CHEMICALS IN PLASTIC

A DANGER TO HUMANS AND THE OCEAN

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP
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INTRODUCTION

PLASTIC IN OUR DAILY LIFE

Synthetic material more commonly referred to as „plastic,“ is pervasive in our lives. Indispensable items for our daily lives including food packaging, clothing, furnishings, vehicles, building materials and even replacement parts for our bodies such as prostheses and tooth fillings are made of plastic.

With such an abundance of such products, it is hardly surprising that so much plastic has been produced that the volume would be sufficient to wrap our planet in film six times. And that‘s not all: worldwide plastic consumption is continuing to rise so rapidly that more than 300 million tonnes of it is produced worldwide each year.

The invention of plastic was a revolution in the history of mankind. The downside is that an enormous quantity (estimated at 10% annually) of the currently produced plastic ends up in rivers, seas and oceans; when converted, this corresponds to one garbage truck load per minute. In the environment, macro- and mesoplastics (> 5 mm) decompose through mechanical, chemical and biological processes into micro- (1 µm to 5 mm) and eventually nanoplastics (< 1 µm). Together with microplastics from other sources, such as from wear of vehicle tyres or leaching of fibres from textiles, microplastic accumulates in the oceans. Plastics have already been proven to be present in all ocean water masses: from the poles to the equator, at the water surface, in deep sea sediments and in coastal regions.

Today, there are more than 50 trillion microplastic particles already present in the world‘s oceans. That is 500 times more particles than stars in our galaxy! Experts expect that this volume of particles will significantly increase by 2050 and will then surpass the weight of all fish in the ocean. However, ocean regions already exist that contain six-fold more plastic than plankton in their water.

Marine organisms ingest plastic through their diet and this leads to the large-scale contamination of fish and seafood stocks with microplastic. The plastic can eventually end up back on our plates via the food chain.

Plastic can contain numerous toxic and hormonally active chemicals. These are released into the immediate environment and can harm humans, animals and ecosystems. We take in these toxic substances through respiration, skin contact and the food chain and thereby endanger our health.

This brochure clarifies the composition of plastics, the harmful chemicals in plastic, and their routes of transport. It also provides specific everyday tips on how everyone can protect their health, the environment and the oceans.

WHAT IS PLASTIC AND WHAT CHEMICALS DOES IT CONTAIN?

COMPONENTS OF PLASTICS

Plastics are linear and branched molecular chains, which are produced from individual building blocks (monomers) through a synthetic binding process (polymerisation). The resulting polymers are composed of five of the six main elements essential to life (carbon, hydrogen, oxygen, nitrogen and sulphur), mixed with various additives.

About 99% of the plastics in use nowadays are produced from fossil fuels. The remaining 1% originate from renewable raw materials like maize or rubber from rubber trees.

Some plastic products are produced from a single type of plastic and are therefore „unmixed“; other products are made of a mix of different plastics.

Because raw plastics are brittle and hard, chemicals are added during the manufacturing process to give specific properties (such as elasticity, stability, colour-fastness, transparency, static charge, static charge, or toughness) and thereby tailor the final product to the particular application. Some additives can prevent or at least slow down decomposition and ageing processes (such as embrittlement, yellowing, loss of sheen/ transparency, or surface cracking) by protecting plastics against environmental influences like water, acids, heat, oxygen and light during manufacturing, processing and use.

Examples of plastic additives

- Antioxidants
- UV-protection agents
- Stabilisers and hardeners (bisphenol A; BPA)
- Plasticisers (phthalates)
- Acid scavengers
- Nucleation agents and clarifying agents
- Antistatics
- Dyes and colour stabilisers
- Optical brighteners
- Propellants and fillers
- Flame retardants
- Biocidal agents

The ratio of additives to plastic depends on the type of plastic and its requirements and can lie between 5% (such as polyethylene) and 80% (such as polypropylene composites). The proportion of additives can also vary greatly within a single type of plastic.

The Resin Identification Code, reviewed at the end of this brochure, can help to determine the type of plastic. However, there is also a downside to it: Additives can have undesirable properties. They can disturb our endocrine system, impair our fertility or promote the development of cancer.

CAN CHEMICALS LEAK FROM PLASTIC AND ENTER MY BODY?

THE PATHS OF CHEMICALS IN THE BODY

Chemicals can leak from plastic, which means that toxic substances and additives can transfer to food, living beings and the environment. This is because plastic has a sponge-like basic structure of linear or cross-linked molecular chains that are more or less interwoven. Additives are not firmly anchored within this structure. Alongside additives, plastics often contain residues from the manufacturing process, including health- and environment-damaging components (such as styrene, melamine and vinyl chloride) or solvent residues (such as chlorinated hydrocarbons). Toxic and hormonally active substances can leak from plastics under certain chemical or physical conditions (heat, UV radiation, greasy/acidic environments) or over the course of the ageing process and accumulate in the environment. Humans can take in the released pollutants through respiration, the skin and the consumption of contaminated food. Particularly alarming is this „migration“ of chemicals when food comes into contact with plastic packaging.

Respiration

When pollutants evaporate from objects like plastic furniture and flooring (such as laminate; i.e. the „new car smell“), they can be breathed in with ambient air.

Skin

Chemicals can also enter our bodies through direct skin contact. This applies especially to contact with soft plastic products (such as hot-water bottles), plastic fabrics (nylon, polyester and polyacrylics) and cosmetics (such as nail polish and exfoliants). A particularly long period of skin contact, intense heat and our sweat can enhance the effect (such as sunbathing on an air mattress).

Food

Plastic additives can pass from packaging to food items and enter our bodies through the consumption of food. Some additives have already been proven to exist in human blood, breast milk and tissues.

Legal regulations state that food packaging cannot pass on substances to food in amounts that are dangerous to health (specific migration level; SML). However, mandatory limits are not established for critical chemicals or for all packaging materials. For example, the EU-wide prohibition on the use of BPA only applies to baby bottles.

Caution in the recycling of packaging

Recycling is a good thing in principle! Certain food packaging is, however, only created for a single use and a specific purpose and should not be reused or misappropriated. The material is mostly harmless to the intended food item but not to foods with other properties. Even if it may seem advantageous, using an empty ice cream tub to hold soup is not healthy! Plastic is a very unstable material. Fine cracks can already develop on the inside of disposable PET bottles during washing up and bacteria can establish themselves within these cracks and pose a risk to health. Some plastic packaging is also not heat- or acid-resistant and should therefore not be filled with hot or acidic food due to the potential for dangerous chemicals to escape. Consequently, you should not use disposable packaging to store food leftovers in the freezer or heat them up in the microwave. The Resin Identification Code (summarized on the last page of this brochure) on your food packaging will tell you the type of plastic.

HOW DO DIFFERENT CHEMICALS AFFECT HEALTH AND THE ENVIRONMENT?

PLASTIC ADDITIVES COMPARED

Describing the complex individual and interacting effects of all additives found in plastics on health and the environment would go well beyond the scope of this brochure. We have therefore limited ourselves hereinafter to the presentation of plastic additives, such as hormonally active substances, that are used in a wide range of products and that are especially harmful to health and the environment.

Brominated flame retardants, phthalates, bisphenol A and organotin compounds are all hormonally active compounds, also known as endocrine disruptors which can interfere with our finely-balanced hormonal system and disrupt hormone-controlled processes such as metabolism, growth, immune system function and organ development. Babies and young children react especially sensitively to hormonally active chemicals. A variety of diseases and disorders including malformations of the sexual organs, infertility, allergies, obesity, type 2 diabetes, different types of cancer, immunodeficiency and learning and behavioural disorders are all associated with these artificial hormonally active substances.

Brominated flame retardants

Brominated flame retardants serve to delay the ignition of flammable plastics (but also in textiles or wood) and to slow down flame propagation. They are inexpensive and combine well with a wide range of plastics, which is why they are found in countless plastic items such as electronic devices, cuddly toys, upholstery and mattresses. During manufacturing, product use and disposal, flame retardants can evaporate and wash out from plastics. In a fully developed fire, even flame-retardant objects will burn and may release highly toxic brominated dioxins and furans. Brominated flame retardants can disrupt functions of the hormonal system and have neurotoxic effects. Due to their chemical stability and good fat solubility (lipophilicity), there is a risk that these substances will accumulate in the environment and bioaccumulate in animal and human tissues. Brominated flame retardants have already been identified in sediment, dust and countless animal species worldwide.

Plasticisers (phthalates)

Phthalates (phthalic acid esters) are used in numerous products such as flip-flops, shower curtains, baby changing mats, floor coverings, children‘s toys, and synthetic leather. Soft PVC can even contain up to 50% phthalates. Since phthalates are not chemically bound to the plastic matrix, they can easily escape from products or dissolve out from products upon contact with liquids or fats. Their odour is particularly discernible in the case of new plastic items. Due to their diverse applications, we are almost constantly exposed to phthalates. They can damage the hormonal system and be toxic to human reproduction (reprotoxic). Large quantities of phthalates are also damaging to the environment. Phthalates tend to bind to particles and are consequently found in the environment wherever products with plasticisers are manufactured or used. Dust particles in the air transport phthalates over large distances. Phthalates can also end up in waste water during cleaning of PVC floors or PVC printed textiles and accumulate in aquatic ecosystems, sediment and organisms. If contaminated sludge from sewage treatment plants is spread on fields, the soils will also be contaminated.

Organotin compounds

Organotin compounds are used as stabilisers in PVC, as catalysts in the manufacturing of silicone sealing compounds, polyesters and polyurethanes, and as biocides. They are often found in inflatable water toys and as bactericides in plastic shoes (flip-flops) as well as sports and functional clothing (football jerseys, cycling shorts and waterproof trousers). They have different toxicological properties depending on the compound. Some organotin compounds damage the immune system, the liver and the nervous system. They can also disrupt the hormonal system and impair fertility. Organotin compounds pollute the environment by accumulating in sediment in bodies of water and in organisms. Due to their toxicity to many aquatic organisms and their effects on the hormonal system, they can impair biodiversity.

OTHER PARTICULARLY WORRYING ADDITIVES

Per- and polyfluorinated chemicals (PFC)

Two of the best known PFCs are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). They are extremely stable, non-biodegradable, and accumulate for a very long time in the soils and surface waters, and enter drinking water and many food items through ground water. They accumulate in organisms, which means that no safe level of exposure can be determined. PFCs give plastics water- and oil-repellent properties (such as waterproof textiles, non-stick coating on cookware, and grease-repellent food packaging) and cause numerous health problems such as high cholesterol levels, chronic inflammatory bowel diseases, testicular and renal cancer, and pregnancy-induced hypertension. In the European Union, PFOA is legally classified as carcinogenic and reprotoxic.

Polycyclic aromatic hydrocarbons (PAK)

PAHs are natural components of crude oil and coal and arise from incomplete combustion of organic materials (coal, heating oil, fuel, wood). Cheap contaminated extender oils are used in some soft plastics and rubbers to save on costs, which leads to an increased concentration of PAHs in numerous consumer products. These can be absorbed through the skin and can damage our health because they are carcinogenic, harmful to development and reprotoxic. Black plastics are frequently contaminated with PAHs because untreated carbon black, which has a high concentration of these chemicals, is used for colouration (such as the rubberised handles of tools and handlebars).

Nonylphenol (NP) and nonylphenol ethoxylates (NPE)

Nonylphenol is a precursor for nonylphenol ethoxylates, which reconvert to toxic nonylphenol in the environment. NPE are used for the manufacture of plastics that come into contact with food items. The compound, which is toxic to mammals and highly toxic to aquatic organisms, can remain in the environment for months, trigger allergies and impair the hormonal system. NP has previously been documented in mineral water, as a contaminant from plastic screw caps, as well as in imported textiles from non-EU countries.

FROM LONG-TERM EXPOSURE, COCKTAIL AND LOW-DOSE EFFECTS: THREE CLAIMS THAT DEMONSTRATE WHAT MAKES THE HANDLING OF PLASTICS CHALLENGING.

"I won't immediately drop dead from it"

Contact with chemicals that are harmful to health and the environment does not necessarily have to be linked to negative consequences for us. What should worry us is the duration over which we come into contact with plastics and the substances they contain. When we unwrap our food items from plastic packaging, perform our yoga exercises on plastic mats, wear flip-flops on our feet, drink from our plastic water bottle, and breathe air in rooms laid out with PVC, this all adds up to a remarkable amount of time during which we have contact with plastics. And this is every day, every week, every month, year after year. The consequences of this long-term exposure, i.e. the fact that we are exposed to a substance for a longer period, are unclear. This uncertainty is above all associated with the extreme difficulty in measuring the long-term effects of chemicals. Relevant studies must take place over several decades and generally have to contend with the problem that links between cause and effect are very difficult to demonstrate. This is because of the multitude of different influences that each of us is exposed to over a longer period. It is therefore better to take precautions and to minimise one‘s own contact with potentially hazardous products and materials as much as possible.

"This is surely all monitored"

This claim is also not entirely incorrect. Chemicals and their effects on different organisms are tested. However, risk assessments of chemicals are mostly limited to just the study of the isolated effect of a substance. Everything else would be associated with a huge amount of effort and is not feasible under laboratory conditions. Our daily life is quite different in reality: every day we use a variety of plastic products - from cooking bags for rice to kettles made of plastic and to-go mugs for coffee. We are therefore exposed to a combination of different chemicals; a whole cocktail of questionable substances. It is from this circumstance that the cocktail effect gets its name: this is how the pollutant content of a single product can lie within the permissible limits but still interact with pollutants in other everyday products to form a harmful cocktail of pollutants and exert a stronger overall effect. The many individual doses of hormonally active chemicals can therefore reinforce each other‘s effects, which is how damage can occur even with concentrations at which each substance would not have an impact on its own.

"The dose constitutes the poison"

This claim points to a problem associated with hormonally active pollutants - the so-called low-dose effect. A threshold level is usually determined for substances, which is the assumption that the human body (or plants and animals will not be damaged so long as this level is not exceeded. Hormonally active substances, however, do not always follow the classic concept of toxicology: „The higher the dose, the stronger the effect.“ In fact, hormonally active substances can already be extremely effective at minute doses, which is why there is no such thing as a „harmless concentration“ of such chemicals. The extent of the damage also depends considerably on the timing and duration of the exposure. The most damage therefore likely comes from hormonally active pollutants in the sensitive embryonic and early childhood development stages, when the hormonal system is intensively involved in the regulation of organ development. Minor changes in hormonal balance early in life can lead to serious delayed-onset damage in later life.

WHAT CAN I DO TO PROTECT MY HEALTH AND ENVIRONMENT?

TIPS FOR CONSUMERS

Avoiding plastics and the chemicals contained in them may appear like the battle between David and Goliath, but we can effectuate some change with small, simple decisions in our daily life. These decisions do not cost much in terms of money or time. The challenge is questioning our routines and observing a few simple rules of thumb:

Tips for materials that come into contact with food

- The ideal containers for storing food items are made of glass, ceramic or stainless steel.
- Food packaging made of glass is the most hygienically harmless option and can be employed as versatile preserving jars to fill with meals after initial use.
- Plastic containers, especially single-use or disposable packaging, should never be used outside of their intended purpose or filled with food items!
- No-one has to give up on their plastic boxes! Transporting or storing food items in plastic containers is hygienically safe if you choose plastics such as polypropylenes (PP; recycling code 5) or polyethylenes (PE; recycling code 4 or 2).
- Food items should never be heated in plastic containers.
- Acidic and fat-containing food items are less suitable for packaging made of plastic and plastic-coated containers.
- Meals should never be transferred to a plastic container while warm.
- Ready-made meals should be heated in the microwave using the lowest wattage and heating duration. Even better would be to transfer the food item to a suitable dish (glass or ceramic container) prior to heating in the microwave.
- The preparation in water baths of food items packaged in plastic should be avoided.
- Take-away meals and beverages should be transferred to personally bought reusable packaging (such as reusable coffee mugs). This will allow you to prevent plastic waste.
- Avoid polycarbonate (PC), PVC, polystyrene, and unidentified plastics for food packaging.
- Particularly important in the case of infants and children is to avoid tin cans, as these can release bisphenol A into the food contents.
- The transfer of pollutants is influenced by the ratio of packaging size to contents, which is why single portion packaging and elaborate packaging is less advisable.
- Cotton bags should be favoured over plastic bags and unpackaged vegetables should be favoured over plastic wrapped and sealed vegetables.
- Only use cookware with non-stick coating or cookware made of silicone strictly according to instructions. Never allow them to overheat (the maximum temperature is often printed on the dish). If the coating already has scratches, the dish should be disposed of.

Tips for cosmetic items and cleaning agents

- Certified natural cosmetics are guaranteed to be free from microplastics and are recognisable by their NaTrue and BDIH labels.
- Identifying plastics in cosmetics is very difficult due to the different labels. Anyone who nonetheless wishes to try this should watch out for and avoid the following ingredients: polyethylene, nylon, acrylate copolymers or acrylate crosspolymers, silicone such as cyclotetrasiloxane and cyclomethicone, and polyquaternium. Microplastics in cosmetics and cleaning agents can easily be identified and specifically avoided by using free apps such as Codecheck and ToxFox.
- Some manufacturers may forgo using plastic particles but not gel-type or liquid plastic. Do not be deceived; check the product even if they carry the label „free from microplastics.“
- You can make your own home-made exfoliants very easily using natural ingredients such as apricot kernel powder, medicinal clay, salt, coffee grounds, sugar or oat-meal.
- You should use cotton cloths to clean instead

of microfibre cloths. Other alternatives are environmentally-friendly sponges made of cellulose or other natural fibres.

- Caution! Many scouring agents such as grout cleaners and glass ceramic stove top cleaners contain microplastics. You can instead clean using completely natural baking powder or baking soda as a scouring agent.

Tips for textiles

- Switch your home textiles and wardrobe gradually to natural fibres (organic cotton, organic wool, linen, silk and hemp), so that no more synthetic fibres are flushed into the environment from your washing machine.
- Avoid plastic fibres such as polyester, nylon and polyacrylics.
- Also avoid textiles that are endowed with biocides (recognisable from their „odour-inhibiting“ or „odour-neutralising“ labels), UV protection (nanoparticles formed of titanium dioxide and zinc oxide), or PFC protection.
- When washing synthetic fibres, the fuller the machine the less friction is generated between laundry items, which results in the release of fewer fibres (microplastics). Low temperatures, short cycles and forgoing prolonged spinning cycles are further measures to minimise the leaching of microplastics.
- The fluff filter should never be rinsed out; always collect lint deposits by hand or remove them with a brush and then dispose of them in the trash. Do not flush them down the drain or toilet.
- When purchasing new (home) textiles, favour textiles with eco-labels and air new home textiles after you have removed them from their packaging. New clothing, bedding and cuddly toys should be washed before the first use.

Tips for household items and everyday objects

- Trust your senses! Strong smelling plastic products often contain volatile organic chemicals that could endanger your health.
- Avoid plastics made of soft PVC. You will generally recognise these from their glossy surfaces and slightly „greasy“ feel.
- When purchasing hard plastic products, favour items with the notice „BPA-free.“
- Choose „switch off/shut down“ instead of „standby“ for electronic devices. This will allow you to prevent these devices from heating up and releasing brominated flame retardants into the ambient air.
- Look out for seals or plastic fillings without bisphenol A at the dentist.
- Exercise your right given to you by the REACH EU chemicals regulation! Request information from manufacturers on potentially dangerous substances in your products!

HOW DOES PLASTIC END UP IN THE OCEAN AND THE FOOD CHAIN?

FROM OUR HOMES INTO THE OCEAN

The routes of plastic lead into the world‘s oceans and from there back to our plates via the food chain. Plastic items, which first decompose into micro- (1 µm to 5 mm) and then into nanoplastic particles (< 1 µm) through mechanical and chemical environmental influences, account for by far the largest proportion (80%–90%) of pollution of our oceans. Inadequately managed landfills and incorrectly discarded municipal waste, the use of mulching films in agriculture, the loss of nets (ghost nets) in fishing, or cigarette butts carelessly discarded at the roadside are just a few of the many sources and routes by which plastic ends up in the ocean.

Fibres, pellets and liquid plastic also enter the sewage system through everyday household activities, such as the washing of plastic fabrics or the use of microplastic containing cosmetics and cleaning agents. A fleece jacket can shed up to one million fibres in a single washing cycle! About 60% of our clothing is currently made of polyester and Europe‘s washing machines flush out approx. 30,000 tonnes of synthetic fibres into the sewage system every year. Sewage treatment plants are often not capable of isolating all these particles and, as a result, many thousands of tonnes of microplastic enters the surrounding rivers and ultimately the ocean unimpeded. Microplastics build up further on the streets in front of our own homes: through the wear of car tyres, lacquers and dyes, as well as the loss of pellets during production and transport.

The water masses of all the world‘s oceans are interconnected and interact. This explains how large quantities of plastic have already been discovered even in remote places like the deep ocean and the Arctic. Current estimates suggest that 70%–95% of this plastic sinks to the ocean floor. This means that the pictures of heavily polluted beaches likely represent only a very small fraction (estimated 5%) of the masses of plastic polluting our oceans.

Marine organisms ingest plastic

Marine organisms confuse plastic for their food and/or ingest food contaminated with plastic. In this case, the smaller the plastic particles, the more organisms can potentially ingest these. This is how many marine animals starve with „full stomachs“: approx. 90% of marine birds worldwide that perished and were subsequently examined were found to have large quantities of plastic in their digestive systems.

The ingestion of plastic by marine organisms has been studied only in the past few years and many methods are currently not yet standardised. Many questions therefore remain unanswered: does plastic accumulate in organisms, and if so, in which body tissues? What health effects does the ingestion of plastic have on the individual health of marine animals but also on populations and biodiversity? Is the consumption of fish and seafood contaminated with plastic damaging to the health of us humans?

Studies on microplastics in marine food chains show great differences in their contamination levels, dependent upon which areas were studied and how the examined animals ingested their food (such as non-selective filtration in the case of mussels and active predators like fish). Estimates revealed that currently one third of global fish stocks are contaminated with plastic.

When predators eat plankton, mussels or small fish, there is a risk that plastic particles will be transferred from the prey to the predator and that plastic will accumulate in marine food chains. This nonetheless depends on the retention time of plastic in the digestive tract of the animal and the ability of the particles to migrate to other organs. The same rule applies here: the smaller the particles, the higher the likelihood of them passing through tissue and cell barriers. The methodology behind this field of research is, however, currently only in the developmental stage and the data for it is still very limited. There are also currently case studies that both point to and refute the accumulation of plastic in the food chain.

Plastic is harmful to marine organisms

Plastics can release hazardous substances when circulating in the aquatic environment or in the digestive tract of animals. Also, during its journey in the oceans, plastic can absorb persistent organic pollutants (POPs) such as polycyclic aromatic hydrocarbons (PAH) or pesticide residues such as dichlorodiphenyl trichlorethane (DDT).

The uptake of (micro-)plastic can damage aquatic life in three different ways: (1) by mechanical injury and blockage of the digestive tract, (2) by release of plastic pollutants, and (3) by adhesion and subsequent release of environmental pollutants. Various studies have detected several reactions to microplastic uptake in mussels and fish: changes in the digestive tract, severe inflammatory reactions in other tissues, decreased reproductive ability and altered feeding behaviour. This indicates a migration of micro- and nano-plastic particles as well as associated pollutants from the digestive tract to other regions of the body and a by-passing of cell barriers.

Is the consumption of marine animals a danger to health?

Plastic is widespread in the oceans and is found in commercially used fish and seafood. It is therefore very likely that humans absorb plastic particles through their consumption. The digestive tract is removed from most marine animals prior to consumption, but the safety of consuming mussels and shrimp is questionable because they are used whole.

Due to the lack of scientific studies, no conclusions can currently be drawn on the retention time of plastic in human digestive tracts, nor the ability of plastic to migrate to other tissues and to accumulate there and release pollutants. However, it is clear that plastic pollution is harming marine biota and we must act fast to reduce this clear and present threat. Addressing the threat of plastic pollution (a threat which is based on sound scientific evidence) will contribute to reducing micro- and nanoplastic pollution.

Marine protection involves chemicals management and resource conservation

Humanity has an intimate relationship with the sea. For as long as we keep poisoning the oceans, we are inflicting serious damage upon ourselves. Marine protection means improved management and a reduction in the incessant flow of chemicals and plastic from cities and industry into the environment. For healthy oceans and improvement to our quality of life, we need responsible dealings with resources, a redesign of products, and closed production loops.

RECYCLED PRODUCTS: HOW GOOD IS SUPPOSED INNOVATION?

FROM THE BOTTLE TO THE FLEECE PULLOVER

Recycling plastic products initially sounds like the ideal solution to the overwhelming waste problem. But how environmentally-friendly are the supposed innovative plastic recycled products really and are they also harmless to health?

We wish to again highlight the example of „PET bottles“ to address this. The returnable bottles from the reverse-vending machines of supermarkets are crushed and compacted into balls in the first step. These plastic balls then go on a long journey. They are often transported by container ship to developing countries, where extremely low labour, social and environmental standards apply. Once they arrive there, the bottle scraps are cleaned, melted down and spun into polyester fibres to manufacture textiles like shirts, socks and fleece jackets. The finished products then undergo another long journey by container ship to find new owners in department stores. The cycle is thereby closed, but at what price?

From an economic point of view recycling has no advantages. The expensive, time-consuming sorting, cleaning and recycling processes cannot keep pace with the low oil prices for new products. Long transportation chains result in high emissions and recycled plastic fabrics can release a large quantity of microplastic into washing water during the washing process that ultimately ends up in our environment.

The recycling process itself poses a further problem. Plastics often exist as mixtures of different types of plastic, but only unmixed plastics can be properly recycled. However, even unmixed plastics contain numerous additives, which cannot all be completely separated during recycling. This results in a recycled plastic (recyclate) with worse properties (such as a lower melt strength and an unpleasant odour). To compensate for these losses in quality, recycled plastics are usually treated with further additives.

At the end of the recycling process, you then have a product with an unfathomable amount of different industrial chemicals, the interactions and long-term effects of which on the environment and health can only be speculated about.

But that‘s not all: recycled products can also contain problematic substances that are no longer used in new materials by the plastic industry for reasons such as voluntary commitments. These pose the fundamental risk that pollutants from waste will be re-incorporated into new products through mechanical recycling and thereby remain in our environment for a longer period of time.

Consideration should therefore always be given to the question of whether it isn‘t cheaper in some cases to process plastic waste in other ways, such as for energy recovery through incineration.

BIO-PLASTICS:
A GOOD ALTERNATIVE?

BIO-PLASTICS: A GOOD ALTERNATIVE?

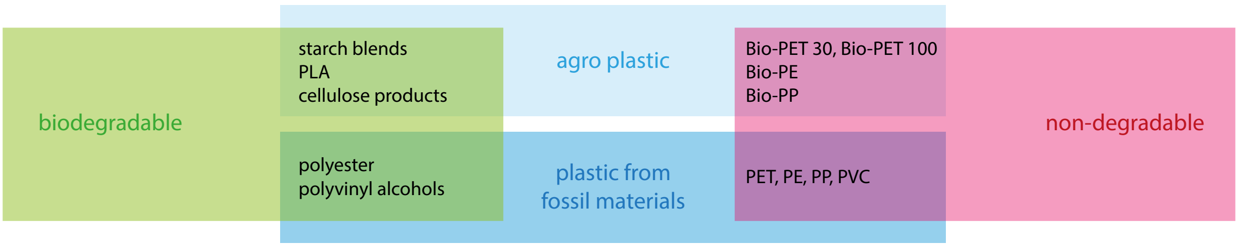
The term „bioplastic“ is confusing because bioplastics can be manufactured from either from fossil fuels, like crude oil, or from renewable raw materials, like maize. There are also mixed types (blends). Both types can be biodegradable or non-degradable. An overview of this terminological chaos is presented in the figure below. This confusion is completed when we include plastic mixtures, or so-called „blends“, that are only partially bio-based (mostly 60%) and also contain conventional plastics. The materials are often advertised as „environmentally-friendly and innovative“ because they save on fossil fuels, so long as they are composed of renewable raw materials (such as maize). They nonetheless create additional pressures on the environment through the use of fertilisers, pesticides and agricultural machinery, as well as the consumption of water. The land requirement for the cultivation of a monoculture stands in competition with food production and the use of genetically modified plants cannot be ruled out. The cultivation and processing of plants for this packaging causes acidification of soils and eutrophication of water bodies. This also results in higher particle emissions.

In the case of biodegradable plastics made of fossil fuels, compostability is emphasized even though full decomposition is only possible under certain industrial conditions. The decomposition process only proceeds very slowly and no valuable compost ingredients, such nutrients, minerals or soil-improving humus are released, meaning no substrate is developed. Biodegradable materials are also manufactured in comparatively low quantities so that the establishment of a dedicated recycling infrastructure is difficult. This is why many bioplastics are discarded as contaminants at composting plants and incinerated.

The processing of bio-plastics tends to incur higher costs and some products have to date exhibited unfavourable material properties. To cancel out these issues, new additives are being developed with which the deficits should be compensated for and that can account for up to 50% of the product weight. The effects of some of these substances on the environment and health are not entirely clear. When these bioplastics end up in domestic compost, their additives escape uncontrollably into the environment.

SUPPOSED NATURAL PRODUCTS: THE BAMBOO MARKETING PLOY

Some manufacturers have in the meantime switched from full plastic to bamboo or wood; but be careful as this does not mean that their products don‘t contain any plastic components! Almost all bamboo products contain moulding plastics such as melamine resin, urea-formaldehyde resins or polylactate. Melamine is a plastic that can release toxic components such as formaldehyde into food items under certain conditions (heat exceeding 70° or exposure to acid). Polycarbonate also contains the hormonally active substance BPA. This is why melamine and bamboo dishes should never be heated or filled with very hot meals or beverages.



GLOSSARY

To provide an overview of the chemicals named in this brochure, the most important terms and substances are summarised again here in a glossary. It is becoming clear how alarming the cocktail effect of mixing chemicals is when some substances are already capable of causing damage within the body on their own.

Term	Explanation
Acetaldehyde	Raw material in the chemical industry: PET bottles may contain this material; impairs taste; potentially carcinogenic
Acrylate copolymer	Microplastic; often in shower gels and shampoos
Acrylate crosspolymer	Microplastic; often in shower gels and shampoos
Additives	Additional substances; give plastics certain desired properties
Antimony	Flame retardant; weak hormone-disrupting action
Biocide	Pesticide; often found in sportswear to counteract odour-causing bacteria
Blends	Plastic mixtures formed partly of bio-based plastics (such as from maize) and partly of conventional plastics (from crude oil)
Bisphenol A (BPA)	Often found in plastic objects and tin cans; is mistakenly recognised as a hormone by the body and thus disrupts the hormonal system
Brominated flame retardants	Inhibit the ignition of flammable plastic and wood (such as upholstered furniture and cuddly toys); hormone-disrupting and toxic
Dioxins	Abbreviation for polychlorinated dibenzodioxins and dibenzofurans; produced as a by-product of chemical processes (such as waste incineration); accumulate in the fatty tissue of living beings and are highly toxic in large quantities; cause disorders of the immune and nervous systems, respiratory tracts, thyroid and digestive tract
Endocrine disruptors	Also environmental hormones; disrupt the hormonal system
Epoxy resins	Synthetic resins; are mostly produced through a reaction with BPA
Formaldehyde	A harmful gas that is found in numerous products (furniture, clothing, tableware and cosmetics) due to its versatile applicability despite its toxic properties; colourless with a pungent odour; very toxic and potentially carcinogenic
Furans	Produced during the heating of objects or food items; potentially carcinogenic
Catalysts	Accelerate reactions in chemical processes
Persistent organic pollutants (POPs)	Organic compounds that decompose or transform only very slowly in the environment
Melamine	Processed into plastic resins together with formaldehyde; both substances are released during heating of the resulting products and are toxic and carcinogenic
Nonylphenol (NP)	Precursor for NPE; transforms in the environment back into toxic NP

Nonylphenol ethoxylates (NPE)	Used for the manufacture of plastics that will come into contact with food items and for the manufacture of plastic fabrics; impair the hormonal system and are allergenic
Nylon	Commercial name for polyamide; synthetic fibres for the manufacture of textiles and other items
Organotin compounds	Sometimes used as biocides; often found in sportswear but also in inflatable water toys; hormone-disrupting
Polycyclic aromatic hydrocarbons (PAK)	Natural component of crude oil and coal; is released during incomplete combustion processes; ingredient in soft plastics (rubber); carcinogenic, damaging to development and toxic to reproduction
Perfluorooctanoic acid (PFOA)	Additive in plastics; water- and oil-repellent properties; is carcinogenic and damaging to the intestines and thyroid
Perfluorooctane sulfonate (PFOS)	Additive in plastics; water- and oil-repellent properties; potentially carcinogenic and damaging to the intestines and thyroid
Polycarbonate	Transparent plastic (such as in CDs, DVDs or as a alternative to glass); BPA may be released when heated; prohibited for use as a material in baby bottles
Polyquaternium	Liquid plastic; often in cosmetic products; non-toxic but poorly degradable
Recyclate	Recycled plastic, such as from plastic bottles
Silicone	Liquid plastic made of crude oil; often in cosmetic products; non-toxic in everyday use but poorly degradable
Vinyl chloride	Used for the manufacture of polyvinyl chloride (PVC); highly toxic and carcinogenic

PLASTIC IS NOT JUST PLASTIC: THE "RESIN IDENTIFICATION CODE"

Numerous plastic containers are provided with an arrow symbol and a number: the Resin Identification Code to identify the type of plastic. The code numbers 1 to 6 each indicate a specific unmixed plastic, while number 7 is a general designation for all other types of plastic (mixtures). The specification is voluntary for plastic manufacturers and was designed to facilitate recycling.

Code	Abbreviation	Description
1 PET	Polyethylene terephthalate Drink bottles, food packaging, "polyester" in numerous textiles	PET drink bottles can contain the weakly hormonally active substance antimony (flame retardant), although in concentrations below the legal limit. Disposable PET bottles can contain acetaldehyde, while reusable bottles mostly do not because an acetaldehyde blocker prevents its transfer. Acetaldehyde can impair taste and has been placed on the list of potentially carcinogenic substances by the EU.
2 HDPE	High-density polyethylene Coating for milk, water and juice containers, and for food and cosmetic packaging	Harmless, so long as it is not exposed to direct sunlight, since otherwise the endocrine disruptor nonylphenol can be released under certain circumstances
3 PVC	Polyvinyl chloride Hard PVC: Drains, window profiles, oil/ vinegar bottles Soft PVC: Floor coverings, toys, hoses, synthetic leather, vinyl carpets, swimming rings	Extremely unsafe. Can cause a variety of toxic chemical leaches (BPA, lead, mercury, cadmium and phthalates) and serious health and environmental problems throughout the entire life cycle. Toxic dioxins (carcinogenic, persistent organic pollutants) can result from disposal. The raw material vinyl chloride is a known carcinogen.
4 LDPE	Low-density polyethylene: Tissue packaging, cling film, inside coatings of milk cartons	Harmless, so long as it is not exposed to direct sunlight, since otherwise the endocrine disruptor nonylphenol can be released under certain circumstances.
5 PP	Polypropylene Food containers, straws, baby bottles, microwavable dishes	Harmless and relatively stable. The stabilising agent (such as oleamide) can leach over time.
6 PS	Polystyrene Styrofoam for transporting meals, disposable cups/lids/cutlery, bicycle helmets, clothes hangers, petri dishes, coffee creamer	Very unsafe. Benzene, a known carcinogen, is used for its manufacture. It can contain toxic vinyl chloride and hormone-disrupting phthalates. The harmful styrene can pass from food packaging into food, especially when this is greasy, hot or acid-containing
7 OTHER	Other plastics Water coolers, drink bottles, microwavable dishes, kitchen appliances, eyeglass lenses, heat-sensitive paper receipts	Collective term for layered or mixed plastics. Avoid when they contain polycarbonate (PC), since this can release high concentrations of BPA.
	Polyurethane (PU) Products for insulating soft or foamed products	Unsafe. The environmentally- and health-damaging isocyanate is sometimes used and dangerous chemicals (isocyanate, hydrocyanic acid, dioxins) can escape during disposal.

IMPRINT

Osterstraße 58, 20259 Hamburg

www.bef-de.org

Authors: Alena Lucht, Hannah Sophia Weber, Fee Widderich; Layout: Matthias Grätz

This brochure was developed and printed as part of the NonHazCity project, with financial support from the INTERREG Baltic Sea Region Programme of the European Union. The contents of this brochure are the views of the authors alone, and not those of the European Commission.

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Baltic Environmental Forum Deutschland
Osterstraße 58 · 20259 Hamburg
www.bef-de.org
bef.deutschland