Study suggests 'biodegradable' teabags don't readily deteriorate in the environment

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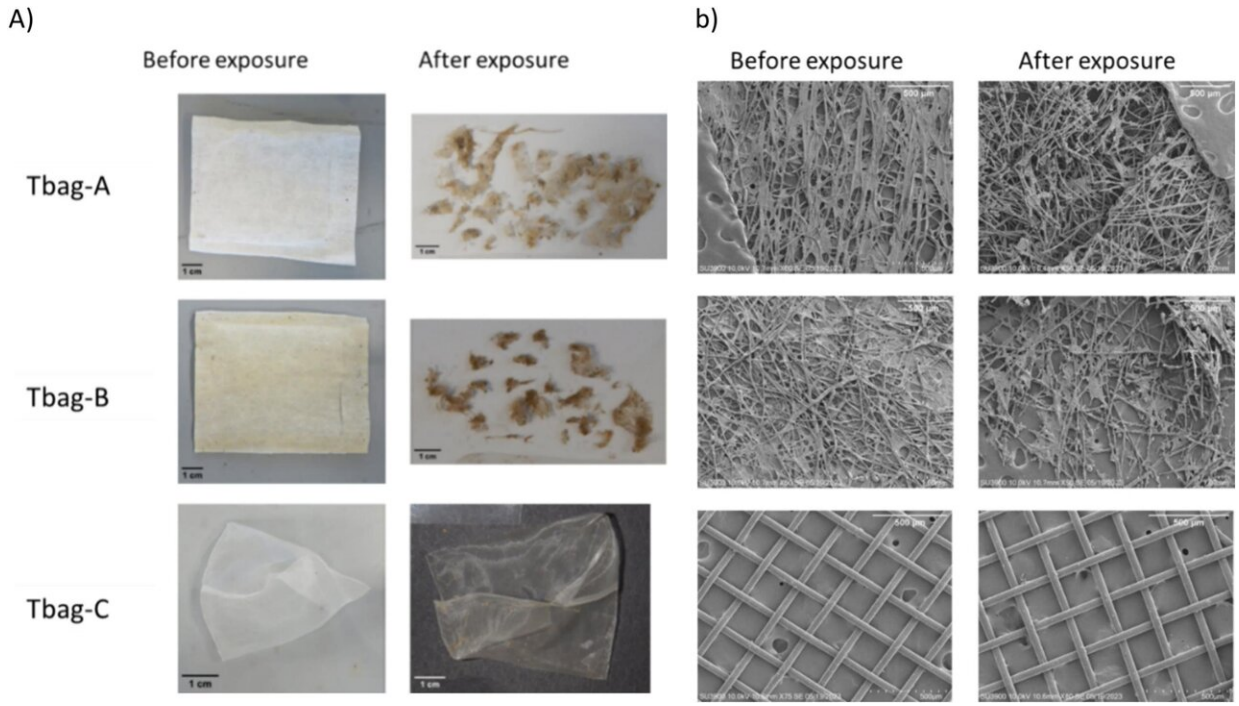

Example a) images and b) scanning electron micrographs of teabags before and after 7 months exposure in soil (−10 cm depth, agricultural field margin in Cornwall, UK), between November 2021 and June 2022. Credit: *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.172806

Some teabags manufactured using plastic alternatives do not degrade in soil and have the potential to harm terrestrial species, a new study has shown.

The research looked at commonly available teabags made using three different compositions of polylactic acid (PLA), which is derived from sources such as corn starch or sugar cane.

The teabags were buried in soil for seven months, and a range of techniques were then used to assess whether—and to what extent—they had deteriorated.

The results showed that teabags made solely from PLA remained completely intact. However, the two types of teabags made from a combination of cellulose and PLA broke down into smaller pieces, losing between 60% and 80% of their overall mass and with the PLA component remaining.

The study also examined the impacts of the disks cut from the teabags on a species of earthworm, Eisenia fetida, which has a critical role in soil nutrient turnover as it consumes organic matter.

Researchers found that being exposed to three different concentrations of teabag disks—equivalent to the mass of half, one and two teabags—resulted in up to 15% greater mortality, while some concentrations of PLA had a detrimental effect on earthworm reproduction.

Writing in the journal *Science of the Total Environment*, the study's authors highlight the need for accurate disposal information to be clearly displayed on product packaging.

Only one of the manufacturers whose products were chosen for the study indicated on the packaging that the teabags were not home compostable.

This could lead to them ending up in soil, while there is also high potential for consumer confusion about the meaning of terms such as

plant-based or biodegradable, emphasizing the need for clear guidance on appropriate disposal.

Dr. Winnie Courtene-Jones, Post-Doctoral Research Fellow at the University of Plymouth, is the study's lead author. She said, "In response to the plastic waste crisis, biodegradable plastics such as PLA are being used in an increasing range of products. This study highlights the need for more evidence on the degradation and possible effects of such materials before their use becomes even more widespread, and to prevent the generation of alternative problems if they are not properly disposed of."

The study was designed to replicate the environmental conditions in which teabags might be discarded on account of a lack of clear labeling as to how they should be disposed.

It used analytical techniques such as size exclusion chromatography, nuclear magnetic resonance, and scanning electron microscopy, allowing scientists to examine not just how the teabags had changed visibly but also structurally.

Study co-author Professor Antoine Buchard, formerly of the University of Bath and now Professor of Sustainable Polymer Chemistry at the University of York, added, "PLA is a bioderived plastic with a reduced carbon footprint compared to traditional plastics, which also degrades under industrial composting conditions. Using a number of chemical analysis techniques, we've shown that when it is not properly disposed of, for example after seven months in the soil, its molecular structure remains intact.

"Labels such as biodegradable and compostable have the potential to mislead the public, therefore it is important that scientists, policy makers and manufacturers work together to ensure clear standards are followed

and that the public has easy access to information on where to dispose of those new plastics."

The research was carried out as part of BIO-PLASTIC-RISK, a four-year project led by the University of Plymouth. It is assessing how biodegradable packaging and products break down and, in turn, whether the plastics or their breakdown products affect species both on land and in the marine environment.

It also builds on previous research suggesting that some products labeled as biodegradable, including carrier bags, do not disintegrate after as much as three years in the environment.

The study has been published in the wake of the fourth session of the Intergovernmental Negotiating Committee (INC-4), where world leaders and scientists were among those to continue discussions towards the Global Plastics Treaty.

Study co-author Professor Richard Thompson OBE FRS, Head of the University of Plymouth's International Marine Litter Research Unit and lead of the BIO-PLASTIC-RISK project, is a co-coordinator the Scientists' Coalition for an Effective Plastics Treaty.

He said, "After 30 years of research on plastic pollution, I am delighted there is now a global consensus, as evidenced by the UN Plastics Treaty, that current production use and disposal of plastic is unsustainable. But it is with immense frustration that I see alternative and substitute materials entering the market without clear guidance on how their benefits might be realized.

"Even if consumers understand how to dispose of these products only around half of households in the UK currently have access to the necessary waste streams for the type of composting required. It is

essential we learn from the mistakes we made with plastic materials by testing and labeling these novel materials in relation to the prevailing waste management infrastructure."

Dr. Mick Hanley, Associate Professor in Plant-Animal Interactions at the University of Plymouth and senior author on the study, added, "In this study, PLA-based teabags did not fully deteriorate, and it seems that composting worms may be harmed by them.

"The lack of clear labeling can lead to consumers disposing of teabags in their compost, where any limit to complete degradation of the material raises the potential for plastics to enter the soil when compost is added to the garden, with potential impacts on garden wildlife and uptake by food plants."

More information: W. Courtene-Jones et al, Deterioration of bio-based polylactic acid plastic teabags under environmental conditions and their associated effects on earthworms, *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.172806

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