DISCOVERY OF NOVEL POLYESTERASES CAPABLE TO DEGRADE PLASTIC WASTE

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ABSTRACT

Synthetic plastics are polymer materials designed to be both formable and resistant, while produced with low-cost methods. Their extraodinery characteristics distinguish them, among materials, in all aspects of our everyday life with more than 350 million tones produced annually worldwide. Unfortunately since 1950, when their widespread production began, just 8% of plastic's total mass has been recycled, whereas about 60% has beed discarded to the environment, making them a global pollution threat [1]. Some of the most used and produced plastics are polyesters, such as the non-biodegradable poly(ethylene terephthalate) (PET), which is mainly used for bottle production. Other polyester plastics include the biodegradable poly(butylene succinate) (PBS), polycaprolactone (PCL), polyhydroxybutyrate (PHB) and polylactic acid (PLA), as well as the non-biodegradable polyester polyurethane (PU) [2]. The purpose of our research was to discover novel enzymes able to degrade these polymer materials, mainly through hydrolysis of their ester bonds, and to investigate the enzymes specificity in each polyester, in order to end up with polyesterases suitable for plastic-waste degradation. The candidate polyesterases were selected either using bioinformatics tools or from already known enzymes with esterolytic activity from literature, while commercial enzymes with proteolytic activity were also tested. As a result, eight enzymes in total were investigated and tested on the polyester plastics, including two well known PETases (IsPETase and leaf-branch compost cutinase, LCC), which were used as benchmark enzymes for PET degradation but also tested on other, new, polyester materials. The yield of degradation was evaluated by measuring plastic's weight loss, variation in molecular weight, through Gel Permeation Chromatography (GPC) and/or hydrolysis products concentration, through High Performance Liquid Chromatography (HPLC). Almost all enzymes showed promising depolymerase action in most materials, while in some cases the candidate polyesterases lead to stronger degradation than the known PET benchmark eznymes. Therefore, it is possible that these novel polyesterases could offer a vital solution contolling plastic's accumulation, specifically by creating synergistic enzyme cocktails for the degradation of polyester plastic-waste mixtures.

KEYWORDS: plastic, biodegradation, polyesterases, polyesters, polyethylene terephthalate

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