BIOPLASTICS
food packaging

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The term "bioplastics" implies that these materials have the same useful characteristics as conventional fossil fuel-based plastics together with a positive connotation of being "bio". But are bioplastics as "sustainable", "bio", and "green" as their marketing suggests?

Can they be a solution to the world's plastic problem? And, what are bioplastics exactly? This fact sheet sheds light on "bioplastics", which includes bio-based and biodegradable alternatives to conventional, fossil carbon-based plastics.

BIO-BASED

Renewable feedstock sources, such as corn and sugar cane, provide the basis for what are referred to as bio-based plastics. After the extraction of these renewable starting materials, they are chemically processed and used to manufacture bio-based plastics. This is, for instance, the case for polylactic acid (PLA) and bio-based polyethylene (bio-PE). Bio-based plastics that chemically resemble conventional plastics are called "drop-in" plastics. Other bio-based plastics are based on natural polymers or fibers, such as starch, cellulose, and bamboo, which are often mixed with man-made synthetic polymers.

BIODEGRADABLE

Biodegradable plastics are designed for microbial conversion into CO_2, methane, biomass, and mineral salts. To what extent and how fast these materials are biodegraded depends on their composition as well as the environmental conditions where degradation should take place, such as humidity, temperature, and the presence of certain microorganisms. However, the specific conditions necessary for full biodegradation are not always given, not even in industrial composting facilities. Furthermore, the degradation of plastic additives is usually not addressed at all.

BIO-BASED & BIODEGRADABLE

Not all bio-based plastics are biodegradable, and not all biodegradable plastics are bio-based. While bio-based PLA is also biodegradable under certain conditions, this is not the case for bio-PE. And, there are also petroleum-based plastics that are designed to biodegrade, such as polybutylene adipate-co-terephthalate (PBAT).

APPLICATIONS

Bioplastics have a wide range of applications spanning from packaging to textiles, the agriculture and automotive sectors, to coatings and adhesives. Rigid or flexible packaging and disposable tableware made of bioplastics are widely used in direct contact with food. Because bioplastic items visually resemble their conventional fossil-based counterparts, identifying them is difficult.

MARKET DATA

In recent years, the annual global production of bioplastics reached around 2.5 million tons. Of the plastics produced worldwide, bioplastics accounted for less than one percent in 2021, with PBAT, PLA, and starch-blends having the highest market share.

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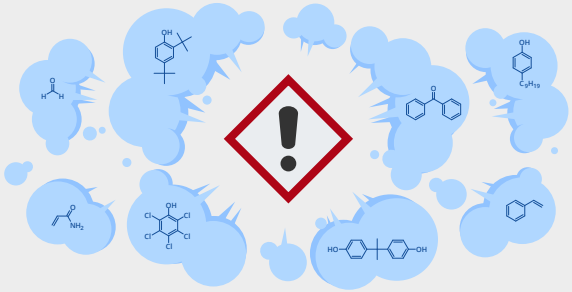
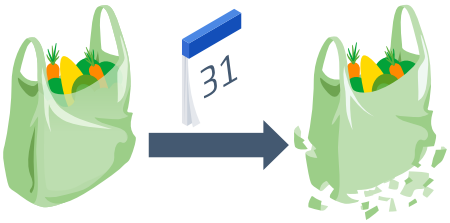
WHAT ARE THE ENVIRONMENTAL AND SOCIAL IMPACTS OF BIOPLASTICS' PRODUCTION?

The use of renewable carbon as feedstock for **bio-based** plastics helps reduce fossil carbon use. In general, plant-based feedstocks have a better carbon footprint than petroleum. However, the production of renewable carbon requires water, land, and chemicals, such as pesticides and fertilizers. Furthermore, plant feedstock cultivation competes with food production. Environmental impacts can be reduced by using waste and by-products from agriculture and the food industry instead of crops cultivated for plastic production.



WHAT IS KNOWN ABOUT THE CHEMICAL SAFETY OF BIOPLASTICS?

Just like conventional plastics, **bio-based** and **biodegradable** alternatives are chemically complex materials. To offset limitations inherent to bioplastic materials, such as brittleness and low gas barrier properties, bioplastics often contain a large variety and quantity of synthetic, man-made polymers, fillers, and additives. But the types, amounts, and hazards of these chemicals in bioplastics are not publicly disclosed, although they might transfer into food or enter the environment after disposal in landfills or home composts. Therefore, adverse consequences for human health and the environment are possible.



WHAT ARE THE PRACTICAL IMPLICATIONS FOR CONSUMERS WHEN USING BIOPLASTICS?

Producers of **biodegradable** plastics aim for stability during use and biodegradation after use. But it is a big challenge to develop materials that biodegrade only at a set time point. Therefore, some biodegradable products may biodegrade already during use, and others may be biodegraded only slowly after disposal, especially when conditions required for degradation are not met.

Products are often labeled as **bio-based** or **biodegradable** without further specification of what this means. Consequently, consumers may be misled. For instance, a purchased "bio-based" product may actually also contain synthetic polymers and hazardous additives, or a "biodegradable" plastic might still not be able to biodegrade in a home compost. In addition, the "bio" label can distract from the root cause of the plastic waste problem, e.g., extensive reliance on single-use packaging that enables globalized business models and convenience.

WHAT ARE THE OPTIONS FOR BIOPLASTICS AT THEIR END-OF-LIFE?

Drop-in plastics, such as bio-PE, can be treated in the same way as their conventional fossil-based counterparts. However, articles made of other bioplastics are typically not sorted and processed separately in waste management systems. Instead, they can even interfere with waste treatment, for example during the recycling of conventional plastics when improperly sorted.

Biodegradable products are made for single-use and not for material circularity. Composting or environmental degradation are typical end-of-life options, leading to the loss of resources and the generation of CO_2. In addition, complete degradation is possible only under strict conditions that are rarely provided. Thus, only for niche applications can the use of biodegradable plastics have advantages (e.g., tea bags). Biodegradable plastics are certainly not a solution to plastic litter. Instead, labeling a product as biodegradable can lead to consumer misunderstanding and as a result even increase littering.

Bioplastics can provide benefits over conventional plastics, such as substituting fossil carbon as raw material and reducing visible plastic pollution. Nevertheless, bio-based and biodegradable plastics can affect environmental and human health to varying degrees: The impacts are largely dependent on the individual product and its specific life cycle. Therefore, bioplastics are not a silver bullet solution for all problems related to current plastic use. Their application and further development require carefully weighing their limitations and benefits.

Factsheets on other materials

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