Degradability of biodegradable polymers: direct comparison of the degradation of PLA, PBAT, PBS and PHBV polymers under different artificial and environmental conditions

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Abstract

Biodegradable products are presented by many as part of the solution to the global plastic crisis due to the persistence of plastic in the environment. However not enough is known about the precise fate of these materials in the open environment and the literature is not yet able to propose a clear standard method to test polymer material in a more systematically comparable way. The aim of this study is to be able to directly compare the degradation behaviour of 4 common biodegradable polymers on the market, Poly(lactic acid) (PLA), Poly(butylene adipate-*co*-terephthalate (PBAT), Poly(butylene succinate) (PBS) and Poly(3-hydroxybutyrate-*co*-3-hydroxyvalerate) (PHBV), in different conditions in the open environment (in soil, marine and air environments). Using different techniques such as size exclusion chromatography (SEC), scanning electron microscopy (SEM), differential scanning calorimetry (DSC) and pyrolysis coupled to gas chromatography and mass spectrometry (Py-GC-MS), the degradation of the polymers was followed for up to 1.5 years in the different environments. Clear signs of hydrolysis were observed in aqueous conditions at temperatures between 30 and 50 C, while the signs of degradation were very limited in soil, seawater, and air for PLA, PBAT and PBS in the field. On the other hand, PHBV showed more significant signs of degradation in field conditions due to surface enzymatic degradation. These results highlight the need to test materials in different conditions, including natural environments in a more systematic way to be able to better compare results.

Keywords: Biodegradable polymers, degradation, characterisation, PLA, PHBV, PBAT, PBS

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