Enhancing Biodegradation Capabilities of the Ideonella sakaiensis Plasmid Using mutD Escherichia coli: A Case Study in the Use of Directed Microbial Evolution and Bioengineering

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Polyethylene terephthalate (PET) is the most produced plastic globally, composing single-use plastic bottles, shopping bags, and more. Consequently, the environment suffers from its production and disposal. Recently, scientists discovered a species of bacteria, Ideonella sakaiensis, the ester bonds of PET as a carbon source, disposing of PET microplastics and macroplastics. The bacterium was immediately considered for PET plastic disposal, although the degradation rate of the bacteria was found to be less than adequate for large scale disposal. The purpose of this experiment was to increase the efficiency of biodegradation. In doing so, a rapidly mutating strain of bacteria, mutD Escherichia coli, was transformed with the plasmid DNA of I. sakaiensis. The transformed E. coli adopted the degradation abilities of I. sakaiensis, as well as the mutagenic properties of the E. coli. It was hypothesized that the transformed bacteria would degrade PET, as well as mutate to achieve a higher rate of degradation, with more efficient strains of bacteria outcompeting less efficient strains in a natural selection process. It was found that the transformed and mutated E. coli could degrade PET 400% more efficiently than I. sakaiensis as a result of this directed evolution. The results' support of the hypotheses presents several universal applications: bacteria is a viable solution for PET disposal. Furthermore, other species of bacteria, such as those naturally occurring in lakes and oceans, can be transformed to degrade PET, efficiently and cleanly ridding the environment of most single-use plastic pollution, which was not thought possible before.

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