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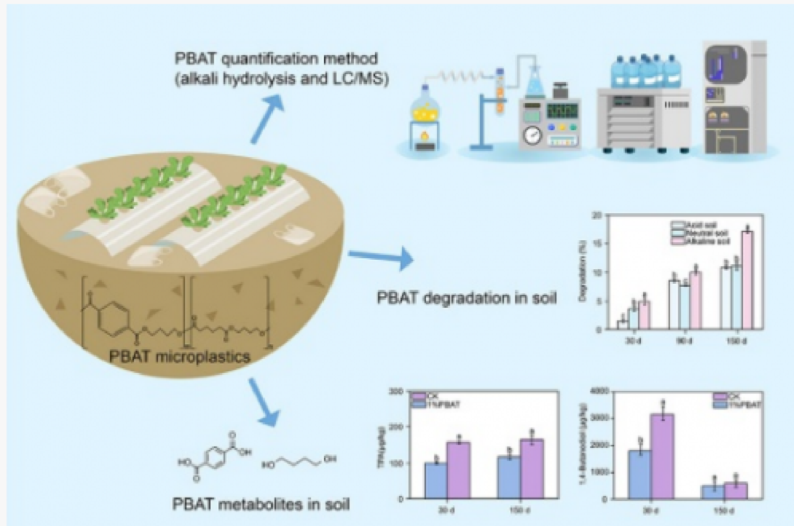
# When biodegradable isn’t fast: Soil study uncovers long-lasting PBAT microplastics and their byproducts



Quantifying and tracking PBAT microplastic degradation in soil.

FAYETTEVILLE, GA, UNITED STATES, November 27, 2025 / EINPresswire.com/ -- Although biodegradable plastics are promoted as eco-friendly alternatives, their microplastic residues may linger in soil for extended periods. A new study has developed a precise method to quantify the degradation of poly(butylene adipate-co-terephthalate) (PBAT) microplastics and identify their breakdown products in various soils.

Biodegradable plastics like poly(butylene adipate-co-terephthalate) (PBAT) are increasingly used in packaging and agricultural films to mitigate plastic pollution. However, mounting evidence suggests they may not break down rapidly under real environmental conditions, leading to the accumulation of microplastics in soil. Conventional analytical methods struggle to quantify these particles and their degradation pathways because microplastics are hard to extract and track. Moreover, PBAT degradation can yield intermediate compounds that may affect soil microbes and plants. Due to these challenges, there is a pressing need to develop accurate analytical tools and conduct systematic investigations on the degradation behavior of PBAT microplastics in soil environments.

Researchers from Nanjing Normal University and Nanjing University have introduced a new quantitative method to measure the degradation and metabolite formation of PBAT microplastics in soil. The study (DOI: 10.1016/j.eehl.2025.100166), published online on June 19, 2025, in Eco-Environment & Health, combined alkali-assisted thermal hydrolysis with liquid chromatography–mass spectrometry to achieve accurate detection. By simulating 150-day soil incubations under acidic, neutral, and alkaline conditions, the team revealed how soil pH profoundly influences PBAT degradation rates and metabolite accumulation patterns.

The researchers optimized a low-toxicity analytical protocol using 1-pentanol and potassium hydroxide to depolymerize PBAT microplastics into their monomer, terephthalic acid (TPA), enabling precise quantification without tedious extraction. This “thermal-assisted alkali hydrolysis” method achieved over 90% efficiency, reducing processing time to one hour. Applying this approach to three distinct soils, they discovered that PBAT degraded most rapidly in alkaline conditions (17.1%) compared to neutral (11.0%) and acidic (10.8%) soils. Enhanced lipase activity—a key polyester-degrading enzyme—correlated strongly with faster PBAT breakdown in alkaline soil.

Meanwhile, metabolite analysis showed that TPA and 1,4-butanediol were the main degradation products. Butanediol accumulated up to 1.6 mg $kg^{-1}$ in soil after 30 days, especially under acidic and alkaline conditions, levels high enough to temporarily stress soil organisms. These results indicate that even “biodegradable” PBAT microplastics can persist for months or years, releasing chemical byproducts during slow hydrolysis and microbial attack. The authors estimated a PBAT half-life of about 453 days in alkaline soils, underscoring the material’s long environmental residence time.

“Many people equate ‘biodegradable’ with ‘disappearing quickly,’ but our findings show that this is not always the case,” said Prof. Fengxiao Zhu, corresponding author of the study. “We found that PBAT microplastics degrade slowly in soil and can leave behind small molecules that may influence microbial activity. Our method provides a much-needed analytical foundation to track these processes more accurately.” He emphasized that understanding the degradation kinetics and byproduct toxicity of biodegradable plastics is crucial before large-scale agricultural applications.

This study provides the first quantitative framework to assess how biodegradable PBAT microplastics behave in different soils. The newly established LC–MS method allows high-throughput, low-toxicity, and sensitive monitoring of PBAT residues and metabolites, offering a practical tool for future risk assessment. The results also highlight the importance of soil pH and microbial enzyme activity in controlling PBAT degradation. These insights can inform better design of biodegradable polymers, guide agricultural plastic management, and support regulatory evaluation of emerging “green” materials to ensure they truly minimize long-term environmental impacts.

References

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