Revolutionizing polyesters: from microplastic-free composting to enzyme-driven recycling for sustainability and circularity

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As the plastic production and consumption continue to rise, plastic pollution—and particularly microplastic contamination—has become pervasive. Developing polymers that are sustainable, non-toxic, recyclable, and compatible with a circular economy is therefore essential. [1] This study investigates the degradation behavior of tailor-made aliphatic–aromatic polyesters synthesized via melt polycondensation from 1,4-benzenedimethanol and aliphatic diacids of varying chain lengths. Degradation was assessed in alkaline solution, industrial compost, sludge water, and via enzymatic hydrolysis using five enzymes: Hi-Cutinase (HiC), Esterase EL-01, and three in-house-produced enzymes: *Ideonella sakaiensis* PETase (IsPETase), *Cryptosporangium aurantiacum* PETase variant M9 (CaPETase), and LCC^{ICCG} (a leaf-branch compost cutinase variant). Complete degradation was observed for selected polymers which was confirmed by compost extraction. Among enzymes, LCC^{ICCG} showed the highest activity at 60 °C, including partial PET degradation (Xc ~ 15%), while HiC was most effective at 30 °C. These results demonstrate the potential of these polyesters for sustainable use, combining efficient biodegradation with enzyme-driven recycling, and offer a promising strategy to combat microplastic pollution.

Keywords: Polycondensation, Enzymatic degradation, Composting, Compost Extraction, Microplastics, PET.

References

[1] Upadhyay, A., Turak, O., Fulajtar, E., Greve, C. R., Herzig, E. M., Höcker, B., & Agarwal, S. (2025). Degradation Behavior of Aliphatic–Aromatic Polyesters: From Microplastic-free Composting to Enzyme-Driven Recycling Possibility. ACS Applied Polymer Materials, 7(7), 4596–4608.

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