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Polyhydroxyalkanoate production from lipid waste streams

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Polyhydroxyalkanoate (PHA), fully biodegradable and biocompatible polyesters, are promising alternatives to petroleum-based plastics. Ralstonia eutropha, the model organism for PHA production, can store carbon up to 90% PHA of its cell dry weight under stress or nutrient limiting conditions. However, high production costs, are preventing their use as bulk material. Inexpensive carbon feedstocks can accelerate the commercialization of PHA. This study focuses on several biogenic waste streams as waste animal fats and waste fat emulgates with a high content on free fatty acids as carbon feedstocks. Besides being inexpensive, the low quality makes them very unattractive for other applications, e.g. the biodiesel production. However, the high melting temperatures >55°C made it difficult to handle, and R. eutropha cells were unable to emulsify the feedstocks under cultivation conditions, and therefore did not grow. An emulsification strategy, which does not involve mechanical pretreatment or any emulsification agents, since this would not be scalable and would increase production costs was developed for these feedstocks. The cultivation process was scaled-up to 100 L with a total yield of 4 kg PHA. The wild type of R. eutropha was used for PHB production and a recombinant R. eutropha strain was used to produce the PHA copolymer poly(hydroxybutyrate-co-hydroxyhexanoate) (P(HB-co-HHx)). An increasing HHx concentration in the polymer directly correlates to an enhancement of the polymer properties as melting temperature, crystallinity and flexibility. Additionally, cultivation conditions for microwell plates were developed, which allows to perform 24 parallel cultivations for an accelerated bioprocess development in the future.

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