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Transport of micron-sized polyethylene particles in green wall media: Effects of size, and surfactant presence

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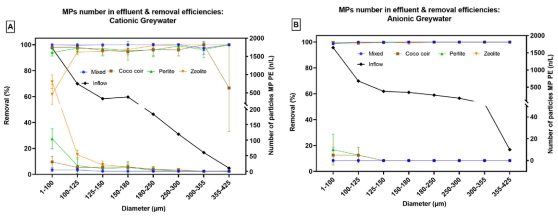

Microplastics (MPs) are ubiquitous contaminants in all environments, with polyethylene (PE) MPs being particularly prevalent due to their widespread use, low density, and hydrophobicity, which influence their transport and retention. However, their bioaccumulation, toxicity, and persistence pose risks to ecosystems and human health. Greywater discharge, containing surfactants from detergents and cleaning products, serves as a major pathway for MPs into the environment. These surfactants interact with MPs, altering their hydrophobicity and influencing their transport and retention behaviour. While nature-based treatment systems such as constructed wetlands and green walls offer promising solutions for MP removal through physical filtration, their migration and mechanisms governing their retention in lightweight green wall media remain poorly understood. This study is the first to evaluate the effectiveness of lightweight green wall media for MP removal in greywater treatment, examining the influence of particle size and surfactant presence. It assessed the performance of four common media types: perlite, zeolite, coco coir, and mixed media (a mixture of perlite, coco coir, and zeolite), in retaining MPs. A five-month column experiment was conducted to draw insight into the transport behaviour and removal efficiency of sphere-shaped PE MP in the presence of cationic (cetyltrimethylammonium bromide, CTAB) and anionic surfactants in synthetic greywater. Mixed media (D50: 2.62 mm) demonstrated the highest MP retention, outperforming single media types and proving to be the most effective option for MP removal in greywater treatment within green wall systems. Smaller MPs (<125 µm) were more mobile, while mixed media achieved superior retention (99 – 100%) due to its finer particles and complex pore structure, enhancing physical filtration. Surfactant interactions further influenced MP transport, with cationic surfactants (CTAB) reducing MP retention by decreasing MPs hydrophobicity, while anionic surfactants promoted retention through weaker repulsion forces, demonstrating the need for optimized media selection and reduce the environmental hazards of MPs affected by surfactant in green wall-based greywater treatment systems. These findings enhance our understanding of the environmental fate of MPs in green wall system and other water treatment applications thorough evaluation of their associated ecological risks in subsurface environments.