Polylactic Acid Degradation is Enhanced by Microbial Processes in Earthworm Guts

Linda Hink*†[1], Stephan Rohrbach[1], Joey Rehkopf[1], Anja Holzinger[2], Alfons R. Weig[3], Heike Feldhaar[2], and Marcus A. Horn[1]

[1]Institute of Microbiology, Leibniz University Hannover – Herrenhäuser Str. 2, Germany
[2]Animal Ecology I, University of Bayreuth – Universitaetsstr. 30, Germany
[3]Genomics and Bioinformatics, University of Bayreuth – Universitaetsstr. 30, Germany

Abstract

Wastewater irrigation, plastic mulching and also inadequate plastic disposal can lead to soil microplastic pollution. Although there is a trend in replacing non-biodegradable with biodegradable polymers, e.g. polylactic acid (PLA), the actual biodegradation is limited in the field, as environmental conditions are unfavourable. We hypothesise that soil-dwelling earthworms enhance this process, which is likely driven by gut microbial activities. This was tested for the compost worm *Eisenia fetida*, a model organism in ecotoxicology, exposed to uncontaminated (control) or PLA-supplemented soil. Subsequently, life history parameters were assessed and amplicon high-throughput sequencing of 16S rRNA genes and short-chain fatty acid concentrations derived from the guts were analysed. The earthworm's reproduction was positively affected by PLA. Bacterial communities in the gut of earthworms exposed to PLA differed significantly compared to the control. Amongst others, taxa such as Phycisphaera-like WD2101, known for their ability to ferment complex carbohydrates, were more prominent in the former. Higher lactate concentrations in the guts of earthworms exposed to PLA than that in controls indicated enhanced microbial activities and potential PLA degradation. Given such evidence, actual PLA mineralisation rates were elucidated in a 13C-PLA-tracing experiment. Indeed, ≈0.07 μmol CO2 d-1 were derived solely from PLA in presence of earthworms and ultimately ≈0.2% degradation of initial PLA were attributed to earthworms after two weeks. In conclusion, PLA affected *E. fetida* positively likely due to enhanced microbial metabolism during PLA degradation. The findings provide strong evidence that conditions inside the earthworm guts are preferential for PLA degradation and suggest potential mitigation strategies for microplastic pollution.

Keywords: Eisenia fetida, gut bacterial community, 13C PLA tracing, mineralisation rate

*Speaker
†Corresponding author: linda.hink@ifmb.uni-hannover.de