Microplastics: Facts, research and open questions

FAQ to the BfR of 5 June 2019

Today, plastic is present almost everywhere in the human environment. The global production of plastics is growing and more and more plastics and microplastics are being released into the environment. This has been known for a long time, especially in regard to aquatic ecosystems. Humans can absorb microplastics, for example, through the air, drinking water, food, dust, and cosmetics.

Microplastics are small plastic particles and fibres. Size specifications for microplastics are not uniformly defined in literature and usual vary between 0.0001 millimetres (mm) and less than 5 mm. Since plastic in the environment breaks down very slowly, it can be assumed that it will continue to accumulate there. The public and scientific communities are currently discussing a possible health hazard to consumers from the possible entry of microplastics into the food chain. It cannot be assumed that plastic particles in food pose health risks for humans based on the current knowledge.

The German Federal Institute for Risk Assessment (BfR) is also conducting research on microplastics and has answered frequently asked questions on this topic below.

What are microplastics?

The term microplastics is used to describe small plastic particles of different sources, sizes, shapes and chemical compositions. The size specifications for microplastics are not uniformly defined in literature and usually lie somewhere between 0.0001 millimetres (mm) to less than 5 mm.

A fundamental distinction is made between primary and secondary microplastics:

- Primary microplastics are industrially manufactured for specific purposes in the form of synthetically based granulates and pellets. Different plastics such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), polyvinyl chloride (PVC), polyamide (nylon) and ethylene vinyl acetate (EVA) are used.

- Secondary microplastics occur through chemical and physical ageing and degradation processes of products such as plastic bags, plastic bottles or tyre wear particles. As far as we know today, the microplastics found in the environment consist mainly of secondary microplastics.

How do microplastics enter the environment?

Primary microplastics are used as granulates or pellets in the manufacture of plastic products. They are also used specifically in industrial sandblasters, for example, as well as in cleaning and polishing agents, as a base material for fertilisers and plant protection products, in paints and varnish, in medical products and in several cosmetic products. As sewage plants cannot sufficiently filter the particles out of waste water, some of them find their way into the water supply system. Microplastics can also end up on fields where sewage slurry has been spread.

Another source of entry of plastic into the environment is through consumers: packaging materials, bags, bottles and canisters can end up in the environment. As plastic hardly degrades, it remains in the environment for an indefinite period and accumulates there. Secondary microplastics are produced here through ageing and degradation processes.

Secondary microplastics are also produced by the wearing and washing of textiles containing synthetic fibres. This applies to fleece garments, for example, which are made from a velour fabric usually manufactured from polyester or polyacrylics. During these processes, microfibers are released from the fabrics into the air and drains**.**

Why are plastic microparticles used in cosmetic products?
Microplastic particles can be used in cosmetic products such as shower gels, exfoliants and toothpaste to very gently remove skin flakes, dirt or plaque. According to information supplied by the European cosmetics association Cosmetics Europe, the quantity of microplastic particles used in this way was reduced by 97% in the years between 2012 and 2017. The BfR does not currently have any data on this, however.

According to estimations made by the European Chemicals Agency (ECHA), microplastic particles made up 0.2% of the microplastics produced in the European Economic Area in 2017. ECHA has now proposed that the use of these microplastic particles be banned in cosmetic products from 2020.

At the request of the European Commission, ECHA prepared a restriction proposal for microplastics deliberately added to products. The BfR is regularly involved in the public discussion of restriction proposals of this kind.

Does the use of microplastics in cosmetic products have to be declared?
All constituents of a cosmetic product are listed in decreasing concentrations in the list of ingredients (INCI list). It does not have to be declared, however, whether they are used as microplastic particles in the cosmetic product.

To manufacture microplastic particles, the raw materials used, such as ethylene, are polymerised to large complexes in order to form a particle. In addition to their function as “little cleaning balls”, polyethylene polymers are used to control the viscosity and formation of films in cosmetic products. The polyethylene used there is shorter chained, however, which means that it occurs as a liquid and not as a particle. If the ingredients are used as the sole criterion, therefore, it cannot be recognised whether a raw material exists in the form of particles.

Are consumers faced with a direct health risk if they use cosmetic products with plastic microparticles?
The BfR has dealt with the question as to whether dermal or unintentional oral intake of microplastic particles from shower gels, exfoliants and toothpaste can pose a health risk. According to the latest available knowledge, a health risk of this kind is unlikely for consumers, in the view of the BfR, as the microplastic particles used in exfoliants and shower gels are much larger than 1 micrometre (1 µm equals 0.001 mm). With particles of this size, uptake through healthy, intact skin is not to be expected if the product is put to its foreseeable use. Even when toothpaste is swallowed, it has to be assumed due to the molecular size that intake via the gastrointestinal tract only occurs to a small extent and only with particles with a size of only a few micrometres, and that the majority of the particles are excreted with stool. It is unlikely that any health-relevant quantities of ethylene are released from polyethylene microplastic particles during passage through the gastrointestinal tract.

More research on microplastics is required to acquire reliable data which will help to make a better estimation of the health risk they pose to consumers.

Can microplastic particles be contained in foods (incl. food supplements)?
As far as we know today, microplastics are probably contained in foods too, but it is not clear in what quantities and what their composition is. The BfR does not yet have any reliable information on the many different entry pathways or on the occurrence, composition, particle size and quantity of microplastic particles in foods. Fundamentally, microplastics can find their way into the environment in many different ways and enter the food chain via the air, seawater, fresh surface water or ground water.

There were reports in the media that microplastics had been detected in honey, mussels and table salt. The corresponding test results do not permit any conclusions on the quantity and composition of the detected microparticles. Microplastics were also detected in beer and mineral water. Current studies using modern measuring techniques show the composition of the substances found in the plastics. The quantification and thereby the determination of the actual exposure quantity still continues to pose a great scientific challenge. For this reason, no conclusions on the average levels of microplastics in foods sold in the German market are currently possible.

The BfR has publications on the occurrence of microplastic particles in fish, mussels and crabs at its disposal. Blue mussels sampled along the French-Belgian-Dutch coast had two milligrams of microplastic particles per gram of mussel meat. Depending on their origin, filamentous plastic particles in quantities of between 2.6 and 6.1 particles per 10 g mussel meat were detected in North Sea blue mussels in the wild and purchased commercially. The majority of studies on the occurrence of microplastic particles in fish relate to examinations of the animals' gastrointestinal tract, which is not eaten with most fish, so that no conclusions can be drawn on the intake of microplastic particles by consumers through the consumption of fish. No reliable data on this is currently available for crustaceans.

Up to 250 plastic particles per litre were detected in some mineral waters, mostly in returnable bottles. As it was not possible to use particle-free negative controls, it remains unclear whether the particles were already in the water or whether they found their way in during cleaning or filling processes or processing in the course of analysis. The composition of the substances contained in the particles indicates contamination during cleaning and refilling of returnable bottles.

Are there any analytical methods to detect microplastics in consumer products and foods?
There are currently no uniform definitions for microplastics and no validated, i.e. generally recognised and tested, methods for the identification and quantitative analysis of microplastics. The large variety of plastics makes qualitative (i.e. the identification of the plastic material) and in particular the quantitative (i.e. the number of microparticles measured) analysis of microplastics more difficult. Various analytical approaches for determining and quantifying microplastics are currently the subject of scientific discussion.

How do humans absorb microplastics?
Humans can absorb microplastics, for example, through the air, drinking water, food, dust, and cosmetics. It is currently not possible to make reliable statements regarding the proportion of various intake pathways. On the one hand, data is not available for all intake pathways. On the other hand, the available studies are difficult to compare and evaluate due to different methods, a lack of data, and different data quality.

What is the BfR researching and assessing where microplastics are concerned?
A BfR Consumer Protection Forum on Microplastics took place at the BfR in June 2019. It focused on the latest scientific perspectives on microplastics in the environment, in foods and consumer products and on the current status of the analysis of microplastics.

A second interdepartmental discussion headed by the Federal Environment Agency was held among the national authorities in November 2018 on the subject “Plastics in the environment – analytics, effects, monitoring”. These meetings are held regularly in order to discuss the latest developments and jointly coordinate how to proceed further.

Together with the Federal Institute of Hydrology and Federal Environment Agency, the BfR initiated a first interdepartmental discussion on microplastics among the national authorities in July 2014. Representatives of 12 different departmental research institutions participated. The institutes’ main areas of research and expertise in the area of microplastics were presented at the meeting and a joint approach for the preparation of an assessment concept was discussed. The essential aspects relating to where microplastics remain were taken into consideration and the relevant questions established.

The “Nanotoxicology” junior research group, which also deals with micro and nano-scale plastic particles, was established in the Food Safety department at the BfR in 2018. The particles differ in their size, shape, material composition, density and frequency of occurrence. The most scientific data is currently available for polystyrene. Cell models of the intestines and liver are used to quantify the intake and characterisation of possibly toxicological mechanisms of action.

Examinations of the uptake of microplastic particles in blue mussels and oysters began at the BfR in 2013. The main objective initially was to develop a standard protocol for the contamination of mussels with defined particles for the production of contaminated reference material. With the developed method, it was possible to reliably contaminate Baltic Sea blue mussels and oysters in the laboratory with plastic particles of different sizes, shapes and materials to an extent sufficient for them to be used as reference material. The results of the first tests on the uptake speed and distribution of microplastic particles in the mussels matched up with the observations of other authors. Furthermore, an animal study was evaluated at the BfR in which mice had been fed with various microplastic particles over 28 days. The quantities administered were well above those which would appear realistic for human exposure. No damaging effects were shown on the intestinal tissue or to other organs of the mice. The results of the animal study were published in the journal *Archives of Toxicology*. In vitro studies are currently being conducted at the BfR in which the possible uptake of various micro and nanoparticles in human intestinal cells is being examined.

Are health impairments possible through the intake of microplastic particles with food?
According to the latest available knowledge, it is not to be assumed that plastic particles in food pose a health risk to humans. Initial independent tests on the oral intake of microparticles conducted at the BfR with various model particles gave no indications of damage to intestinal tissue. Due to the poor data situation, however, no synoptic assessment of the effect of microplastic on the intestinal barrier and subsequent risk assessment can be made yet.

It is to be presumed that the level of knowledge of microplastics will be significantly further developed in the coming years, thus enabling a better assessment of the possible health risks.

It has also to be assumed that microplastic particles smaller than 1 mm are completely excreted through the gut. Very little is known to date about the systemic distribution of smaller particles in the body. According to the European Food Safety Authority (EFSA), it is very likely that only particles with a size of less than 150 micrometres (1 µm equals 0.001 mm) could fundamentally overcome the intestinal barrier, whereas only particles smaller than 1.5 µm can be distributed in the body. Available studies show that with 0.04 – 0.3% (results from studies with rodents), absorption into the intestine is low. Little is known up to now about systemic distribution within the body. No publications on the effect of microplastics on humans are currently available.

Can microplastics be a transport vehicle for other undesired substances?
It has been reported that substances can attach themselves to microplastic particles. These substances, e.g. polychlorinated biphenyls (PCB) or polycyclic aromatic hydrocarbons (PAH) can interact with the microplastic particles depending on their physicochemical surface properties. Whether uptake via these microplastic particles, which are charged with substances, can actually contribute to human exposure has not been investigated yet. Whether contaminants that may have bonded with the cells of the particles can be released again or whether they remain permanently bonded to the particles has not been sufficiently researched either.

A model calculation made by the European Food Safety Authority (EFSA 2016) shows that daily intake of PCB and PAH through the consumption of contaminated microplastic particles in mussels can increase by a mere 0.006% where PCB are concerned, and less than 0.004% where PAH are concerned compared to other intake pathways.

The extreme scenario was assumed here in which a consumer eats 225 g of mussels containing 7 micrograms (1 µm equals 0.001 mm) of microplastic particles per kilogram (kg) of mussels every day (equates to 900 particles) which in turn have high levels of PCB and PCH which transfer completely to the consumer.

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