Biodegradability and ecotoxicity of a biobased and biodegradable mulch film using key organisms in soil ecosystems

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Abstract

Biobased and biodegradable plastic mulch films are an increasingly attractive alternative to their conventional counterparts, with the promise of safeguarding the health of agricultural soils and their inhabitants through the complete biodegradation of the material (and consequent elimination of removal costs) contributing to the value of these mostly petrochemical-independent materials. However, these plastics' current certification processes prove themselves lacklustre in predicting biodegradation performance and ecotoxicological effects in natural settings, the relatively few studies done on the topic disputing this perceived environmental-friendliness.
This study assessed the biodegradation of a commercially-available biobased and biodegradable mulch film by the soil-dwelling fungal species *Penicillium brevicompactum*, in solid culture media and locally sourced agricultural soil, for the duration of 15 and 28 days, as well as the ecotoxicological effects of microplastics from the same material on the key earthworm species *Eisenia andrei*, at environmentally-relevant concentrations ranging from 0.125 to 0.500 grams per kilogram of soil, both in their pristine state and after UV-C radiation weathering.

The results obtained in the biodegradation assays – mass variation, microscopic analysis and FTIR analysis – suggest *P. brevicompactum*'s capability to accelerate the mulch film's natural biodegradation process. In the ecotoxicological assays, exposure to any concentration of pristine microplastics seemed to increase *E. andre*i's sensitivity to touch, had apparent adverse effects on energy reserves, and resulted in significant decreases in offspring numbers

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(upwards of 30%); conversely, weathered microplastics seemed to show no such negative effects, bar specimen sensitivity.
Since the mulch film's weathering is expected to happen if properly used, the studied material seems to be an environmentally-friendly alternative, given its potential for faster biodegradation by normal soil dwellers and low toxicity to a key-species in the ecosystem. Notwithstanding, these findings highlight the shortcomings of currently applied standards, that can ignore the role of chronic ecotoxicological effects on naturally-occurring organisms.

Keywords: Biofilms, Eisenia andrei, Penicillium brevicompactum, Plastics biodegradation, Soil ecotoxicology.