Development of aged and pristine polymers open database for the identification of environmentally aged microplastics using pyrolysis-gas chromatography-mass spectrometry

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Abstract

Microplastic pollution is a growing environmental concern, with plastic debris fragmenting into ever-smaller particles that enter our ecosystems. However, accurately identifying these microplastics, especially aged particles that may have undergone physical and chemical changes, remains a challenge. While commercial databases containing reference spectra for Py-GC-MS analysis exist, they can be unreasonably expensive, and therefore inaccessible to many research groups, especially for researchers in developing countries. To address this gap, our goal is to create a freely available, open-source database of Py-GC-MS spectra for various polymers, including both pristine and aged samples. For this purpose, a series of 7 petroleum-based polymers and 4 bio-based polymers were subjected to controlled aging conditions (UV, temperature and humidity) for one month and analyzed by Py-GC-MS afterwards to generate a reference open database of characteristic pyrolysis products. For most of the studied polymers, the pyrograms of both pristine and aged samples exhibited similar distributions, indicating that the accelerated aging process for one month does not significantly alter their molecular structure pyrolysis products. Further research is needed to investigate the impact of aging on a wider range of polymers and under different environmental conditions. Furthermore, the developed reference database should be expanded to include additional polymers and their aged counterparts. In conclusion, Py-GC-MS should be integrated into microplastic identification protocols to account for the potential presence of aged microplastics in environmental samples. Thus, the generated reference database can serve as a valuable resource for researchers and environmental scientists working in the field of microplastic pollution by facilitating identification of microplastics in the environment for researchers without access to commercial polymer databases. Acknowledgement: French ministries of Europe and foreign affairs, of higher education, research and innovation Franco-Serbian Hubert Curien partnership Pavle Slavic (no12); Ministry of Science, Technological Development and Innovation, Republic of Serbia, (451-03-66/2024-03/200134); COST Action CA20101.

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