Separation and quantitation of microplastics in green waste compost

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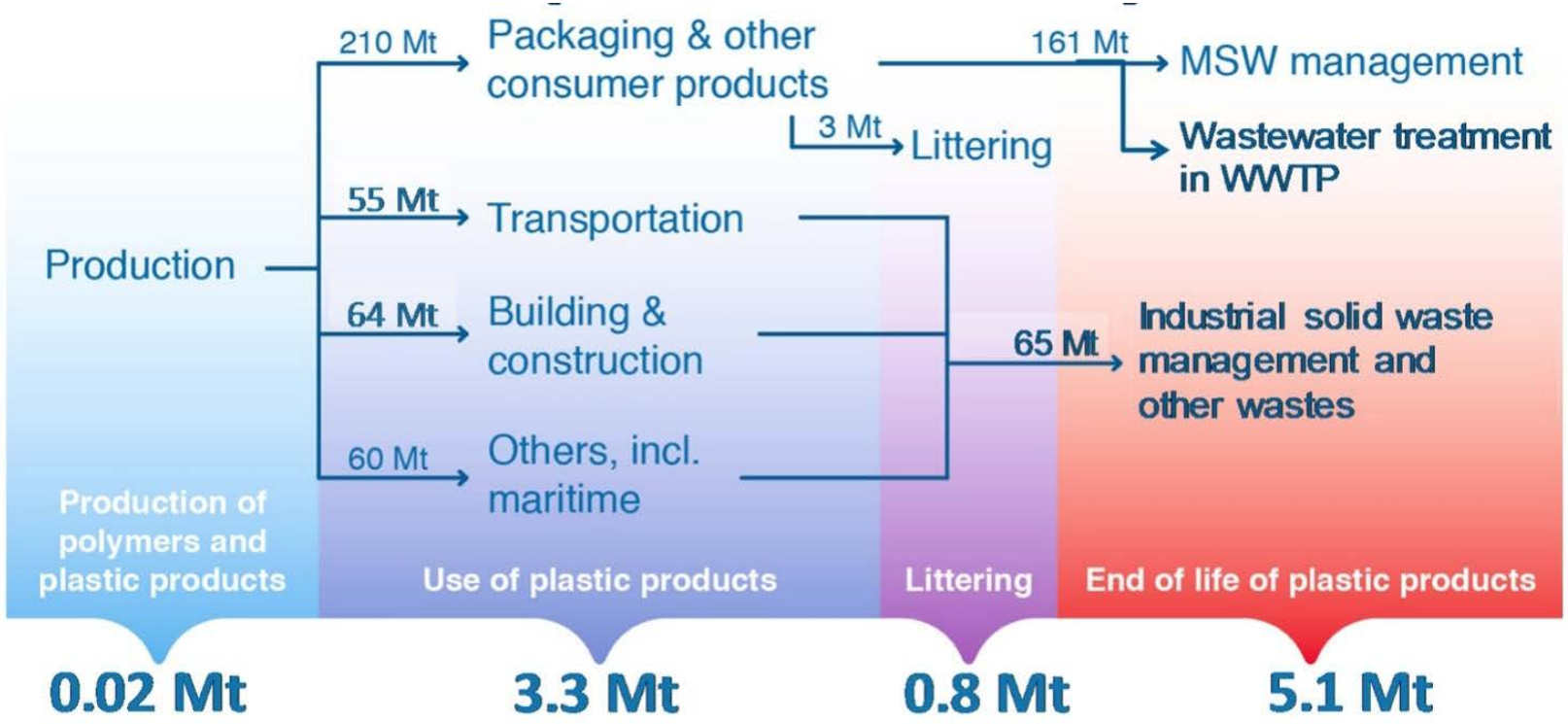
Introduction

- 368 million tones of plastics were produced globally in 2019
- 57.9 million tones of plastics were produced in Europe in 2019
- 9.2 Mt of plastic is lost to the environment on different stages of life cycle, 3 Mt is **microplastic**



pic. 1. Global plastic life cycle

Sources: Ryberg, M. W., Hauschild, M. Z., Wang, F., Averous-Monnery, S., & Laurent, A. (2019). *Global environmental losses of plastics across their value chains. Resources, Conservation and Recycling, 151, 104459.*

Microplastics and their sources

- Microplastics are synthetic organic polymer particles with a size 1 µm - 5mm
- Primary microplastics are particles that are already 5.0 mm in size or less before entering the environment
- Secondary microplastics are formed from breakdown of larger plastic material

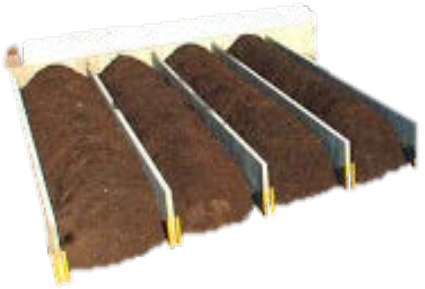
Primary sources

Secondary sources

Green compost as a source of microplastics

- Braun et al. (2020) found microplastic (1-5 mm) concentration 12 ± 8 to 46 ± 8 particles kg^{-1}; use of such green composts as a fertiliser resulted in application to the land from 0.34 to 47.53 kg plastic ha^{-1} a^{-1}.
- Weithmann et al. (2018) found 20-24 microplastic (1-5 mm) particles kg^{-1} in green compost samples

Green waste
+ disposal bags
+ accidentally trapped plastic waste



Composting

Screening

Ready compost
+ small impurities,
including microplastics

Oversize fraction,
including plastics

Aim and sampling point

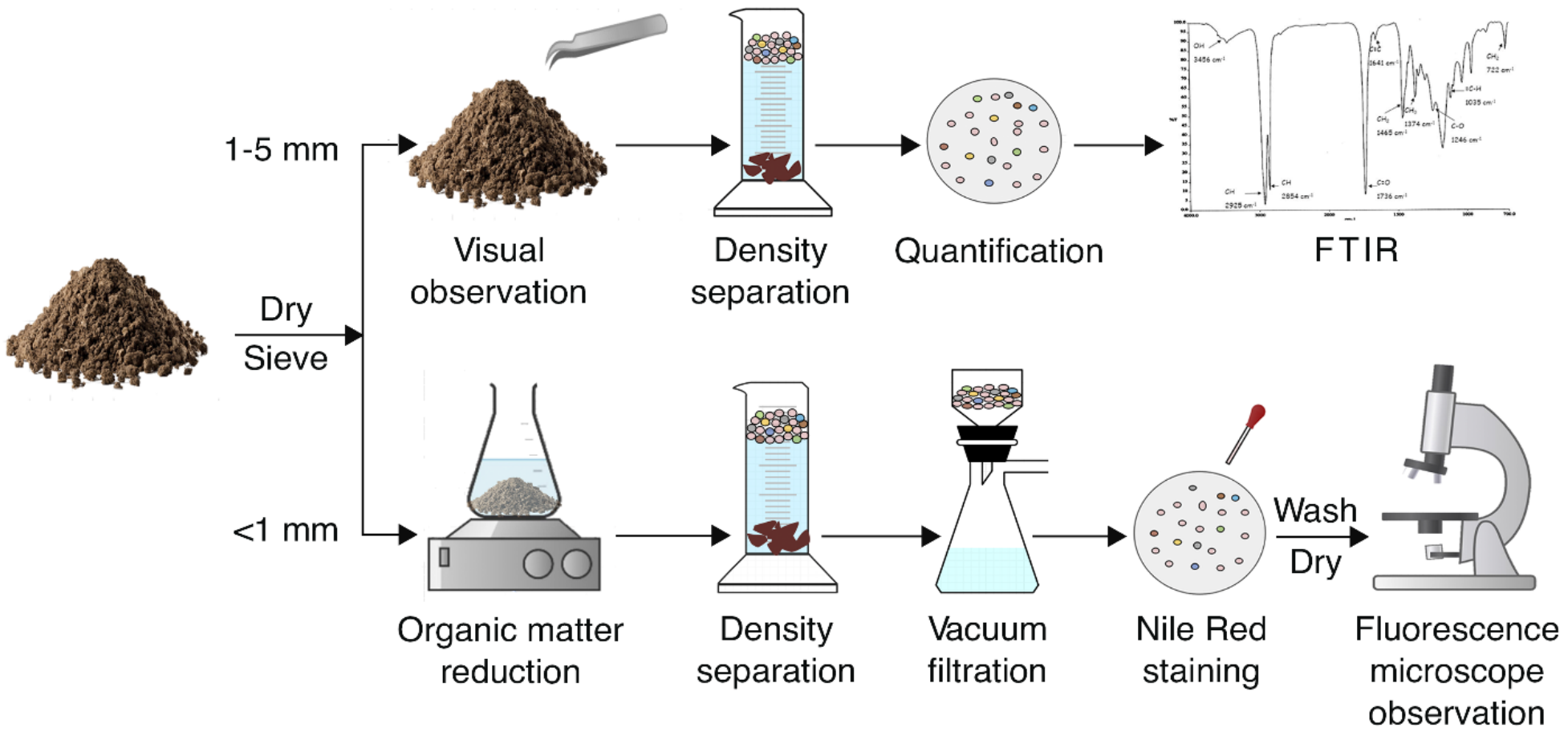
The aim was to develop a general algorithm for both large and small microplastics quantification in green compost samples and determine the microplastics abundance in real samples.

Sampling point – Alytus regional waste management centre;

Sampling fraction – certified green compost < 1 mm;

Sampling time – October 2020 and February 2021

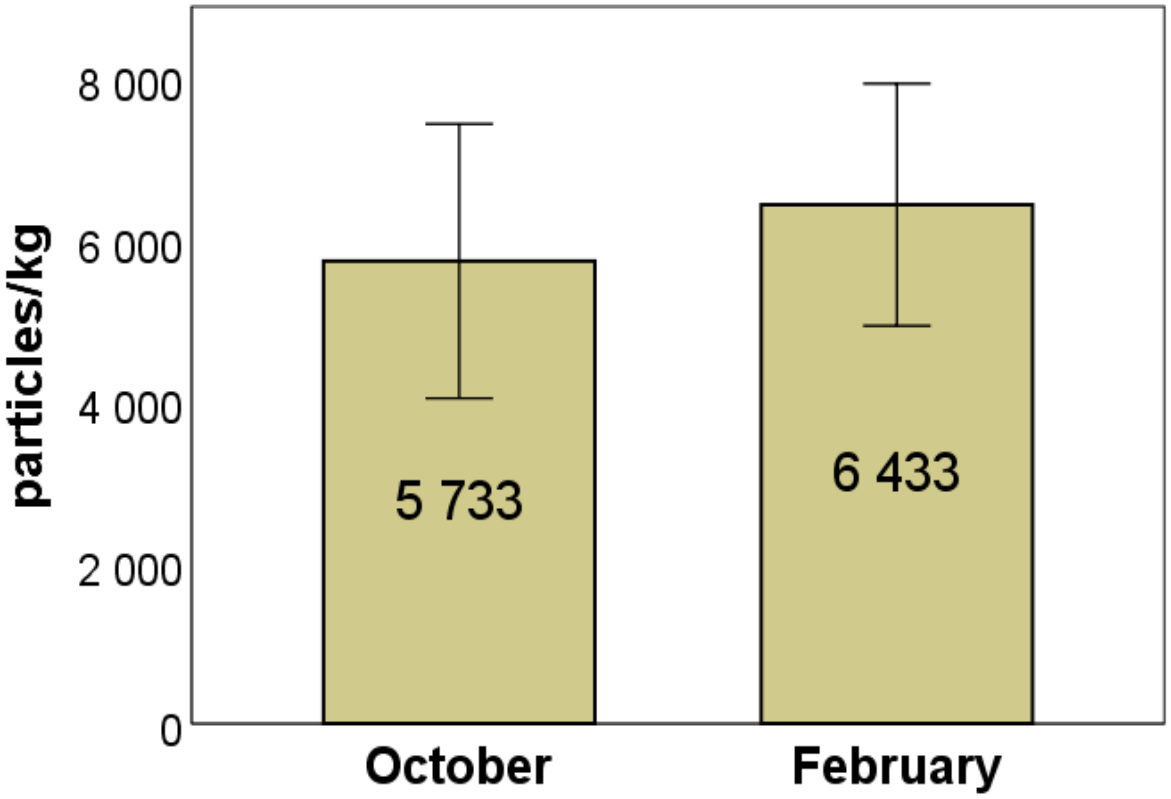
Methodology



pic. 2. Algorithm for microplastics extraction and identification

Results (1) Microplastics amount

- Green compost samples contained 5733 ± 850 particles kg^{-1} in October samples and 6433 ± 751 particles kg^{-1} in February.
- The average for two seasons mass concentration of large microplastics (1-5 mm) in green compost was 0.237 g kg^{-1}

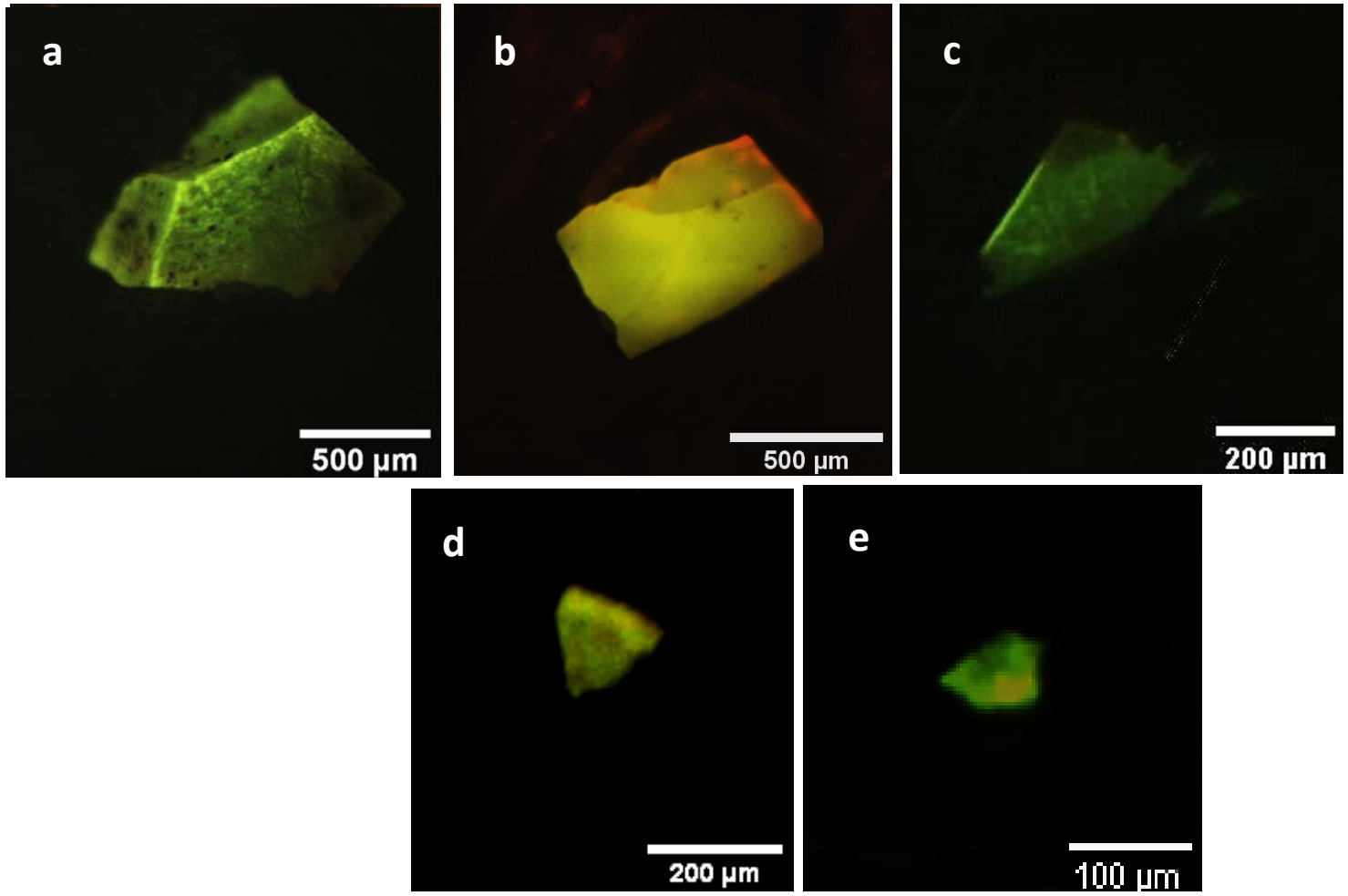


pic. 3. Abundance of microplastics (mean±SD)

Results (2) Size fractions of microplastics

Main microplastic size classes:

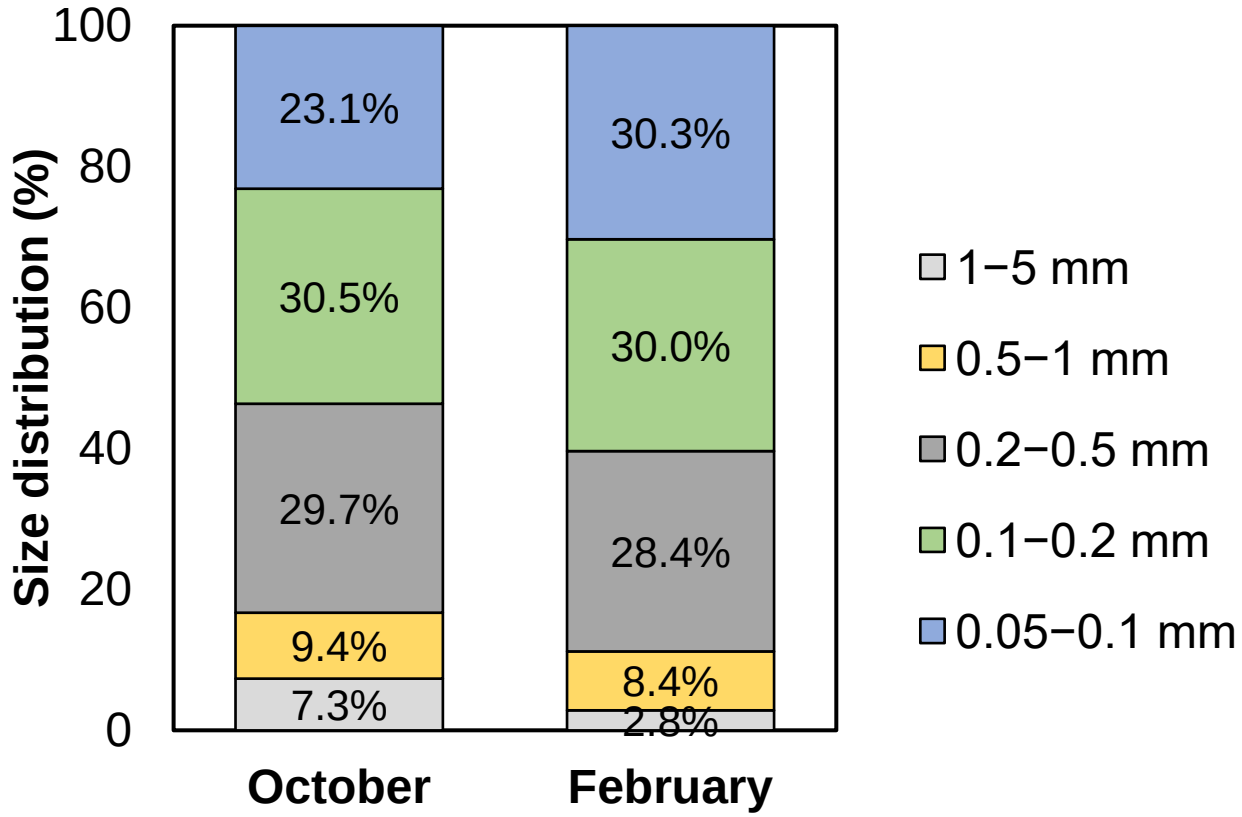
- 1−5 mm;
- 0.5−1 mm;
- 0.2−0.5 mm;
- 0.1−0.2 mm;
- 0.05−0.1 mm.



pic. 4. Microplastics of different size classes : a) 1 − 5mm; b) 0.5−1 mm; c) 0.2−0.5 mm; d) 0.1−0.2 mm; e) 0.05−0.1 mm.

Results (3) Size distribution of microplastics

Most microplastics (about one third) were 0.1–0.2 mm in size in October samples and 0.05–0.1 mm in February samples. Microplastics less than 0.5 mm account for 83.3–88.7% of green compost microplastics.

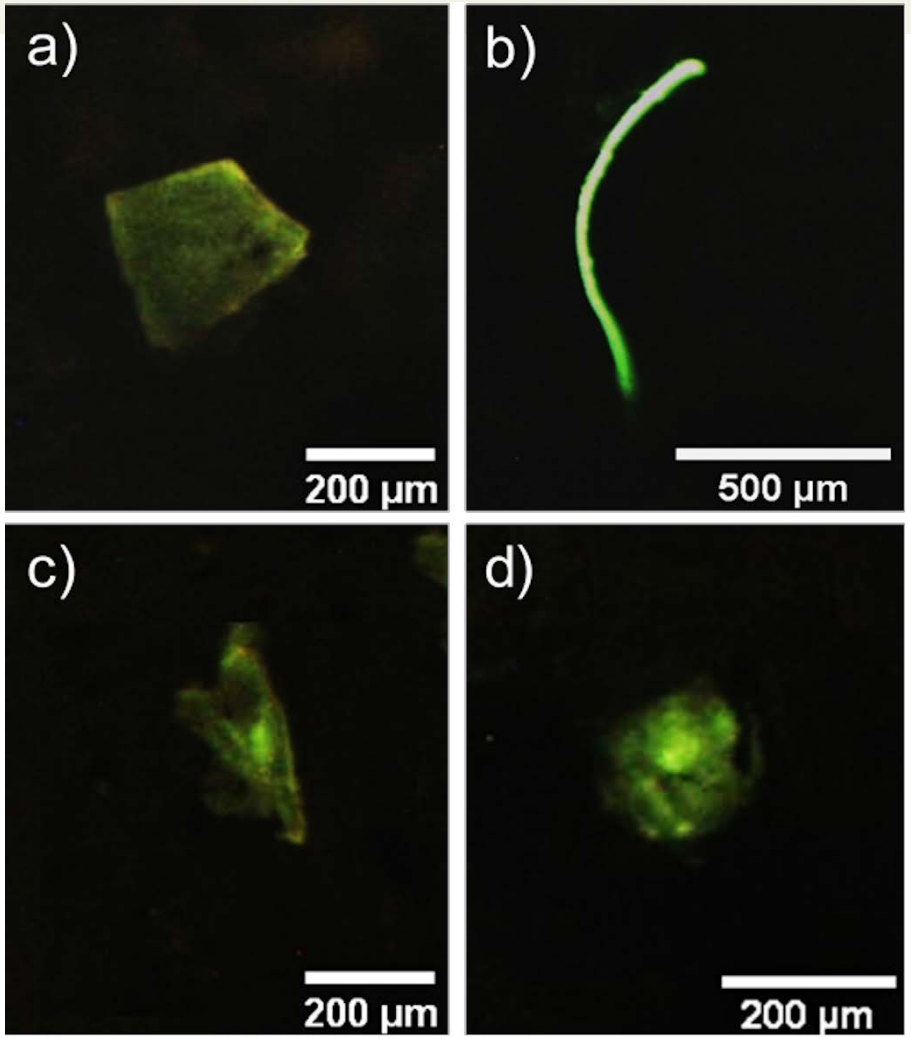


pic. 5. Size distribution of microplastics

Results (4) Microplastics morphology

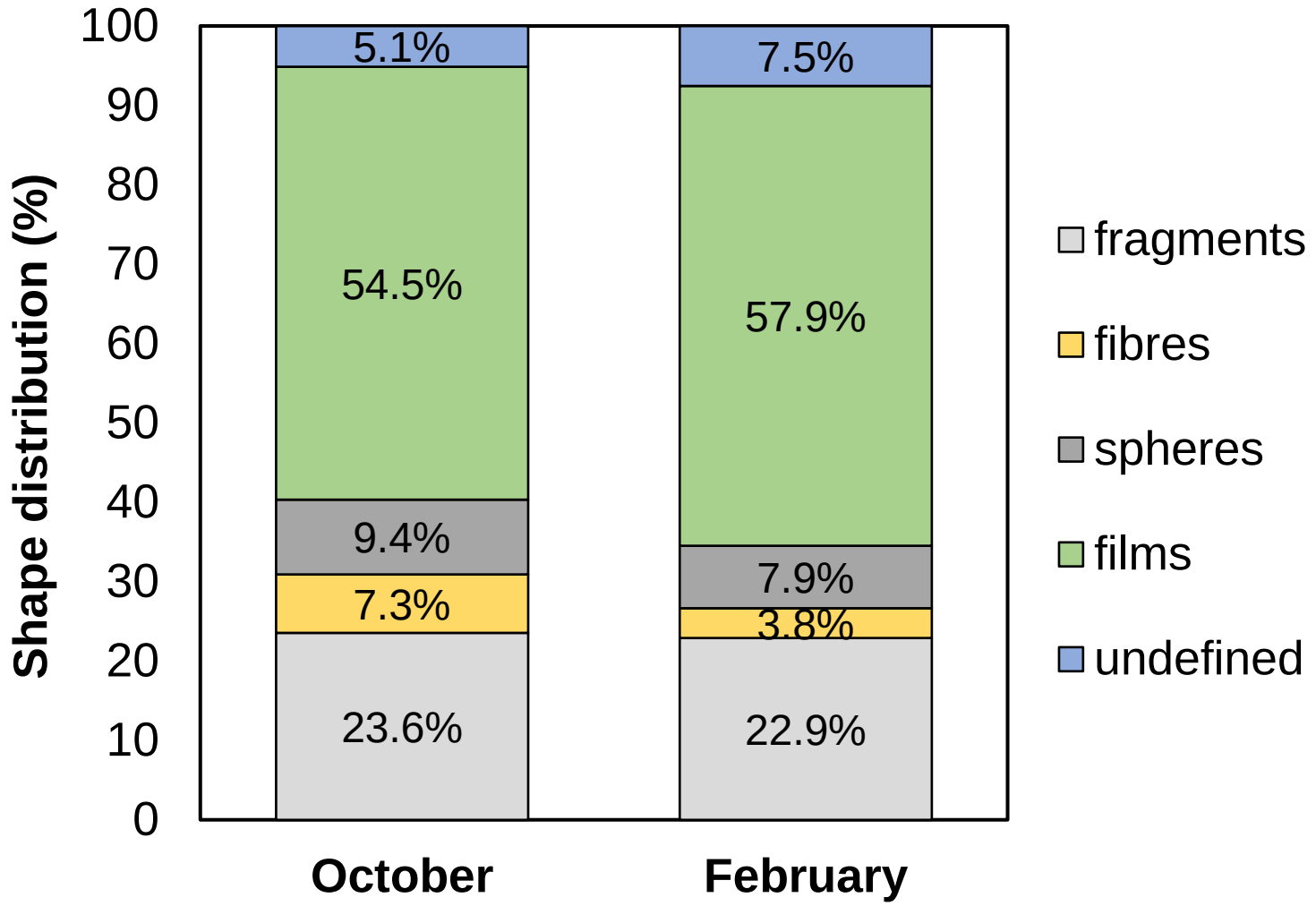
Common shapes of microplastics particles:

- Fragments (a);
- Fibers (b);
- Films (c);
- Spheres (d).



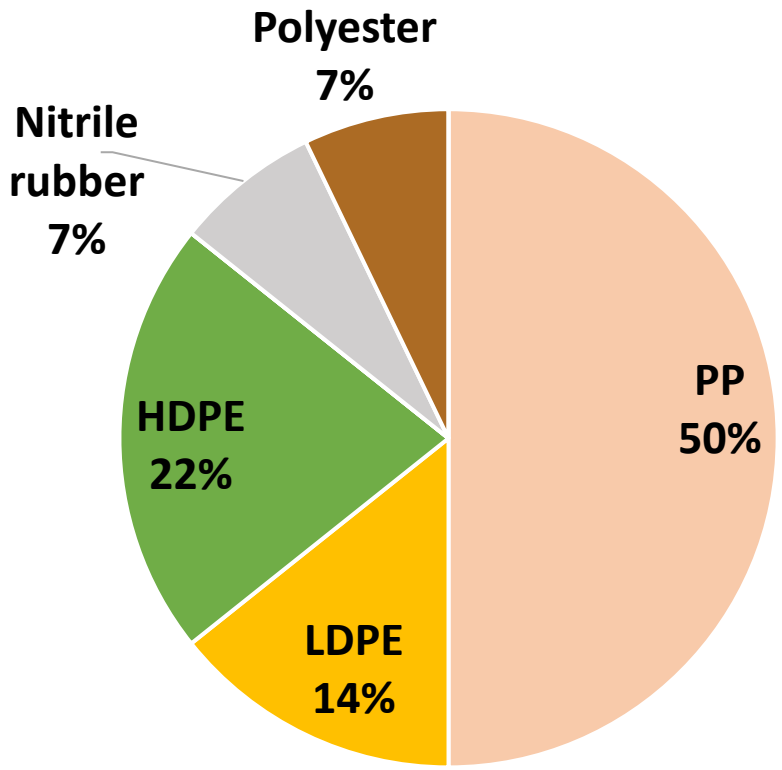
pic. 6. Microplastic shapes: a)fragments; b)fibers; c)films; d)spheres.

Results (4) Microplastics morphology



pic. 7. Shape distribution of microplastics

Results (5) FTIR analysis



pic. 8. Percentages of different polymer types

- PP is used for food packaging, sweet and snack wrappers, hinged caps and pipes;
- LDPE is a popular material for bags, film, trays, containers and food packaging production;
- HDPE is used for toys, bottles, pipes and houseware production;
- Nitrile rubber is a synthetic rubber polymer, which is often used for glove production;
- Polyester is widely used for synthetic textile production.

Conclusions

- Green compost is a significant source of microplastics and it application to the land contributes to microplastics release into the environment
- Green compost from Alytus MBT contained 5733 ± 850 particles kg^{-1} dry weight in October 2020 and 6433 ± 751 particles kg^{-1} in February 2021.
- The majority of microplastics were classified as films.
- The FTIR spectroscopic results showed that PP was the dominant polymer type in green compost.
- Considering FTIR and morphological analysis results, the main microplastic sources in compost samples were plastic bags and food packaging.

Thank you for your attention!

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