Poly(ethylene terephthalate) (PET) bottles and packaging have been used widely throughout modern society due to their practical utility, but such widespread use has led to significant global plastic pollution. While PET is theoretically recyclable, it often ends up in landfills due to public negligence, and thus scientists have started to look for new ways to degrade polyesters such as PET to reduce its environmental footprint. Present estimates suggest that 150-200 million tons of plastics accumulate in landfills, out of the 359 million tons of plastics produced annually worldwide[1]. Finding a solution to plastic pollution becomes more and more of an issue each day, and recent research just might have a solution.

To combat this issue, recent studies have looked to plastic-loving enzymes. Some physical properties of polyesters, however, limit polymer accessibility and mobility, posing significant challenges for enzyme reactions. Firstly, plastics are insoluble and densely packed materials, resulting in enzyme action that could be limited to the plastic surface without infiltrating into the interior of the polymers. Consequently, the plastics must be fragmented or ground to increase enzyme-plastic interactions, which may not be feasible in all situations. Secondly, polymers have high molecular weights, on average, and thus the enzyme reaction is slowed. To combat this challenge, the polymers' molecular weight distribution must be measured. Thirdly, polymers in the crystalline regions are more stable than those in the amorphous region. As a result of this distinction, polymers with higher degrees of crystallinity are more resistant to enzymatic degradation. Finally, enzymes should be able to operate at temperatures near the polymers' Tg to take advantage of the reduced rigidity exhibited when the polymers are in their glassy phase. Polymer materials, including polyesters, differ considerably in crystallinity, molecular weight distribution, and other parameters, making comparisons and conclusions difficult to draw between studies[2].

Despite these difficulties, researchers have recently examined an isolated bacterium called Ideonella sakaiensis (which produces an enzyme called PETase) and have compared it to the known enzymatic compounds: Thermobifida fusca (TfH), LC cutinase (LCC), and F. solani cutinase (FsC)[3]. Through their studies, they have found that PETase is much more effective in degrading highly crystallized PET samples. This targets one of the key difficulties faced when handling plastic waste, showing promise in the field. Despite the success in this aspect, the researchers found that PETase was considerably more active at temperatures much lower than PET's glass transition temperature[3]. Importantly, this does not discount PETase as a solution to this ever-growing problem, simply providing room for improvement in the heat-labile nature of the enzyme. Ideally, PETase should be optimized such that it can operate effectively in the 75C temperature region so that it can more efficiently degrade mobile (glassy) samples of PET. Another area for improvement is to conduct 3D scans of PETase's structure to determine the exact binding mechanism of the enzyme[3]. This would allow more selective usage for different PET weight distributions, further enhancing the degradation process.

Ultimately, PETase shows promise for improving the state of PET degradation but requires genetic engineering and modifications to become a widely used solution to plastic pollution. Based on findings presented above, I believe PETase to be a reasonable enzyme to research further in the hopes of finding an effective and efficient way to handle the world plastic problem. As the rate of production of plastics continues to increase[4], it is imperative that we find a solution to our plastic waste problem, and engineering bio-friendly techniques to tackle this issue is a step in the right direction towards reducing our overall environmental footprint.

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