Toxicological Profiles of Polyethylene Terephthalate (PET) and Its Additives:

A Systematic Review Across Ecosystems and Human Health

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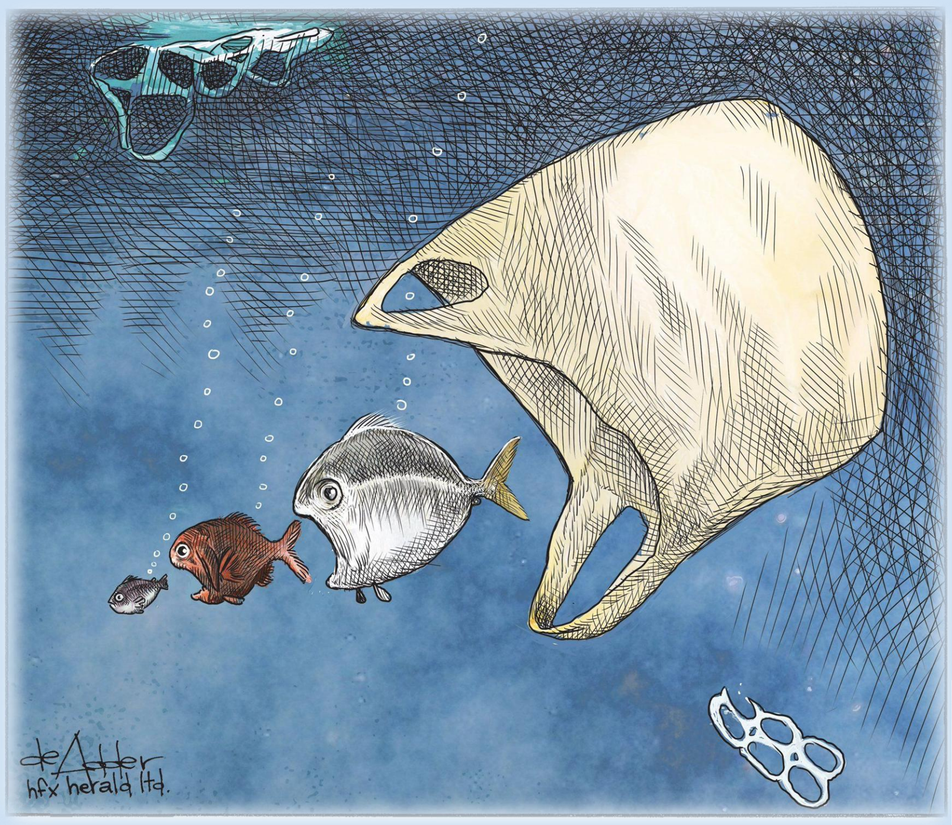
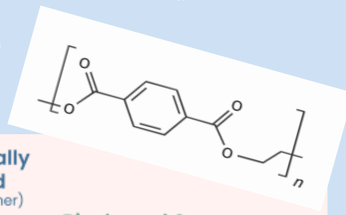
Introduction

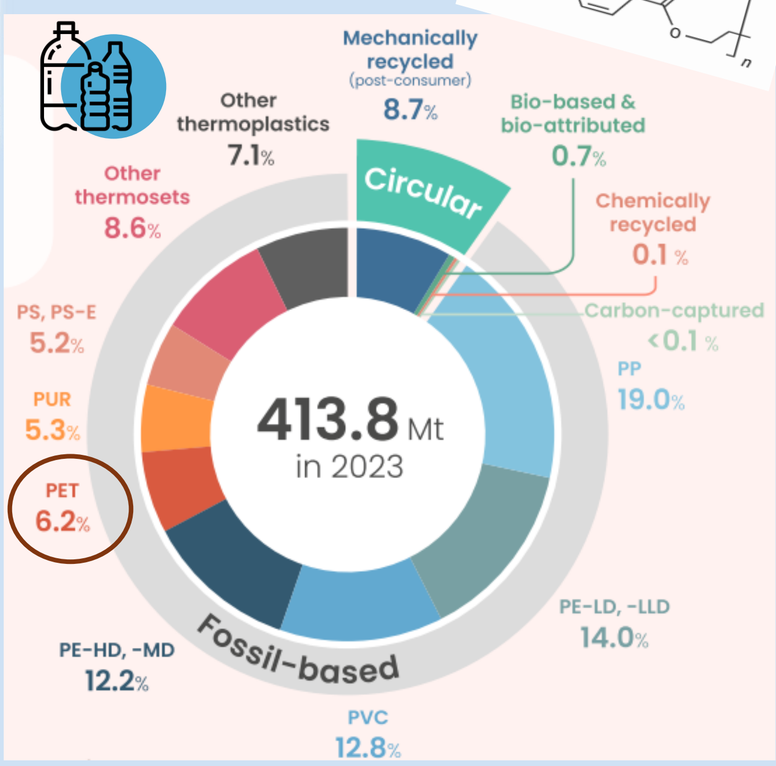
Although PET micro- and nanoplastics (MNPs) have been detected in various human and animal biological samples we still have no enough data about their toxicity. In addition to PET itself, many additives which are added during the plastics manufacturing process can be potentially toxic and hazardous as well.



Materials and methods

We made a systematic overview of published scientific data about toxicity of PET type of plastic and its additives. From the collected data, a toxicological database was created to evaluate the possible adverse effects on aquatic and terrestrial ecosystems and on human health.





Global plastic production (2023)
PlasticEurope 2024

Questions

- How safe is PET, as one of the most widely used plastic types?
- What is the effect on ecosystems and human health if it is a MNP?
- What are the short- and long-term results of toxicological tests of PET particles and their additives?
- Can we identify knowledge gaps in connection with (eco)toxicity of PET MNPs and/or its additives?

Results and discussion

The global production of PET type of plastics, such as packaging materials, was 25.66 Mt in 2023. PET as macroplastic released into the environment can cause (eco)toxicological effects because of its structural features and additive content.

Albeit many studies declare PET as the least toxic plastic type, various experiments using animal models have confirmed that virgin PET fibres have several size-related adverse effects, such as oxidative stress, neurotoxicity, reproductive toxicity, and endocrine or energy metabolism disruption. According to these studies, the acute toxic effect causing sizes were 100 μm in zebrafish (*Danio rerio*), 100<x<500 μm in sea urchin (*Paracentrotus lividus*), 2 μm in fruit fly (*Drosophila melanogaster)* and 200 nm in Kunming mice.

The number of long-term research is lacking, as also the role of additives remains a blind spot in these scenarios. Separetaly examined PET additives, such as BHT's median lethal dose (LD_{50}) is 2000 mg/kg in mouse and the median lethal concentraton (LC_{50}) in zebrafish embryos was 4.388 mg/L. The LC_{50} was found to be 164mg/L for another non-biobased PET additive, TiO_2-NPs, in Mozambique tilapia (*Oreochromis mossambicus)*.

Future studies need to focus on chronic exposure to mixed additives and PET particles together to better model real-life scenarios.

Most **frequently studied** plastic additives:
- Bisphenol A,
- Phthalates (e.g. DEHP, DBP),
- Flame retardants (e.g. PBDE),

Most frequently used **PET additives e.g.**:
- Irganox 1010,
- **BHT (2,6 di-tert-butyl-p-cresol),**
- formaldehyde,
- Pb,
- **TiO_2 (rutile)**,
- ZnO

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Aknowledgements

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