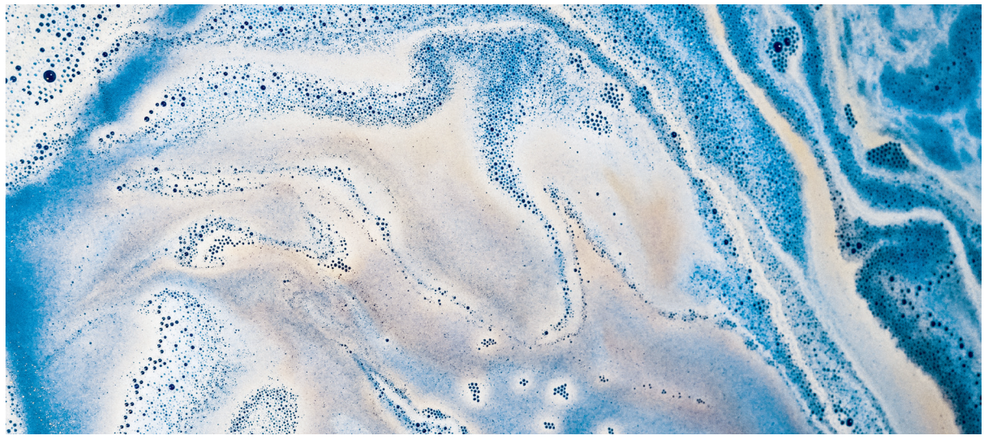
Microplastics

Occurrence, toxicity, analytical methods



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A. What are microplastics?

No uniform definition for microplastics is currently provided by the available literature. The term microplastics covers a mixture of small plastic particles and fibres of varying size, origin, and chemical composition. Hence microplastics are understood to be a mixture of various synthetic plastics. These minute plastic particles fluctuate in size between one micrometer and up to less than five millimetres.

B. How do microplastics occur?

A basic distinction is made between primary and secondary microplastics.

Primary microplastics arise from basic pellets and granulates industrially produced on a scale used to make both various plastic products as well as cosmetic products.

Secondary microplastics arise from larger plastic parts as a result of chemo-physical and biological degradation and weathering processes. Wave movement and UV radiation cause plastic products such as plastic bags and plastic bottles to disintegrate into minute plastic particles. Secondary microplastics, so to speak the decomposition products of macroplastics, are the main source, according to current knowledge.

For a long time microplastics were regarded as little more than a global environmental issue due to the fact that plastic waste gathers in the world's oceans and represents a hazard for marine organisms. However, the plastic particles get mistaken for nutriments and are taken up by zooplankton. This in turn is consumed by fish and accumulates along the marine food chain.

C. Where do microplastics come from?

The worldwide production of plastics is increasing exponentially, leading to the release of ever more plastics into the environment. Secondary microplastics have many and varied pollutant sources. A huge number of products are packed in plastic and the plastic packaging, bottles, and disposable plastic articles are subsequently thoughtlessly dumped into the environment (littering). In addition to this, many articles of clothing are manufactured using synthetic plastics, e.g. polyester, polyethylene, or polyacrylic. Microplastics are released from plastic-based textiles during the washing process and hence pass into the waste water system. The abrasion of tyres is also a source of secondary microplastics. Since the plastic polymers are only degraded very slowly, they accumulate in marine and terrestrial ecosystems. They are distributed around the world's oceans where several so-called plastic islands have already formed.

Moreover, plastic particles are deliberately manufactured and designed for use in cosmetic products such as shower gels, peeling products, toothpastes, and cleaning agents, due to their mechanical cleaning effect. These primary microplastics are passed into the sewage system. Since microplastics cannot be fully removed in wastewater treatment plants, the plastic particles pass into the water cycle system. These tiny plastic particles are largely non-degradable and hence persistent.

D. How do microplastics get into foods?

Microplastics find various routes of entry into the environment and, due to the fact that microplastics accumulate in marine organisms, they can enter the human food chain via the oceans, sweet waters and ground water, and via the air.

Germany's Federal Institute for Risk Assessment (BfR) currently has no solid data to confirm the occurrence of microplastics in foods. Microplastics can indeed partially be taken up in foods, particularly through the consumption of fish and seafood. However, since most scientific examinations are focused on the gastrointestinal tract of animals, which goes uneaten, no exact conclusions can be drawn on the contamination of consumed foods.

Several reports on the occurrence of microplastics in honey, beer, and mineral water were published in the past. However, these did not examine the chemical composition of the particles in greater detail. The results of recent research show that, in addition to entry via marine organisms, a direct intake of microplastics via the human nutrition also needs to be examined and analysed. Hence we call for the research and examination of other plastic-packed foods.

E. Do microplastics pose a health risk?

In a recent risk assessment published in 2016, the European Food Safety Authority (EFSA) comes to the conclusion that compared to processing aids used and adherent contaminants the direct health risk of microplastics is to be deemed low. For microplastics averagely contain 4% in technical additives, such as softeners and flame retardants as well as other undesirable substances, due to the fact that the plastic particles absorb various other constituents. Several types of contaminants, especially nonpolar substances such as heavy metals and POPs (persistent organic pollutants), can accumulate and pass over into living organisms. POPs such as dioxins and PCBs accumulate along the food chain and are highly toxic for humans.

The data available on the chemical composition, particle size, and concentration of microplastic particles in foodstuff is currently insufficient to enable a toxicological risk assessment. According to the Federal Institute for Risk Assessment (BfR), a health risk caused by microparticles stemming from cosmetic products is unlikely since, due to the particle sizes involved, an uptake via the intact skin is highly unlikely.

F. Do maximum levels exist for microplastics in foodstuffs?

Currently there are no official regulations governing microplastics as food contaminants since the relevant data available are insufficient. However, various adherent undesirable substances are subject to maximum levels set out in the Contaminants Regulation (Regulation [EC] No 1881/2006).

G. How are microplastics analysed?

Analysing micoplastics is a challenging task for which cleanroom conditions are required. Two methods are used for the qualitative and quantitative determination of microplastics. Minute plastic particles can be selectively identified using FTIR and Raman spectroscopy. FTIR (Fourier-transform infrared) spectroscopy is a standard method enabling differentiation between individual polymers having a particle size of up to 20 µm. FTIR microscopes enable simultaneous examination of individual parts of the sample as well as several spectra at various points on a larger surface via FTIR imaging. The frequently used transmission procedure places the plastic particles on a filter material such as silicon or aluminium oxide for measurement purposes. A comparison is subsequently made against reference samples contained in a database.

Raman microscopy provides a higher resolution and hence enables the identification of smaller particles measuring down to 1 µm. However, the fluorescence of the samples may cause problems in the analysis. In addition, pyrolysis-based or thermal extraction and desorption-gas chromatography coupled with mass-spectrometry can be used to identify the occurring microplastic particles. Since the polymers are destroyed in this process, no statement can be made about the size and number of particles.

H. Conclusion

In summary it can be stated, that microplastic particles are found ubiquitously and partly have the potential to release adverse substances into foodstuff. Consequently, a structured root-cause analysis to minimize their occurrence in food is regarded as indispensible and must become subject of further fundamental investigations.

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