

Enzymatic Degradation of PET plastic

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Abstract

Polyethylene terephthalate (PET) plastic is one of the most commonly used polymers worldwide and found in high rates as environmental waste. Previous studies have shown that the degradation of plastics using commercial grade enzymes is possible and highly effective in lab settings. However, the effectiveness and rates of enzymatic plastic degradation at environmentally relevant conditions is less known. In this study, we set up a series of sacrificial incubation experiments using a commercial enzyme, *Humicola insolens* cutinase (HiC), to examine the effect of various environmental variables, including temperature, pH, and salinity, on the hydrolytic degradation of PET. This was performed by measuring the mass loss at different time points during degradation, dissolved organic carbon produced in solution by PET hydrolysis, the Fourier transform infrared (FTIR) spectra of the PET surfaces, and scanning electron microscope (SEM) images of the PET surfaces. The results indicate that the degradation rate is 15-times faster at 55 °C than at 40 °C at pH 8 (1.93 mg day⁻¹ versus 0.13 mg day⁻¹), giving an initial estimate for the activation energy of PET hydrolysis of 2.2 kJ mol⁻¹. In the 55 °C experiment which ran for 10 days, there was a noticeable decrease in the plastic strength and deformation of the plastic after 1 week of degradation. In the 40 °C experiment (duration 16 weeks), FTIR spectral changes were observed as early as week 6, with peaks of interest at 2,970 cm⁻¹, 2,350 cm⁻¹, 1,240 cm⁻¹, and between 1,300-1,000 cm⁻¹. Ongoing experiments with pH and salinity will provide insight into their effects on the PET degradation rate. Altogether, these results will provide a comprehensive framework for predicting PET degradation rates, and by extension, other plastics that are degraded by hydrolysis, at environmentally relevant pH, temperature, and salinity conditions. In addition, these results provide insight into the effect of degradation on the chemical spectra of plastics and microplastics.

Keywords

plastic, Polyethylene terephthalate

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Conflicts of interest

The authors have declared that no competing interests exist.