The impact of plastic particles on intestinal cells: a realistic approach

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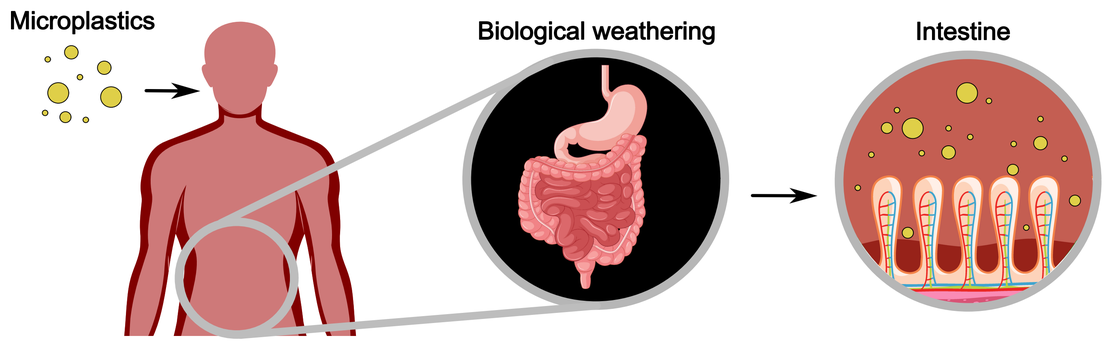
Background

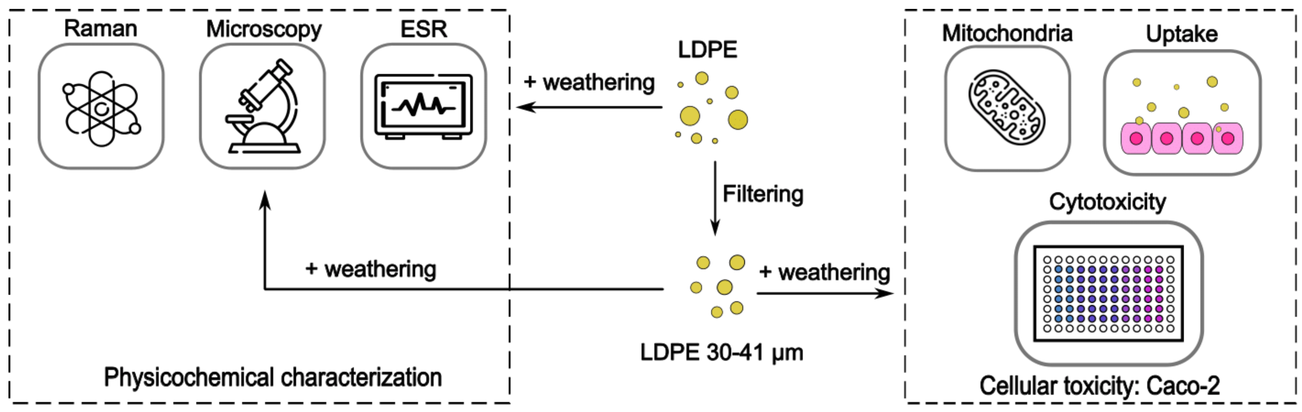
- Plastic waste in the environment can be degraded into secondary micro- and nanoplastics (MNPs).
- MNPs have different sizes, shapes, composition, ...
- Humans can take up MNPs via ingestion.
- Their effects in human tissues will depend on their characteristics.



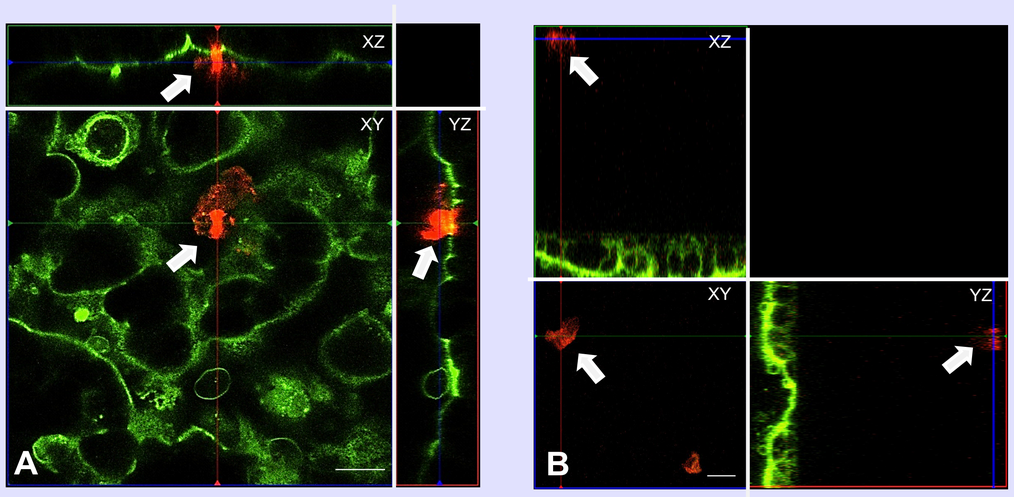
AIM: Assess the impact of MNPs with realistic properties in models of the digestive tract, taking into account the weathering effect of the stomach acid.

Materials and methods

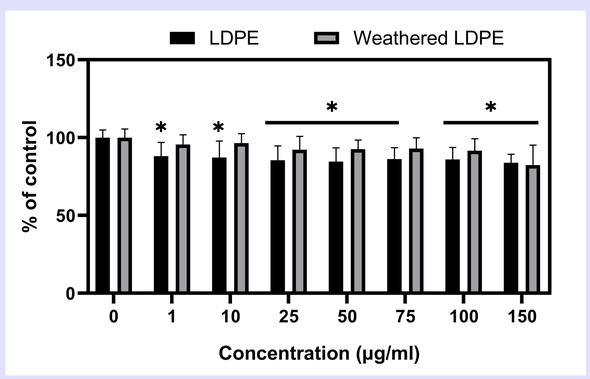
- Low density polyethylene (LDPE) was selected as environmentally relevant secondary microplastic.
- Physicochemical characterization: LDPE stock and fraction.
- Cellular toxicity: LDPE fraction.
- Experiments with pristine and weathered material.



Results



Confocal microscopy showed that there was no uptake of LDPE particles by intestinal cells. The particles were in contact with the cell membrane (A) or were floating in the cell culture medium (B).



LDPE and weathered LDPE had a negative effect on the cell viability even without uptake. They affected the cells by interfering with the cell membrane and/or by changing the composition of the cell culture medium.
* $p < 0.05$

Assay/test	LDPE 30-41 µm	LDPE-ASA 30-41 µm
ESR (ROS radicals)	↑	↑↑
Raman microscopy (-O-, CH3, CH2, C-H bonds)	Control	↑
Raman microscopy (O-H and C=O bonds)	Control	↓
Size (major axis)	56,707 ± 0,246	61,045 ± 1,389
Size (minor axis)	32,864 ± 0,626	32,044 ± 1,075
Cytotoxicity (5, CFDA-AM)	↑↑	↑
Uptake	-	-
Flotability	0%	25%
Mitochondrial footprint	↑	↑
Mitochondrial branch length	↑	↑
Mitochondrial network	-	↑

Summary of the results of LDPE and LDPE weathered in artificial stomach acid (LDPE-ASA). Both particle types released ROS radicals and interfered with cell viability and intracellular homeostasis of mitochondria. The degree and nature of the effects were particle-specific

Conclusion

This study shows that particles induce stress in gut cells, even without uptake. The main effects were a decrease in cell viability and reorganization of the mitochondrial network. Weathered and pristine MNPs induced different toxicity responses, indicating the need to include physicochemical characterisation for risk assessment.

What is next?

Screen a wider array of environmentally relevant plastics to find new biomarkers and improve risk assessment of plastic waste and their effects on human health.

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