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AIRBORNE MICROPLASTICS: CURRENT APPROACHES FOR SAMPLING, ANALYSIS AND ENVIRONMENTAL IMPLICATIONS

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Introduction

Microplastics (MPs), are polymer fragments <5 mm, that have been recently identified in the atmosphere, aspect that opened a new research direction regarding mobility, long-distance transport and human exposure through inhalation. Although studies in recent decades, concerning that compounds, have been focused on aquatic ecosystems, researches on its presence in ambient air are still limited.

The main sources of atmospheric PMs are including road traffic (tire and brake abrasion), industrial activities, synthetic textiles, urban dust and plastic's degradation. In Romania, research has so far focused on the waters, but studies on outdoor and indoor air are lacking.

Globally, major challenges include the lack of standardized sampling and analysis methods, the difficulty in differentiating MPs from other particles, the absence of uniform spectral databases, and the underestimation of exposure to particles <10 µm. This paper integrates international sampling, pretreatment, and analysis methods, adaptable to the Romanian context, providing a basis for the development of a standardized monitoring system and for assessing the impact on health and the environment.

Materials and methods

The methodology for assessment of atmospheric MPs includes three main stages: sampling, pretreatment and analysis. Sampling is carried out by passive (gravitational sedimentation on glass or aluminium collector surfaces) and active methods, involving vacuum pumps, membrane filters (polyester, alumina, polycarbonate) or large-volume collectors. Portable filters and cartridge vacuum cleaners are used indoors. Sample pre-treatment aims to eliminate organic and mineral interferences through oxidative digestion (H_2O_2, Fenton), enzymatic digestion or density separation (NaCl, $ZnCl_2$, NaI). The stages are carried out under controlled conditions to avoid contamination. The analysis is based on visual screening (optical microscope) spectroscopic identification (FTIR, Raman), chemical quantification (pyrolysis-GC/MS) and morphological/elemental characterization (SEM-EDX).

Results and conclusions

International studies have identified a variety of air polymers, such as polyethylene, polypropylene, polyethylene terephthalate, polystyrene, polyvinyl chloride, polyurethane and synthetic fibres (nylon, acrylic).

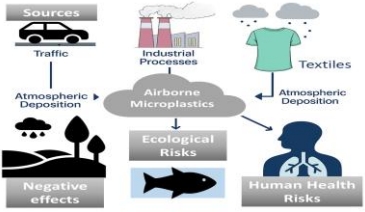

Figure1. Sources, transport, and impacts of airborne microplastics on the environment and human health – original source

Textile fibres are dominant in the urban environments, accounting for over 60–80% of particles, while fragments of polyethylene and polypropylene are common in industrial areas. Sizes generally range between 10 and 500 µm, but inhalable particles below 10 µm have been detected mainly indoors, raising concerns for respiratory health (Fig. 1).

Studies on outdoor/indoor MPs concentrations reported globally differ considerably, as follows: concentrations 0.3-1.5 particles/m³ were identified in the outdoor environment 1.0-60 particles/m³ in the indoor environment, in Paris (using the FTIR stereomicroscopy technique coupled with ATR), concentrations of 575-1008 particles/m^2/day were identified by passive sampling of atmospheric air, in Aveiro, Portugal, concentrations of 6 fibers/m^3, fiber sizes 17-3669 (µm) [1], in China (using the fluorescence stereomicroscopy technique, Raman) 275MPs/m^2day, are just a few examples [2]. The sampling methods, quantification and reporting of results for MPs in the air differ greatly for the ach study. These variations highlight the lack of standardization and the difficulty of comparing results.

Their long-distance transport and indirect bioaccumulation threaten food chains. In Romania, the lack of studies and data on ambient air represents an important gap, requiring adapted national monitoring programs to international methodologies.

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