Identification and Quantification of Micro-bioplastics in Environmental Samples by Pyrolysis-Gas Chromatography–Mass Spectrometry

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Abstract

Bioplastics are materials that are biobased and/or biodegradable, but not necessarily both. Concerns about environmental plastics pollution is constantly growing with increasing demand for substituting fossil-based plastics with those made using renewable resource feedstocks. For many conventional bioplastics to completely decompose/degrade, they require specific environmental conditions that are rarely met in natural ecosystems, leading to rapid formation of micro-bioplastics. As global bioplastics production and consumption/use continues to increase, there is growing concern regarding the potential for environmental pollution from micro-bioplastics. However, the actual extent of their environmental occurrence and potential impacts remains unclear, and there is insufficient mass concentration-based quantitative data due to the lack of quantitative analytical methods. This study developed and validated an analytical method coupling pressurized liquid extraction and pyrolysis gas chromatography–mass spectrometry combined with thermochemolysis to simultaneously identify and quantify five targeted micro-bioplastics (i.e., polylactic acid, polyhydroxyalkanaoate, polybutylene succinate, polycaprolactone and polybutylene adipate terephthalate) in environmental samples on a polymer specific mass-based concentration. The recovery of spiked micro-bioplastics in environmental sample (biosolids) ranged from 74 to 116%. The limits of quantification for the target micro-bioplastics were between 0.02 and 0.05 mg/g. PLA and PBAT were commonly detected in wastewater, biosolids and sediments samples at concentrations of between 0.07 and 0.18 mg/g. The presented analytical method enables the accurate identification, quantification, and monitoring of micro-bioplastics in environmental samples. This study quantified five micro-bioplastic types in complex environmental samples for the first time, filling in gaps in our knowledge about bioplastics pollution and providing a useful methodology and important reference data for future research.

Keywords: Pyrolysis, Bioplastics, Micro, bioplastics, Quantification, Extraction, Pyr, GC/MS

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