Toxic plastic particles: microplastics as vector for cyanobacterial toxins microcystin-L R and -LF

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Preferred presentation medium: oral

Are you a student? Yes (1st year) RSC member?: No

Plastics have become a global concern due to their persistence and potential for harm to wild life. Plastic particles can enter the aquatic environment in a wide range of sizes; if particles measure less than 5 mm (in all dimensions) they are defined as microplastics. The disposing of domestic and industrial wastewater in water bodies is not only a source of microplastic but also of nutrients in freshwater. An increased of influx nutrients can lead to eutrophication which, in turn, can lead to the mass occurrence of harmful cyanobacteria (blue-green algae), called blooms. Cyanobacteria can produce a diverse range of toxins. Microcystins (MC) are the most frequently reported cyanobacterial toxins in the environment. The microcystin family shares a common peptide structure containing multiple non-standard amino acids and two variable amino acid moieties. The adsorption of two microcystin congeners (MC-LR, most commonly reported and MC-LF, most hydrophobic) onto microplastics was elucidated. To this end, four polymers (polyethylene terephthalate, low density polyethylene, polyvinyl chloride, polystyrene) in three microplastic sizes were selected due to their world-wide use and reported freshwater occurrence. Further, the effect of the pH of the matrix was considered. It was found that the following factors affected adsorption: hydrophobicity of the microcystins > particle size > polymer type > pH. The smallest particles showed the most adsorption of microcystins-LF under pH 7 onto polyethylene terephthalate (PET), up to 63%. Meanwhile, the largest sizes did not display apparent interaction with either congeners analysed. The preference of adsorption of MC-LF was as follows: polyethylene terephthalate > polyvinyl chloride > low density polyethylene > polystyrene.

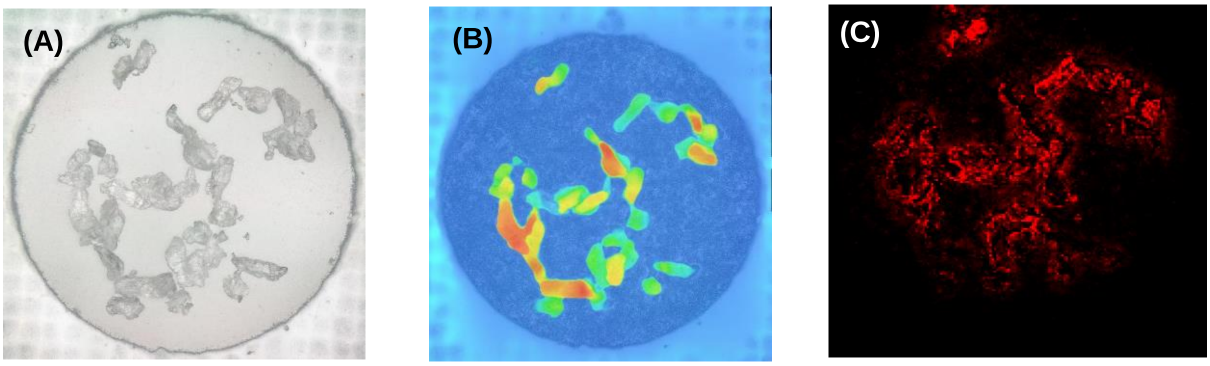

Figure 1: Results demonstrating the adsorption of Microcystin-LF onto PET particles at pH 2. (A) Optical image of the particles of PET size of 0.09-0.125 mm before matrix application (B) Topographic image showing height variations of the PET particles represented by the colours light blue, green, yellow and red, from 44 to 155 µm, respectively (C) High-resolution MALDI MSI: the red shading represents presence of MC-LF on the PET particles determined by detection of all three MC-LF adducts (H,Na,K).

While microcystin-LR is often used to represent the behaviour of all microcystin, it has distinctly different chemical properties from others microcystins, especially when their hydrophobicity is concerned. The current investigation highlighted the potential of microplastic particles to act as vectors for cyanobacterial toxins, the problems arising from using microcystin-LR as a stand in for all 247 microcystin congeners described to date, and the chemical properties of the microplastic particles play a major role in the adsorption behaviour of micropollutants.