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Bio-based recycling of polyethylene terephthalate (PET) and its effectiveness

S. Menaka Devi

Amity Institute of Microbial Technology, Amity University Uttar Pradesh, Noida, UP 201313, India
Corresponding author: Salam Menaka Devi (salammenaka@gmail.com)

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Introduction: The accumulation of polyethylene terephthalate (PET) waste in the environment has led to increasing global concerns because of the extremely low degradation properties of this polymer. The evolution of microbes leading to abilities to degrade certain polymers is very promising and gives us the opportunity to identify and utilize these properties to solve the long-time existing problem of plastic waste. At present, mechanical, and chemical degradation processes of plastics for their recycling are commonly adopted. However, both the methods remain unattractive due to lower quality product in case of mechanical degradation and high cost and pollution effects in case of chemical degradation. Biological degradation serves to be eco-friendly and cost-effective alternative. The present article discusses about the prospects of using micro-organisms to degrade plastic waste in the environment and how it is going to be an extremely important area of research in the upcoming future.

Methods: Important research works that have been done in order to find a way to biologically degrade PET is discussed. The various methods of PET degradation and the microbes which have been so far identified to be capable of degrading PET are mentioned. The enzyme involved in degradation for each microorganism is being explored to get a better understanding of the degradation mechanism. In addition, current status of bio-upcycling of PET is being discussed which is an alternative way of managing the ever-increasing build of plastic waste.

Results & Discussions: Different types of PET hydrolases have been isolated from fungi as well as bacteria and some of them have shown remarkable degradation of crystalline PET with upto 50% weight loss and in about two to three weeks' time (1). Some of the PET hydrolases have been characterized to be stable at high temperatures of 50 to 70°C which is an advantage for industrial application as efficient degraders of PET (2). Further, with site directed mutagenesis and protein engineering of the enzymes responsible for PET degradation, significant increase in activity was observed in some cases (3, 4). Further, exploration of microbial enzymes with the ability to degrade the petroleum-based plastics is a major area of current research. The degradation products can be recycled into useful polymers that are industrially important.

Conclusions: Many of the PET hydrolases isolated so far from fungi as well as bacteria are able to degrade crystalline PET significantly. The discovery of thermostable PET degrading enzymes is of major interest since they can be used for efficient degradation of PET at high temperatures. The hydrolysis products, ethylene glycol and terephthalic acid, can be used by certain microorganisms which can synthesize biopolymers, such as polyhydroxyalkanoate, that has a wide range of applications in packaging and in medical fields. Thus, the biobased recycling of PET shows an alternative efficient means to solve the problem of ever-increasing plastic waste, and the importance of exploring the wide range of microorganisms present in the environment.

Keywords: PET hydrolases, MHET hydrolases, Polymers, Monomers, Depolymerization

References

1. Farzi A, Dehnad A, Fotouhi AF. Biodegradation of polyethylene terephthalate waste using *Streptomyces* species and kinetic modeling of the process. *Biocatal. Agric. Biotechnol.* 2018; 17:25-31.
2. Tournier V, Topham CM, Gilles A et al. (2020). An engineered PET depolymerase to break down and recycle plastic bottles. *Nature.* 2020; 580 (7802): 216-219.
3. Son HF, Cho II, Joo S et al. Rational Protein Engineering of Thermo-Stable PETase from *Ideonella sakaiensis* for Highly Efficient PET Degradation. *A.C.S. Catal.* 2019; 9:3519-3526.
4. Furukawa M, Kawakami N, Tomizawa A, Miyamoto K. Efficient Degradation of Poly(ethylene terephthalate) with *Thermobifida fusca* Cutinase Exhibiting Improved Catalytic Activity Generated using Mutagenesis and Additive-based Approaches. *Sci. Rep.* 2019; 9(1): 16038.

