الجَمعيّـة العِلميّـة المَلكيّـة
Royal Scientific Society

Micro-FT-IR Imaging for Analysis of Microplastic in Water

Diya Alsafadi
Biosynthesis & Biocatalysis Research Unit, Applied Research Centre, Royal Scientific Society, Amman, Jordan, email: diya.alsafadi@rss.jo

Abstract

Microplastics (MPs) are generally defined as water-insoluble, solid polymer particles that are less than 5mm in size[1]. Recently, MPs have attracted worldwide attention, when high amount of MPs have been detected in raw water (surface and ground water) as well as drinking water treatment plants[2]. Therefore, MPs have been recognized as chemicals of concern by many of leading health and environmental agencies around the world such as the World Health Organization (WHO) which have recently published a report that looks at the impact of MPs in drinking water on human health[3]. The WHO report highlighted key areas that require further research, including the need for improved methodologies for detecting microplastics and identifying key microplastic transport pathways.
Data on the amount of microplastic in the treated wastewater and drinking water are limited in Jordan. Also, methods of sampling, isolating, purifying and identifying microplastics in Jordanian water standards are not available. The aim of the present study is to investigate the content of microplastic particles in the water supply chain in Jordan using fourier-transform infrared (FTIR) microscope. The method is under validation and we expect to show to image and identify different microplastic types such as polyethylene, polypropylene, polyvinyl chloride, polystyrene). The use of micro-FT-IR spectroscopy also provides a considerable reduction in analysis time compared with another methods, such as Raman microscopy.

Introduction

MPs enter water sources in different ways such as surface run-off (e.g. after a rain event), wastewater effluent (both treated and untreated), combined sewer overflows, industrial effluent, degraded plastic waste and atmospheric deposition. MPs can also come off clothing during normal washing. Additionally, plastic bottles and caps that are used in bottled water may also be sources of MPs in drinking water[3].
Figure (1) shows the pathways of microplastics transport[4].

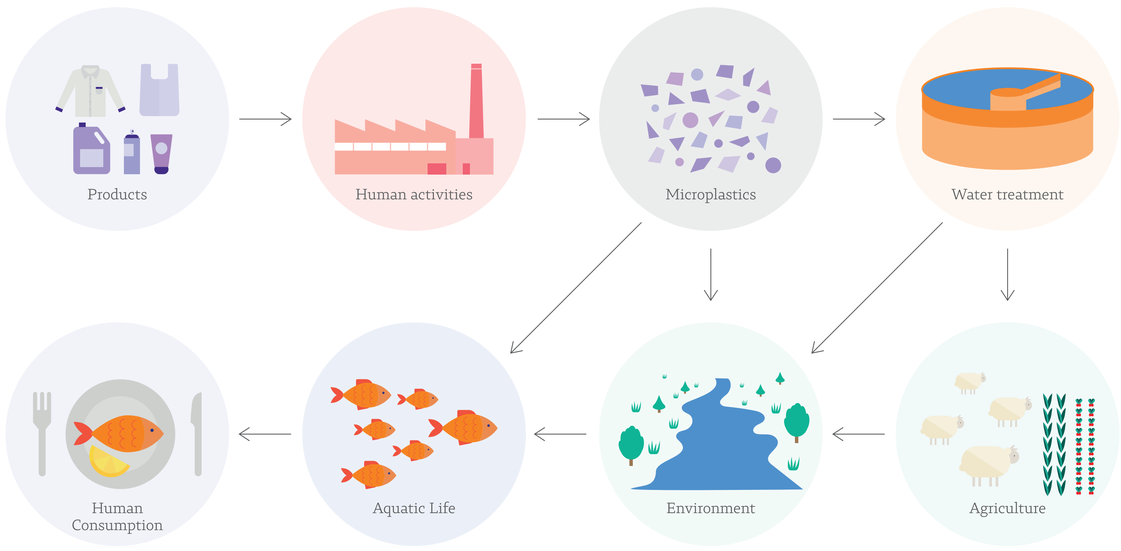
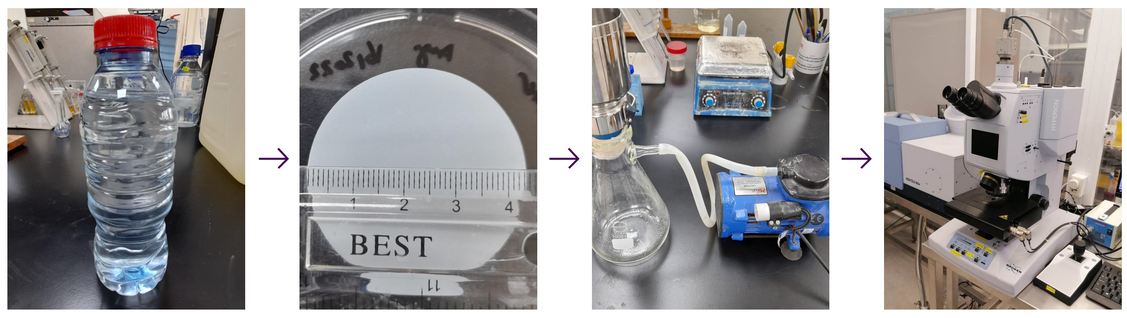


Figure 1: Pathways of microplastic transport

Methods

The collected water was filtered through an Aluminum oxide membrane filter (0.2 Micron). A pretreatment step using 30% hydrogen peroxide (H_2O_2) was employed for wastewater samples to remove biogenic material, and focal plane array (FPA)-based reflectance micro-Fourier-transform (FT-IR) imaging. The plastics were analyzed using a Bruker Hyperion micro FT-IR spectroscope equipped with a Specac Golden Gate attenuated total reflectance (ATR) accessory, with 50 coadded scans carried out for each experimental replicate at a spectral resolution of 4 cm^{-1} and a wavenumber range of 4000 cm^{-1} – 650 cm^{-1}



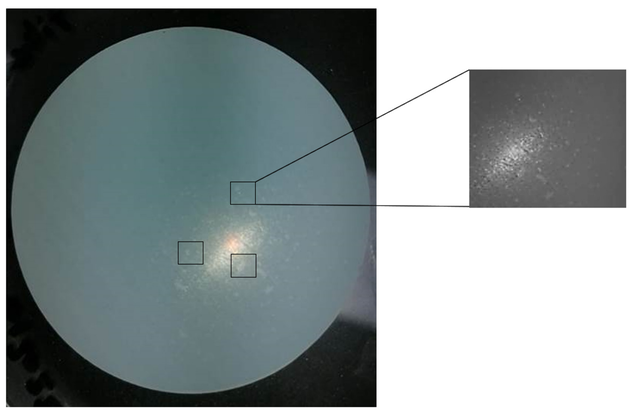
Sample collection | Aluminum oxide membrane filter (0.2 Micron) | Sample filtration | FITR microscopy

Why Micro-FT-IR ?

Micro-FT-IR combines infrared spectroscopy with an optical microscopy approach. Micro-FTIR instrument can account the number of MP particles in the sample and offers the possibility to identify the type of plastic. This technology is enable the identification and quantification of MP down to 10 microns or less. Additionally, the FTIR microscope has the added advantage of being able to generate a two dimensional spectral map of the sample by moving the microscope stage in small steps and collecting spectra at each step. These spectra, combined together, create a high resolution spatial map of material composition across a sample and increase the reproducibility of the measurements.

Results

This study proves that bottled water from local market contains microscopic plastic pieces. These small plastic particles might be caused by the packaging material or cleaning processes of bottles. The plastic that deducted mainly PET and PEST
(sum of polyesters, incl. PET).



References

1. Bergmann, M., Gutow, L., Klages, M., 2015. Marine Anthropogenic Litter. Springer2- M. Musa, R. Phillips, *Catal. Sci. Technol* **1**, 1311–1323 (2011).
2. SAPEA, 2019. Science Advice for Policy by European Academies - A Scientific Perspective on Microplastics in Nature and Society. SAPEA, Berlin.
3. WHO, Microplastics in drinking-water, 2019. World Health Organization (WHO).
4. Xuan-Thanh Bui, et al. 2020. Microplastics pollution in wastewater: Characteristics, occurrence and removal technologies., *Envir Technol & Innovation*

Conclusion & Future Work

FT-IR spectroscopy can be used as powerful technique for identification of microplastics for several reasons, including efficiency of cost, reliability, and ease of use. Additionally, infrared spectroscopy is nondestructive therefore the sample can be taken for further spectroscopy analysis. Micro-FT-IRFuture experiments will be conducted to identify the microplastics in different organic-rich environments, such as peat soils and sea and river sediments.