SETAC Europe 29th Annual Meeting in Helsinki

Poster# MO285

Mechanical stress causes microplastic release from PET mineral water bottles

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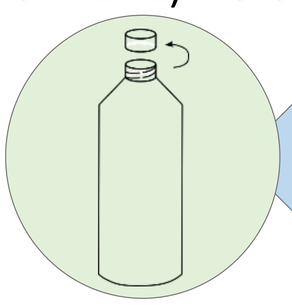
Introduction and objectives

- Sources of human microplastic (MP) intake need to be investigated in order to assess quantities and risks related to MP properties.
- Our objective was to evaluate single-use plastic bottles as one of proven sources of MP intake by humans, especially considering the effect of daily use such as the abrasion of the plastic material.

Study question | **Do plastic bottles release wear particles and fragments from breakage upon exposure to mechanical stress, and if so, in which quantities and sizes?**

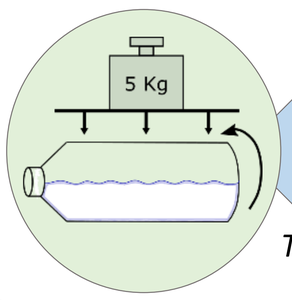
Material and methods

Single-use water bottles from 3 different brands (differing in net-weight) were purchased. The bottles (all made of PET with screw caps made of HDPE) were exposed to following treatments:



Openings/closings:
1 x; 10 x; 100 x

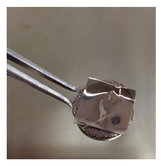
To analyse PET bottleneck and HDPE cap of 9 bottles



Squeezing:
none; 1 min, 10 min

To analyse PET inner wall and filtered water of 18 bottles

Filtering water on membrane



Sample preparation (gold coating)

Removing bottle material (caps, bottleneck, inner wall)

SEM
(scanning electron microscopy)
Morphological analysis
> 1 µm particle size

To inspect plastic surface on bottles for signs of stress (abrasion, loose particles, cracks) and to count and measure particles of filtered water

EDX
(energy-dispersive X-ray spectroscopy)
Elemental analysis
> 3 µm particle size

To identify detected particles on plastic surface and membrane of filtered water as PET or HDPE material

Results and discussion

Bottlenecks and caps

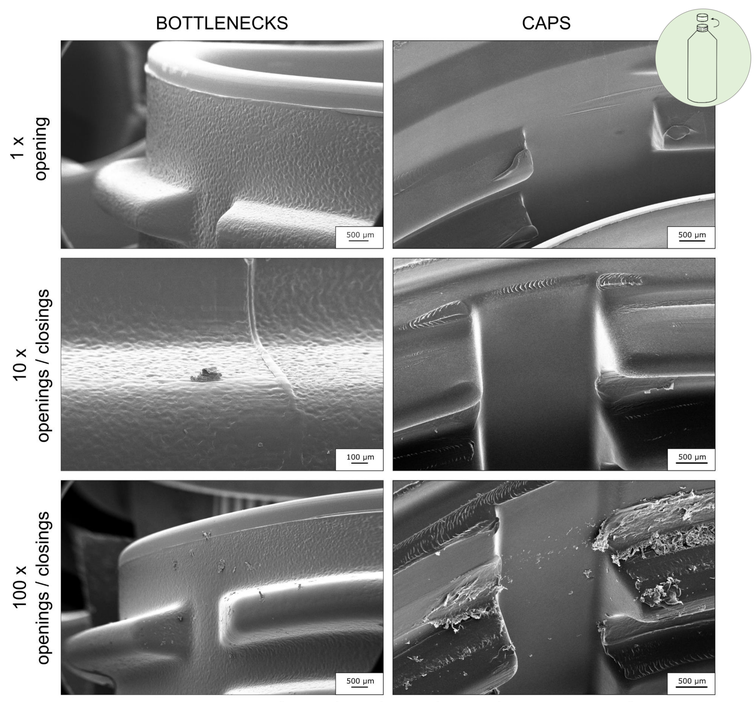


Fig. 1. SEM images of PET bottlenecks and HDPE caps from bottles after exposure to mechanical stress

- Strong effect of mechanical stress (release of MP particles) on caps (Fig. 1). The effect was impressive after 100 times opening/closing. Bottlenecks were less affected then caps.
- EDX analysis confirmed plastic origin of loose particles on cap and bottleneck. Their size ranged from 0.5-1 µm (25 %), 1-5 µm (64 %), 5-40 µm (11 %), with Brand 2 having the most particles: **2.150 particles/mm²** inner surface of cap (after opened 100 x) .

Mineral water

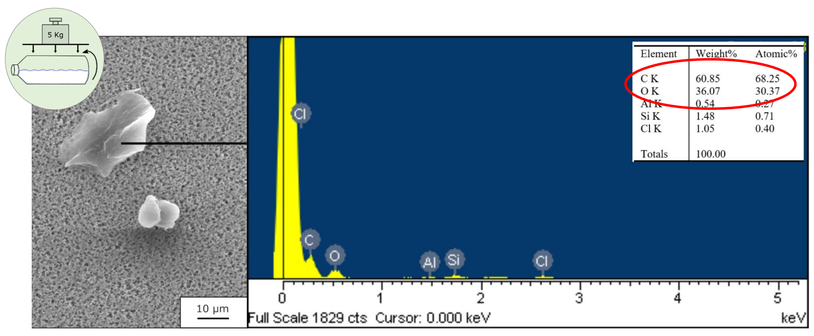


Fig. 2. SEM image and respective EDX spectrum with elemental quantitative data of analysed particle from filtered water showing PET particle with specific elemental composition of C:O = 73:27 ± 5% and traces of other elements.

- Particle concentration* did not significantly increase after exposure to mechanical stress.
- EDX performed on 58 particles on filtered water (9 bottles, each 250 ml) revealed 2 PET particles, 3 µm and 24 µm in size (Fig. 2).

* It is worth noting that observed particles in filtered water were not only of polymeric origin, therefore the results indicate solely if the application of mechanical stress had the presumed effect of particle release from bottle material into the water.

Bottle inner wall

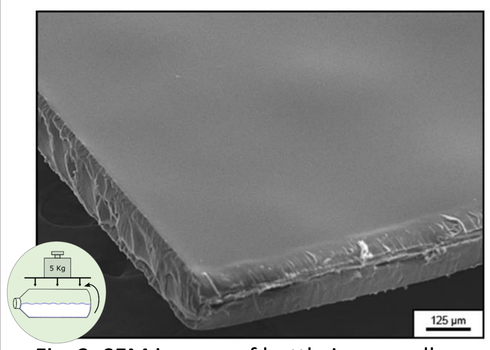


Fig. 3. SEM images of bottle inner wall samples after exposure to mechanical stress (no treatment, 1 min and 10 min squeezing/crushing).

- No stress cracks on the inner wall surface after the treatments (Fig. 3) → the bottles itself are not a consistent source of MP particles in water.

Take home message

- This study showed the release of numerous plastic particles with extended mechanical stress on PET bottlenecks and HDPE caps, whereas the effect was more pronounced for caps, revealing them as the weakest link in the system.
- PET material of tested bottles were resistant towards mechanical stress (squeezing/crushing) and did not release particles into the mineral water. Out of the particles found in water, few could be identified as PET.

→ **Yes, plastic bottles released MP particles upon exposure to mechanical stress. Chances of MP ingestion by humans increase with frequent use of the same single-use plastic bottle, though only from the bottleneck-cap system.**

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