A novel approach to extract, purify, and fractionate microplastics from environmental matrices by isopycnic ultracentrifugation

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Abstract

Microplastics (MP) are increasingly accumulating in the environment. Therefore, reliable extraction and detection methods are crucial to assess ecological risks and determine the level of pollution. However, the extraction of MP from complex environmental matrices such as soils remains challenging. Frequently applied extraction protocols are density-based, utilizing different saturated salt solutions. However, these approaches are not capable to fractionate mixtures of different MP particle types according to the specific polymer densities. Here, we present in a proof-of-concept study the simultaneous extraction and separation of MP mixtures based on the particle-specific buoyant densities via an isopycnic ultracentrifugation approach. This was accomplished by preparing diffusion-based caesium chloride density gradients with densities ranging from 1.1 to 1.5 g mL-1, sufficient to fractionate many common polymer densities. MP particles with a low (PA66), medium (PBAT), and high (PET) density were selected and incubated in a soil for 6 months. After extraction and isopycnic separation a clear banding of the MP particles at expected buoyant densities was observed. The polymer-specific separation ($\geq$ 87.6%) was supported by μFTIR imaging of subsamples from fractions with highest particle counts. In addition, our workflow achieved quantitative MP recoveries between 86-99%. Moreover, we were interested in the capability of preserving MP-associated biofilms during ultracentrifugation. Therefore, soil-incubated MP particles were inspected before and after isopycnic separation using confocal laser scanning microscopy. Preliminary results indicate a possible preservation of extracellular polymeric substances and microbes. Thus, we believe isopycnic ultracentrifugation offers a novel approach with wide application potential for polymer-specific extraction and resolution of MP particles.

Keywords: soil pollution, microplastic analysis, isopycnic ultracentrifugation, μFTIR spectroscopy

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