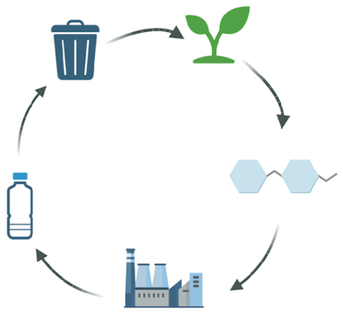
Biodegradation of Bioplastic using Bacteria Isolated From Wastewater

Chloe DelSignore, Nicoly Welter, Vinka Oyanedel-Craver
Department of Civil and Environmental Engineering,
University of Rhode Island, Kingston, RI 02881 USA

Introduction



- Plastic Pollution is one of the biggest issues society faces today.
- Bioplastics is an emerging solution because it offers a more sustainable end of life option, however research focuses on compost biodegradation.
- Biodegradation is not fully understood in wastewater facilities.

- Goal: Examine the Biodegradation of bioplastic in a liquid media containing bacteria isolated from a wastewater treatment plant.

Methods

- Bacteria was collected from a wastewater treatment plant
- Samples include two different bioplastics cutlery sets; Polylactic Acid (PLA) and Polystyrene/Agave composite (PS/Agave)

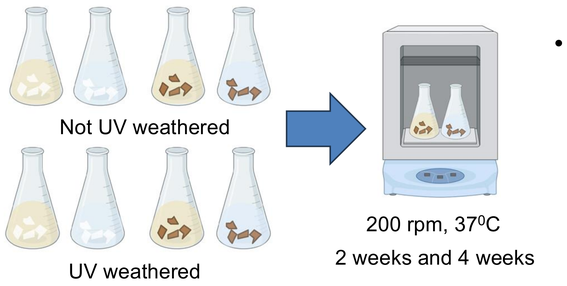


Figure 1. Experimental Methodology

- Analysis tests include weight loss %, metal leachate (ICP-MS), elemental bonds (FTIR), surface characterization (SEM)

Results

Elemental bonds (FTIR)

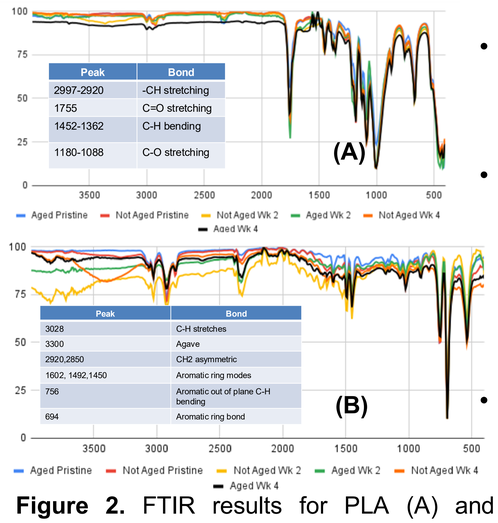


Figure 2. FTIR results for PLA (A) and PS/Agave (B)

- Both plastics show changes in peak intensity across the wavelength spectra.
- Specifically, the PS/Agave displays an intensity decrease around 3330—a characteristic peak of the agave—indicating slight degradation.
- Overall, the FTIR results do not show significant degradation in the elemental bonds of the plastics

Results Cont.

Surface Imaging (SEM)

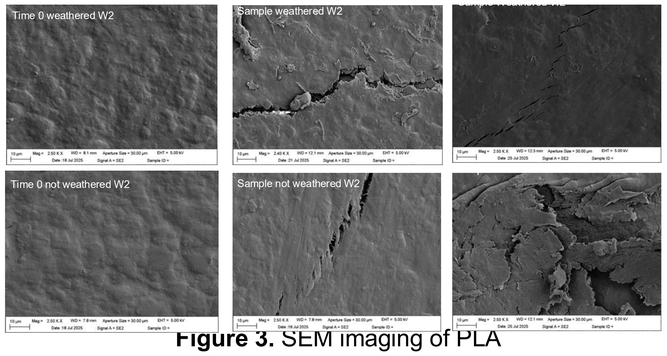


Figure 3. SEM imaging of PLA

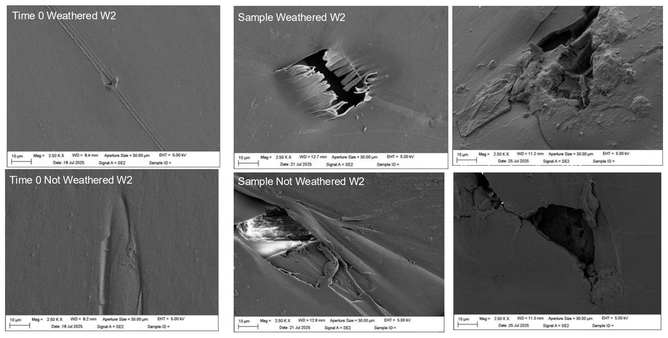


Figure 3. SEM imaging of PS/Agave

- Surface imaging shows cracks and attached bacteria in PLA after two weeks
- PS/Agave exhibits cracks as well, yet also peeling of the material
- These cracks and peeling features are on the nanoscale indicating these changes are minute and represent only a small amount of biodegradation

Leachate Tests (ICP-MS)

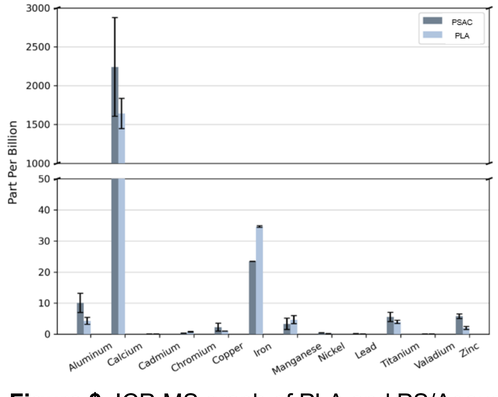
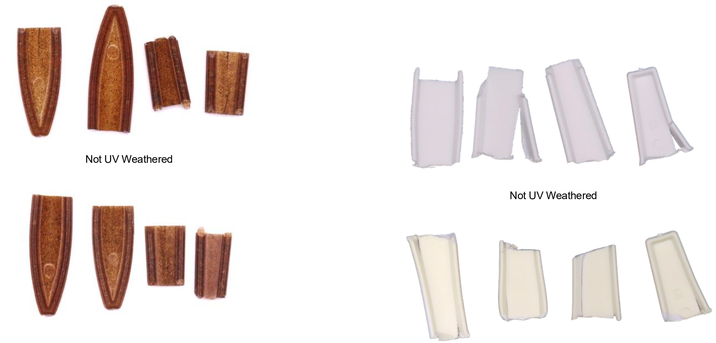


Figure $. ICP-MS graph of PLA and PS/Agave

- Leachate tests show elevated levels of calcium leachate for both PLA and PS/Agave due to the kaolin additive in PLA and agave ashes in the PS/Agave

Results Cont.

Weight loss %



- Visually, not UV weathered PS/Agave and UV weathered PLA exhibited the greatest changes.
- Overall weight loss ranged from 0.005% to 0.384% in samples.
- The negligible weight loss % supports that biodegradable plastics are not easily degraded in these conditions.

Conclusions

- Results show slight biodegradation of bioplastics PLA and PS/Agave, however, results in this study are insignificant compared to biodegradation rates of compost.
- The Biodegradation of bioplastics is conditional and have the possibility of persisting like conventional plastics if not disposed of properly.
- Further studies are needed to fully understand the fate of bioplastics and to make an impact toward true environmentally friendly plastics

Acknowledgements

This work is supported by the U.S. National Science Foundation under Award #2348968, REU Site: URI Plastic Initiative at the University of Rhode Island, and the Donald R. Wilson Jr. Family Foundation. Partial support for professional development activities was provided by EPSCoR Cooperative Agreement #OIA-2433276 and the RI Commerce Corporation through the Science and Technology Advisory Committee. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the funding partners.

References

- IUCN. "Plastic Pollution." *Iucn.org*, May 2024, iucn.org/resources/issues-brief/plastic-pollution.
- Filiciotto L, Rothenberg G. Biodegradable Plastics: Standards, Policies, and Impacts. ChemSusChem. 2021 Jan 7;14(1):56-72. doi: 10.1002/cssc.202002044. Epub 2020 Oct 28. PMID: 33112051; PMCID: PMC7821290.
- Báreková, A., Demovičová, M., Tátošová, L., Danišová, L., Medlenová, E., & Hlaváčiková, S. (2021). Decomposition of Single-Use Products Made of Bioplastic under Real Conditions of Urban Composting Facility. *Journal of Ecological Engineering*, *22*(4), 265–272. https://doi.org/10.12911/22998993/134040