DyLeMMA: A dynamic leaching method to assess the fate of plastic additives in microplastic pollution

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Abstract

Microplastics are ubiquitous contaminants that may harm wildlife through the leaching of chemical additives, such as UV stabilisers and plasticisers. Leaching processes will affect the behaviour and fate of these chemical contaminants, and therefore the risk that microplastics present to organisms. However, most studies examining the leaching kinetics of plastic additives use methods that may not be environmentally relevant. We present the development and validation of an environmentally relevant dynamic leaching method to assess additive leaching under sink conditions. Dynamic leaching conditions were attained using a sequential batch approach with period media replenishment over a 64 day test duration. Analysis was performed using a high-resolution liquid chromatography-mass spectrometry method enabling targeted quantification of additives and screening for non-intentionally added substances. Four common plastics (polyethylene, polyethylene terephthalate, polyvinyl chloride, and nylon 6), into which common chemical additives were incorporated, were used to validate and demonstrate the method. Sink conditions (where a solute's concentration is kept below its solubility limit) were maintained so that leaching processes were not hindered by additive concentration attaining equilibria, representing environmental compartments where near infinite dilution occurs, as within rivers, lakes, and oceans. Across the four plastics, leaching behaviour was found to be vastly different, with cumulative additive release spanning five orders of magnitude. This work highlights the importance of robust and standardised test methods to understand the leaching kinetics of chemical additives from microplastics which is prerequisite to producing meaningful risk assessments.

Keywords: Plastic pollution, microplastic, plastic additive, leaching, release kinetics

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