Mimicking the enzymatic plant cell wall hydrolysis machinery for the degradation of polyethylene terephthalate

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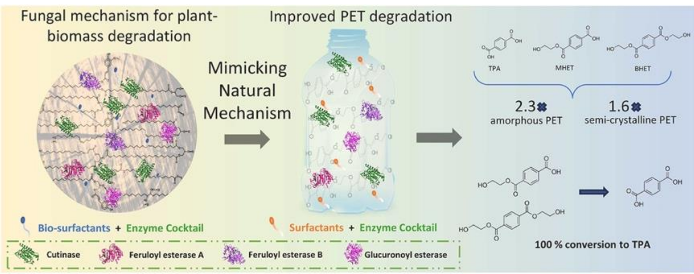
Plastic pollution presents a global challenge, impacting ecosystems, wildlife, and economies. Polyethylene terephthalate (PET), widely used in products like bottles, significantly contributes to this issue due to poor waste collection. In recent years, there has been increasing interest in plant biomass-degrading enzymes for plastic breakdown, due to the structural and physicochemical similarities between natural and synthetic polymers [1]. Filamentous fungi involved in hemicellulose degradation have developed a complex mode of action that includes not only enzymes but also biosurfactants; surface-active molecules that facilitate enzyme-substrate interactions. For this reason, this study aimed to mimic the mechanism of biomass degradation by repurposing plant cell wall degrading enzymes including a cutinase and three esterases to cooperatively contribute to PET degradation. Surfactants of different charge were also introduced in the reactions, as their role is similar to biosurfactants, altering the surface tension of the polymers and thus improving enzymes' accessibility. Notably, *Fusarium oxysporum* cutinase combined with anionic surfactant exhibited a 2.3- and 1.6-fold higher efficacy in hydrolyzing amorphous and semi-crystalline PET, respectively. When cutinase was combined with either of two ferulic acid esterases, it resulted in complete conversion of PET intermediate products to TPA, increasing the overall product release up to 1.9–fold in presence of surfactant. The combination of cutinase with a glucuronoyl esterase demonstrated significant potential in plastic depolymerization, increasing degradation yields in semi-crystalline PET by up to 1.4-fold. The approach of incorporating enzyme cocktails and surfactants emerge as an efficient solution for PET degradation in mild reaction conditions, with potential applications in eco-friendly plastic waste management.



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[1] A. Zerva, C. Pentari, C. Ferousi, E. Nikolaivits, A. Karnaouri and E. Topakas, "Recent advances on key enzymatic activities for the utilisation of lignocellulosic biomass," Bioresource Technology, vol. 342, pp. 126058, 2021.