Separation and quantitation of microplastics in green waste compost

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• 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

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
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.
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
• 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)
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 – 5 mm; b) 0.5–1 mm; c) 0.2–0.5 mm; d) 0.1–0.2 mm; e) 0.05–0.1 mm.
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.
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

- 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.

Pic. 8. Percentages of different polymer types
Conclusions

• Green compost is a significant source of microplastics and its application to the land contributes to microplastics release into the environment.
• Green compost from Alytus MBT contained $5733 \pm 850$ particles kg$^{-1}$ dry weight in October 2020 and $6433 \pm 751$ 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!