Selection of Carbon Feed Stocks for Cost-Efficient Polyhydroxyalkanoate (PHA) Production

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Raw materials require the major part of biopolymer production costs; this share contributes with up to 50% to the entire process expenses. Recent studies indicate that PHA production from pure sugars such as glucose or sucrose has already been optimized to a high degree. Therefore it is of importance to enhance cost efficiency of PHA production by substituting pure substrates by cheaper carbon feed stocks or by integrating PHA production into energetically autarkic production lines of the carbon sources.

Whey from dairy industry

The utilization of polluting whey combines an economic progress with solving an ecological hazard. Whey was applied as carbon source for three wild type PHA producers: *Haloferax mediterranei*, *Ps. hydrogenovora* and *Hydrogenophaga pseudoflava.* Among these strains, *H. mediterranei* constitutes an outstanding candidate for PHA production on whey. This is due to its high robustness and stability; the risk of microbial contamination during cultivation is negligible, saving a lot of energy for sterility precautions. The strain grows on whey with a max. specific growth rate $\mu_{max.}$ of 0.11 h^{-1}. PHA was accumulated at a max. specific production rate of 0.08 g/g h. Conversion yield for whey to PHA amounted to 0.3 g/g. The production of PHA copolyesters without co substrates, the excellent polymer characteristics together with a cheap isolation method make the strain of special interest [1,2,3].

Raw glycerol liquid phase from Biodiesel production

H. mediterranei was also used for PHA-production on glycerol liquid phase (GLP), a side stream of the biodiesel production from plant oils and tallow, containing about 70 wt.-% glycerol. In all Europe, the total production of biodiesel is estimated for 2008 with 2,649.000 metric tons. GLP nowadays constitutes a surplus material. Its utilization leads to an enormous cost advantage compared with commercially available pure glycerol, possessing a market value of 900 € per metric ton (year 2002). On bioreactor scale, *H. mediterranei* was able to grow on GLP at a specific growth rate of 0,06 h^{-1} and produced PHA (76% of cell mass) at a specific rate of 0,08 g/g·h. The yield for PHA from glycerol was calculated with 0,23 g/g, resulting in a final concentration of 16,2 g/L PHA [1,2,3].

Sugar cane sucrose

A different approach is provided by the utilization of carbon sources that feature a considerable market value and do not constitute waste materials, but are produced within a process integrating the fabrication of the carbon substrate and PHA. This will soon be realized in the south-central region of Brazil: starting from sugar cane, saccharose, ethanol and PHB are produced by *Wautersia eutropha*. The needed energy for polymer production is directly available from burning bagasse, a major by product of the sugar production. Due to the autarkic energy supply and the at-house availability of the carbon source saccharose, the production costs per kilogram PHB are estimated with less than US$ 3 [3, 4].

Keywords: biodegradable polyesters; polyhydroxyalkanoates; whey; raw glycerol phase; sugar cane sucrose

References

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