A Green Alliance: Evaluating the Synergistic Dynamics of PETase Expression and Plant-Microbe Interactions in Enhancing Microplastic Degradation Pathways in S. alterniflora

Emmi, Vibhan (School: College Park High School)
Siddiqi, Adam (School: College Park High School)

Microplastics, originating from various sources, threaten ecosystems such as the Gulf of Mexico, where they accumulate in food chains and impact vast wildlife & humans. On the other hand, microorganisms equipped with enzymes like PETase offer a promising solution for breaking down plastics into less harmful components. Current plant-microbe symbiotic relationships continue to host this bioremediation, but degradation rates are largely ineffective. Wetlands, functioning as natural filters before particles reach larger water bodies, such as oceans, provide a perfect environment for such interactions. This experiment delves into how these relationships can help tackle the microplastic crisis. 44 bacterial species were isolated from Spartina alterniflora, a resilient grass species native to the Galveston Wetlands, with six bacteria showing PETase activity in a PET microplastic-infiltrated environment, the common type of plastic found in many plastic containers. Virtual simulations were used to modify genes to create optimal conditions with high Ca2+ and Mg2+ concentrations for PETase activity within the rhizosphere of S. Alterniflora. In silico predictions showed that the engineered transporters could increase root-zone Ca2+ and Mg2+ concentrations by over 5-fold. These predicted ion levels were then replicated in laboratory assays to test their effect on PETase activity, which revealed a 52% increase in degradation of PET microplastics in three-week laboratory tests. Additionally, plant health and structural integrity of the ion-treated plants were maintained, demonstrating that introduced concentrations did not negatively hinder plant growth. These findings exhibit the potential of enhanced wetland plants as a natural, sustainable solution for microplastic pollution

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