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Microplastic Fibres in Sewage Sludge Compost: A Noteworthy Source of Microplastics to the Terrestrial Environment

Introduction

Wastewater treatment plants (WWTPs) have been found to be a significant route through which microplastics can enter the environment. In earlier studies, wastewater treatment processes have been shown to effectively remove microplastics from the wastewater influent into sewage sludge, with only ≤ 2% (when using secondary and tertiary processes) of the microplastics being released to aquatic environment via effluent water. However, the application of processed sewage sludge, such as composted sewage sludge, as fertilizers to the soil acts as a direct source of microplastics to the terrestrial environment. The objectives of this study were 1) to develop sample preparation methods for isolating microplastic fibres from sewage sludge compost samples, and 2) to investigate the number concentration of microplastic fibres in a sewage sludge compost used to make commercial garden soil.

Fig. 1 Average microplastic fibre numbers in the three 1.0 g composted sewage sludge samples.

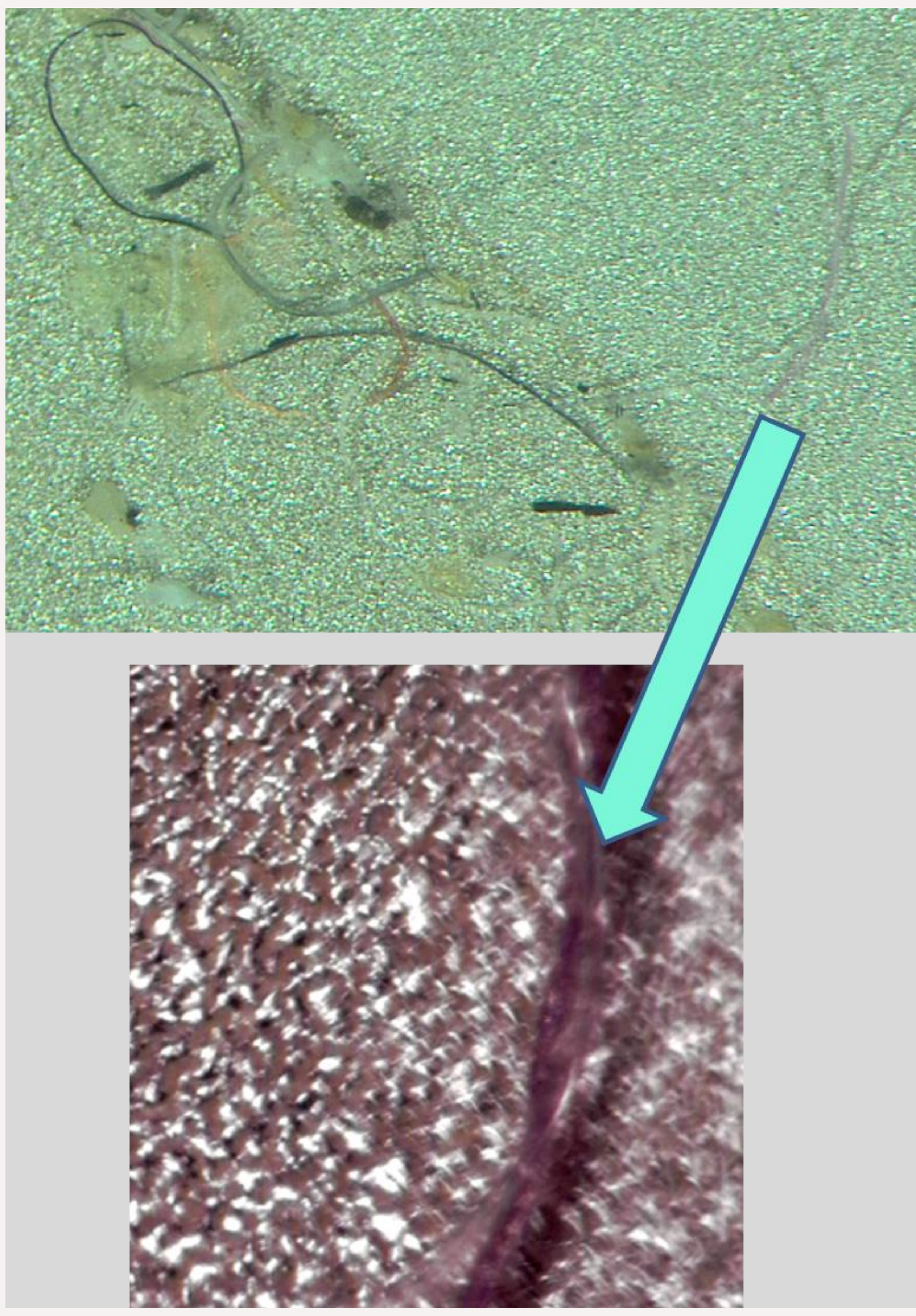

Fig. 2 Fibres on the silver membrane filter, as seen through the stereomicroscope (upper image) and FTIR-microscope (lower image)

Methods

- Three 1.0 g replicate samples of freeze-dried sewage sludge compost
  - Sewage sludge from two major WWTPs in Finland
  - The sludge is mixed with peat (1:1 ratio) prior to composting
  - After composting, the compost is mixed with peat, sand and biotite to make commercial garden soil product
- Multistep sample pretreatment process including:
  - Sieving (1 and 0.5 mm mesh sizes)
  - Organic matter removal (30% hydrogen peroxide and Fenton's reagent)
  - Density separation (NaI, 1.8 g/cm^3)
  - Filtration onto stainless steel filters (47 mm diameter, 20 µm mesh size) between sample preparation steps
- For analysis, the final filtration was done onto two silver membrane filters (25 mm diameter, 5.0 µm pore size)
- Observation of all the fibres on the whole filter area with a stereomicroscope (Olympus SZ61)
- Identification with a Fourier Transformation Infrared microscope (FTIR; Spotlight 200i, Perkin Elmer) in reflectance mode, based on visual and statistical comparison to the library spectra (score >0.70 for all, except for acrylic and polyamide fibres >0.80)
- Three laboratory blanks to assess the sample contamination
- To roughly evaluate the recovery rate, one compost sample spiked with polyester fibres (400-1000 µm long) was analysed

Results

- The number concentrations of microplastic fibres were over 260 fibres per 1 g of sewage sludge compost, in all the replicate samples
- The majority of the analysed fibres were microplastic fibres
- The most common synthetic fibre in the sewage sludge compost was polyester, followed by acrylic fibres
- No polyamide fibres and only 7 to 14 cellulose fibres were found in the compost samples
- The recovery rate for polyester fibres was 65%
- On average, there were 2-3 microplastic fibres in the blank samples
  - This suggests low contamination levels from the laboratory environment

Conclusions and Future Research

- The results indicate a substantial release of microplastic fibres from WWTPs to the environment
  - Over 260 000 microplastic fibres per kg of sewage sludge compost
- Assuming that the compost composes at least 40% of the final garden soil product, the number of microplastic fibres is over 100 000 per kg in the garden soil product
- The lack of polyamide fibres is surprising
  - Recovery tests should be done for polyamide fibres to see if the sample preparation destroys polyamide fibres
  - Also, the composting process should be considered as a factor for the lack of polyamide fibres => samples at the beginning of the composting process should be analysed in the future for comparison

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