
Exploring plastic additive leaching in seawater: The role of biofilm on colonized surfaces

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Abstract

In seawater, plastic releases chemical compounds with implications for marine fauna and seawater biogeochemistry. These compounds can be additives or polymer degradation products, and their release process is enhanced by sunlight radiation. The presence of microorganisms in seawater also leads to rapid formation of a complex biological layer on plastic surfaces known as 'biofilm'. This biofilm is composed of a mixture of microorganisms, extracellular compounds, and organic matter adhering to the plastic surface, fundamentally altering its properties and interactions in the environment. All studies analyzing plastic leaching in seawater have used new virgin plastic, ignoring the role of biofilm in this process. This study explores this phenomenon to understand whether biofilm presence on plastic enhances or inhibits the leaching process in seawater.

Two experiments were conducted to study plastic additive leaching in seawater: one with low-density polyethylene (LDPE) colonized by biofilm and another, as a control, with new LDPE without biofilm. Plastic pieces were incubated in sterilized seawater under artificial UV and visible radiation. In the experiment with non-colonized plastic, dark treatments were also performed to study the effect of radiation on leaching. Samples from water, plastic, and biofilm were meticulously collected at specific intervals. Organophosphates (OPEs) released by plastic into seawater were analyzed using an Agilent 7890A gas chromatograph coupled to an Agilent 7000B triple quadrupole mass spectrometer.

The experiment with non-colonized plastic revealed substantial concentrations of OPEs, indicating their potential for leaching under diverse light and darkness conditions. A notable observation was the distinct response among various OPEs to UV exposure. These results will be compared with those obtained from the experiment with colonized plastic. Findings from this study are expected to offer critical perspectives in comprehending the complex dynamics of chemical leaching associated with plastics in marine environments.

Keywords: Organophosphate esters, plastic pollution, Leaching, biofilm

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