Standardized fluorescent staining method for fast and affordable microplastics monitoring and its application for a long-term monitoring of microplastics in the effluent of a German wastewater treatment plant.

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Abstract

One of the biggest challenges in microplastics (MP) research is the lack of standardized, fast, and affordable MP monitoring. There are a variety of methods used for sampling, sample processing and detection, which makes it almost impossible to compare data among different studies. Additionally, commonly used methods for MP detection are time consuming and require expensive measuring devices and well-trained staff. Fluorescent staining of MP in environmental samples is a promising approach for fast and inexpensive MP detection.
To receive better fluorescence properties of MP and reduce the risks of false positives, the fluorescent properties of 23 chemically modified Nile red derivates were investigated. It is demonstrated how to modify a standard microscope or camera with a low budget into a fluorescent imaging tool. Subsequently, a standard protocol for MP sampling, sample preparation and detection was developed. For standardized detection, an automated particle counting software is applied to analyze the fluorescent images. Methods to avoid and control contamination of the samples with MP are presented. Depending on the imaging tool used and the number of samples taken, the average processing time per sample was 25-60 minutes including sampling, sample processing and detection.
The developed method was applied for the long-term monitoring of MP in the effluent of a German wastewater treatment plant (WWTP) over a period of 10 months. The results show high temporal fluctuations of the MP contamination ranging from 1-145 MP/l. This demonstrates that a larger number of samples is needed to properly evaluate the MP outputs of WWTP, for which the developed method is well suited. The investigated WWTP was equipped with granulated activated carbon and an advanced oxidation process (H2O2 + UV-C), which showed no effect on the MP concentrations, as they are designed to remove dissolved organic trace substances, but not suspended micropollutants as MP.

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