all 3 stages of the process (acidogenic fermentation, PHA-storing culture enrichment, and PHA batch production) in order to identify the main process parameters implicated in the inter-dependent optimisation of the overall process and that may be used as levers for process control. The use of a membrane bioreactor (MBR) in the acidogenic fermentation step allowed for a higher yield and volumetric productivity in volatile fatty acids (VFA) compared to continuous stirred tank reactor (CSTR) operation. The organic acids produced included lactate, acetate, propionate, butyrate, and valerate. Both reactors were successfully operated without nutrient supplementation, showing that proteins from cheese whey were used as nitrogen source.

Fermented cheese whey produced in the MBR was fed to a sequencing batch reactor (SBR) operated under feast and famine conditions, with a sludge retention time (SRT) of 4 d, and a long cycle length (12 h). Due to the strong selective pressure imposed, a high enriched culture on PHA accumulating organisms was achieved. This culture was not able to use the protein, thus requiring nitrogen supplementation.

Batch PHA accumulation assays performed with the enriched culture, demonstrated a stable PHA accumulation performance at a maximum PHA content of about 50%. A co-polymer of P(HB-co-HV) with an HV fraction of approximately 30% was obtained. The study fully demonstrates the feasibility of using excess cheese whey as a valuable feedstock for PHA production and, moreover, points to routes for further process development.
