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Comparison of ASTM and in-line microplastic sampling methods for drinking water

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Abstract

Monitoring microplastics in source and treated drinking waters has become increasingly important due to existing and anticipated legislation. However, the absence of standardized protocols has led to a wide range of sampling methods being applied in previous studies, making it difficult to compare results. While ASTM International published in 2020 the only known standardized method for microplastic sampling in drinking water (ASTM D8332-20), concern exists regarding limitations associated with the use of open sieves when compared to enclosed “in-line” filtration methods. As such, direct comparison and evaluation is required in order to provide guidance regarding the monitoring of source and treated drinking water. This study compared the performance of both the ASTM sieve stack as well as in-line filtration methods in terms of recovery of environmentally and toxicologically relevant microplastic sizes ($< 20 \mu\text{m}$) as well as potential susceptibility to extraneous particles. The methods examined incorporated 20 and 5 μm pore size sieves (ASTM) or similarly sized membrane filters (in-line filtration), operated in-series. Spike and recovery trials were conducted by spiking fluorescent polyethylene terephthalate (PET) fragments of known size and concentration into the equipment while filtering source water on-site at three different drinking water treatment facilities. Particle recovery was analyzed using fluorescence microscopy, while microplastic particles in non-spiked blank samples were examined using Raman spectroscopy. The enclosed in-line filtration method achieved $82 \pm 7.5\%$ and $99 \pm 6.9\%$ recovery of microplastics in the 5–10 μm and 10–15 μm size ranges, respectively, compared to only $20 \pm 5.3\%$ and $66 \pm 9.6\%$, respectively, for the sieve stack method; recovery of microplastics $> 15 \mu\text{m}$ was comparable between the two methods. The sieve stack method resulted in 8.6 \times more non-spiked particles than the in-line filtration method. The enclosed in-line method is therefore recommended to be used for microplastic sample collection. Future research should explore ways to improve particle recovery during sample extraction and digestion.

These advancements will serve as significant steps towards standardization of microplastic sampling in drinking water.

Introduction

Microplastics are a contaminant of emerging concern, with their presence being reported in source and treated drinking waters around the globe. Despite a lack of a consensus among researchers, the International

Organization for Standardization [1] defined microplastics as synthetic polymers (excluding natural polymers) $\geq 1 \mu\text{m}$ and $\leq 1,000 \mu\text{m}$ in size. Regulators such as the State of California [2] define them as chemically derived plastics that range in size from 1 nm to 5,000 μm . Microplastics $< 20 \mu\text{m}$ are a primary concern in drinking water as they: i) represent the most common size reported [3–7], and ii) can translocate from the gastrointestinal system to other organs, thereby posing potential health risks [6–10]. Recent studies have shown microplastics to be present in human blood [11], brain [12], cardiac plaque [13], and liver samples [9], among others. Concentrations of microplastics in previous studies regarding source and treated drinking waters are summarized in Table S1.

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ASTM Standards related to environmental sampling American Society for Testing and Materials,2014

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Voluntary Products Standards ,1978

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ASTM Sampling Methods and Analytical Validation for Lead in Paint, Dust, Soil, and Air K. Ashley, G. Dewalt, A. Feng, ME. McKnight, PC. Schlecht, R. Song, 1996 ASTM Subcommittee E06 23 on Abatement Mitigation of Lead Hazards has developed a number of standards that are concerned with the sampling of lead in environmental media namely paint dust soil and airborne particulate An ASTM practice for the collection of airborne particulate lead in the workplace has been published New ASTM standards for the collection of dry paint film samples surface soil samples and surface dust wipe samples for subsequent lead analysis have also been promulgated Other draft standards pertinent to lead sampling are under development The ASTM standards concerned with lead sample collection are accompanied by separate sample preparation standard practices and a standard analysis method Sample preparation and analytical methods have been evaluated by interlaboratory testing such analyses may be used to assess the efficacy of sampling protocols

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