Hungarian University of Agriculture and Life Science Szent István Campus

Agriculture water management engineering

Master Degree

Investigation of Micro Polymer Origin

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The production of plastic has become a significant part of human life, with annual global production reaching 380 million tons, resulting in 250 million tons of plastic waste. Environmental pollution caused by microplastics (MPs) is a growing concern worldwide, as it has largely anthropogenic origins, prompting research into the consequences of uncontrolled MPs in the environment. This scientific study focuses on examining the main sources of microplastic pollution, which are secondary microplastics arising from the degradation of larger plastic debris and washing machines.

To accurately detect microplastic polymer origin in environmental samples, pretreatment reagents are commonly used to extract them from interfering substances. However, the use of inappropriate pretreatment reagents can damage or underestimate microplastics. Therefore, the first part of this research aims to evaluate the effectiveness of commonly used digestion solutions in extracting microplastics (MPs) with the least effects on microplastic polymers to evaluate the efficiency of commonly employed digestion solutions in extracting microplastics while limiting the effects on polymer particles. Additionally, the study examines the resistance of various commonly used polymer types, namely PET/PETE, HD-PE, PE-LD, and PP, under different experimental conditions for various types of solutions, namely sulfuric acid, hydrochloric acid, phosphoric acid, and sodium hydroxide, to evaluate their resistance. The second part of this study focuses on investigating the role of the washing processes of synthetic textiles on microplastic release and the effectiveness of sand filters in screening out microplastics.

The study found that HD-PE demonstrated the best resistance to acid and base digestion solutions and the least effect on particles, while PP showed the opposite, indicating that the PP polymer may present more potential to exist in the environment as a microplastic. The proposed digestion protocol, H_2SO_4, allows for the investigation of microplastic origins with minimal damage to the polymers, while the use of H_3PO_4 is not supported, as it shows effects on polymers that may alter the polymer particles and cause errors in identifying the origin of the polymers. In the second part of the study, washing and rinsing synthetic fabrics released microfibers ranging from 25 to 20 fibers from the washed fabric, indicating the release of microfibers during the washing process. However, when the sample was filtered with a sand filter, no fibers were found, indicating the effectiveness of the sand filter in capturing possible microplastic from the washing samples.

The primary objective of this scientific investigation is to identify polymer types that exhibit reduced resistance to digestion, thereby enabling crucial information to be obtained on the sources of microplastics in the environment and assisting in the development of effective strategies to minimize their impact. Furthermore, the data collected from this research could be utilized to create measures that restrict the discharge of microplastics into the ecosystem, with particular emphasis on safeguarding water bodies, which are significantly impacted by this type of pollution and are vital for human health and well-being. In general, this research establishes the basis for the preparation and pre-treatment of microplastics and the assessment of their contamination and associated risks in the environment. By providing insights into the sources, impacts, and fate of microplastics, this study informs the development of prospective solutions despite uncertainties surrounding the origins and interactions of microplastics with diverse materials.

The present scientific investigation provides recommendations for mitigating the release of microplastics into the environment, based on the research findings. Specifically, monitoring the utilization of washing machines and synthetic textiles, and implementing sand filters to trap microfibers and microplastics are recommended. The study suggests the utilization of HD-PE and PET/PETE polymers instead of PP, as they demonstrate superior resistance to digestive solutions and are less prone to become microplastic. Adequate pretreatment reagents for extracting microplastics are also emphasized, with the use of the H_2SO_4 digestion protocol recommended for investigating microplastic origins with minimal damage to the polymers. Additionally, relying solely on weight differences may not yield accurate results, leading to potential errors and overestimation of the findings, and it is important to incorporate microplastic analysis into the research.