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Unraveling the degradative potential of plastics from a specialized bacterial consortium

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Introduction

Petroleum-derived synthetic plastics are materials resistant to degradation, composed of polymers with long carbon chains. The production of plastic products has been increasing due to its versatility and unique characteristics. At the end of its useful life, waste difficult to manage is generated. In recent years, the microbial degradation of plastics has been proposed as a promising solution to address this growing problem. Numerous studies have shown the ability of certain microorganisms to degrade some synthetic polymers. In addition, the degradation of plastics using consortia is considered a more viable strategy than the use of pure cultures for the effective management of this recalcitrant waste. This research deals with the study of the capabilities of a new bacterial consortium made up of *Pseudomonas putida* REBP7 and *Bacillus subtilis* REBM2, to degrade linear low-density polyethylene (LLDPE).

Experimental

Two bacterial strains (*Pseudomonas putida* REBP7 and *Bacillus subtilis* REBM2) were selected from the microbial collection of the BIO175 research group of the University of Almeria. The two strains were tested in pure culture, separately, and in co-culture, for the formation of the consortium. The different inocula were incubated with shredded LLDPE as the only carbon source at 30 °C for 5 months. Microbial growth, plastic weight reduction, and organic compounds release, were determined by plate counting, plastic weighting, and total dissolved organic carbon analysis, respectively (Figure 1A). Furthermore, the ability to colonize the surface of the plastic, as well as the alteration of its structure by the members of the co-culture were assessed by analyzing Scanning Electron Microscope (SEM) images on the LLDPE films after 2 months at 30 °C incubation period (Figure 1B).

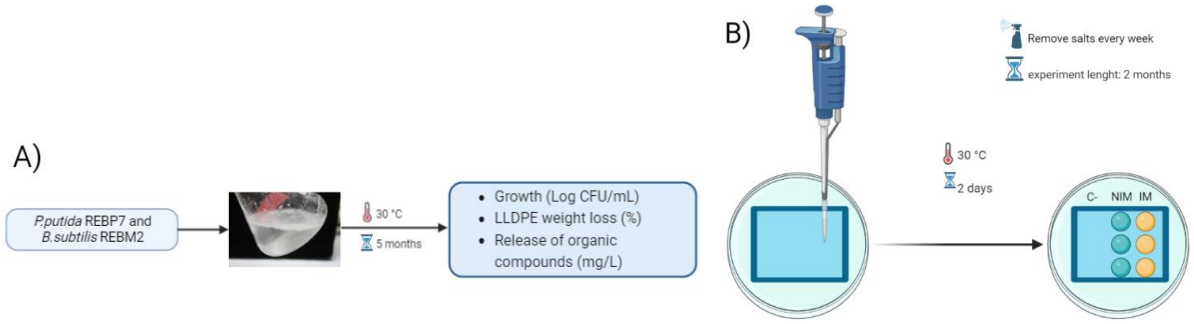

Figure 1. Experimental design: A) Test on medium with LLDPE as the only carbon source; B) Test on LLDPE films.

Results and Discussion

In general, similar degradative capacities were observed when *P. putida* was employed in individual culture and in consortium with *B. subtilis*. High levels of microbial growth, reduction of plastic weight (≈15%) and release of organic compounds were obtained in all the cases. Additionally, the colonization study revealed significant alterations on the surface of those plastics that had been treated with the consortium or any of the microorganisms as pure culture.

Conclusions

The study shows that *P. putida* REBP7 is capable of utilizing and growing at the expense of LLDPE as the sole carbon source. This has been evidenced by the significant weight reduction of LLDPE and the release of organic compounds, which indicates excellent qualities for plastic degradation. However, the consortium of *P. putida* REBP7 and *B. subtilis* RBM2 does not improve the degradation abilities demonstrated by *P. putida* REBP7 in pure culture. This is possibly due to the reduced growth rate of *B. subtilis* RBM2. Nevertheless, both strains colonize and cause surface alterations on LLDPE films, which indicates the start of degradation processes. The findings are promising, especially for *Pseudomonas putida* REBP7, making it a potential bacterial strain for the degradation of plastic waste on an industrial-scale. Although it is worth continuing to study and characterizing the consortium in depth.

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Biography

After obtaining his Bachelor's degree in Biotechnology and a Master's degree in Agroalimentary and Industrial Biotechnology, Martin Segado is currently pursuing a Ph.D. in Biotechnology at the University of Almeria (UAL).