Evaluation of microplastic load in a waste water treatment plant (WWTP)

Chioma Ekechi Onwuchekwa and Tammy H. Boles, PhD

School of Environmental Studies
College of Interdisciplinary Studies

TENNESSEE TECH

Introduction

Demand for global plastic production currently exceeds 300 million tons/yr, and the world's oceans receive five to thirteen million tons/yr. In the environment may undergo some form of weathering by mechanical forces, micro-organisms and/or ultraviolet radiation from the sun, resulting in the breaking down large plastics into smaller plastic particles referred to as microplastics

Microplastics are plastic fragments with measured diameter(s) less than 5mm and have been found in marine, freshwater, wastewater and terrestrial systems. Microplastics have been ingested by smaller aquatic and terrestrial organisms, resulting in biomagnification of microplastic pollution in natural food webs. Furthermore, microplastics are ubiquitous and buoyant, making them excellent vectors of chemical pollutants in the environment

The aim of this study is to evaluate the role of Cookeville waste water treatment plant (WWTP), Tennessee, in the release of microplastics into the environment by identification and quantification of microplastics in Cookeville WWTP

Materials and Methods: Waste Water

- 1) 1L each of influent was spiked with 1.5 grams of polyethylene terephthalate (PET) pellets in triplicates; 8L each of samples from influent, aeration, clarifier and effluent from the Cookeville WWTP were wet sieved with 5mm, 1mm and 0.3mm mesh size sieves; 100 mL of optima LC-MS grade ultrapure water without PET granules was used as the control sample.

Figure 1: Wet sieving setup

- 2) Wet peroxide oxidation on residual solids was carried out using 30% H_2O_2 + 20 mL catalyst + heat at 90°C
- 3) 24 h Density separation, using a saturated solution of NaCl (6g NaCl per 20 mL sample). Floating particles were collected, dried for 24 h and weighed

Figure 2: Density separation

- 4) Particle identification and measurement was carried out using a Bruker LUMOS FTIR microscope in ATR mode and ImageJ software.

Materials and Methods: Sludge

8L of sludge was collected from the Cookeville, WWTP using amber glass jars. Sludge samples were oven dried, rather than being wet sieved, prior to wet peroxide oxidation. Subsequently, the sludge samples were treated exactly as the waste water samples in steps 2 – 4

Figure 3: Flowchart of sludge sample treatment process

Results

- Average recovery of PET granules from spiked samples: 95%
 - 91.6%, 99.6% and 93.8% for samples 1, 2 and 3 respectively
- No evidence of plastic particles in the control and samples from the clarifier, aeration and effluent
- Two rhomboid and trapezoid shaped plastic particles were found in the influent and identified to be polyvinyl chloride (PVC).

Figure 4: FTIR spectrum of PET granules

Figure 5: Recovered plastics

Results cont.

Figure 6: FTIR spectrum of the recovered PVC

- Particle sizes of the recovered PVC were above the upper size boundary, 5mm, for microplastics. However, this has shown that the WWTP can be a source of plastics in the environment.

#	Length(mm)	Perimeter (mm)	Area (mm²)
1	15.1	145.0	222.1
2	55.0	70.0	844.9

Table 1: Particle sizes of recovered PVC

Future Research

There is a need for continual research and standardization of methods to provide a better understanding of the presence and fate of microplastics in the aquatic environment. We plan to collect more samples over longer periods, to obtain working solutions that are representative, rather than single grab samples.

Select References

- Arthur, C., Bamford, H. & Baker, J. (2009) 'Proceedings of the International Research Workshop on the Occurrence, Effects and Fate of Microplastic Marine Debris. Sept 9-11, 2008'. NOAA Technical Memorandum NOS-OR&R-30.
- Mai, L.; Bao, L.-J.; Shi, L.; Wong, C. S.; Zeng, E. Y. A Review of Methods for Measuring Microplastics in Aquatic Environments. *Environ Sci Pollut Res Int* **2018**, 25 (12), 11319–11332. <https://doi.org/10.1007/s11356-018-1692-0>.
- Masura, J., et al. 2015. Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.
- UNEP (2016). Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, Nairobi.

Acknowledgement

We wish to thank the Water Center at Tennessee Tech. for granting us unrestricted access to the LUMOS FTIR microscope, the School of Environmental Studies, the Department of Chemistry, Dr. Justin Murdock and Dave Hobbs of Tennessee Tech. and John Buford and other staff of the Cookeville Wastewater Treatment Plant for their continual assistance.