
Into the Multiverse: Analysis of microplastic leachates using comprehensive multi-dimensional gas chromatography-mass spectrometry

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Abstract

Plastic and microplastics in the marine environment can leach chemical compounds. Many such chemicals may incite toxicity in exposed organisms. The identification and assessment of plastic-associated chemicals released into the marine environment is a growing area of research. However, a large number of chemical compounds in microplastic leachates remain unidentified, meaning a suite of toxic compounds may be overlooked. Herein, we present the development of a novel method for the analysis of marine microplastic leachate using comprehensive two-dimensional gas chromatography-mass spectrometry (GCxGC-MS). The use of multi-dimensional chromatography provides greater separation capacity over traditional one-dimensional techniques, therefore aiding in the identification of multiple, and potentially previously unidentified, compounds within complex leachate samples. To our knowledge, this is the first use of this technique for the analysis of microplastic leaching under marine conditions. Method development was performed using virgin samples of conventional polymers (low-density polyethylene (LDPE), polypropylene (PP), polyethylene terephthalate (PET) and polyvinyl chloride (PVC)) and bio-polymers (polylactic acid (PLA), polybutylene succinate (PBS), poly(butylene adipate-co-terephthalate) (PBAT), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV)). First, organic extracts were analysed by one-dimensional gas chromatography-mass spectrometry (GC-MS) and subsequently by GCxGC-MS. The organic extract analysis enabled a comprehensive determination of chemical composition in samples and optimisation of the chromatographic parameters. Next, leachates were prepared in simulated marine conditions, for example in filtered seawater at ambient temperatures. Different pre-concentration methods were trialled including solid-phase extraction of aqueous leachate samples as well as online headspace solid phase micro-extraction and direct immersion. The method affords the identification of chemicals of potential concern associated with microplastics in the environment, which can be used to inform ecotoxicological studies and environmental monitoring.

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