"Tailor made " polyhydroxyalkanoate production and their associated biodegradation in marine environment

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Abstract

Polyhydroxyalkanoates (PHA) are polyesters derived from bacterial cultures (biosourced). They offer a diverse range of chemical structures with remarkable functional properties . Moreover, some of them have already demonstrated much greater biodegradation capacities than conventional polymers although the molecular mechanisms involved in their biodegradation in the marine environment are still little studied.
Our work on the biosynthesis of custom PHA from different bacterial strains and different carbon sources has made it possible to produce 6 short-chain (scl) and medium-chain (mcl) PHA by fermentation process. We then carried out biodegradability tests of these PHA in the marine environment, approaching natural marine conditions. The microbial inoculum used for these tests was the biofilm that naturally colonized PHA films incubated in natural seawater for one month. Biodegradability was followed in artificial seawater during three months with PHA as the sole carbon source by several complementary methods: consumption of oxygen, bacterial production, ATP and microscopy. Evolution of microbial communities were studied along the three-months experiment on each PHA by 16S rDNA gene sequencing.

Our results confirm the microbial activities on all PHA and the biodegradability of certain PHA in the marine environment. For example, consumption of oxygen was 2 to 40 times greater for PHA than for polyethylene while cellulose was 24 times greater than this same petrochemical polymer. It demonstrates that the type of PHA have a significant impact on their biodegradation kinetics. A better knowledge of the role of the structure of PHA, their properties and the bacterial mechanisms involved in their biodegradation will allow the development of "tailor-made" PHA adapted to biodegradation in the marine environment.

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