Demystifying Compostable and Biodegradable Plastics

Do Safe and Sustainable Options Exist?

July 2024

Executive Summary

Bioplastic products marketed as “plant-based,” “eco-friendly,” “biodegradable,” and “compostable” are becoming popular in the food industry with rising public awareness about the problems with single-use plastic packaging and plastic pollution. From earthy-looking, molded fiber bowls and utensils made from cornstarch to clear biodegradable cups and pale-green biodegradable garbage bags, the alternatives to traditional plastics are growing.

The packaging industry markets these materials as a solution to plastic pollution, claiming they break apart faster in the environment, are made from safer materials, and have smaller carbon footprints than traditional plastics, which are created from fossil fuels. With global plastics production surging, and millions of tons of plastic waste clogging our landfills and oceans, there is a clear need for alternatives to plastics.

However, just because a product is “biobased,” “compostable,” or marketed as a “bioplastic” does not necessarily make it better.

Bioplastic is an umbrella term for plastic that is:

- Partly or entirely derived from renewable plant materials (also known as “biobased” plastic);
- Biodegradable; or
- Both of the above.

They are made using the same processes as traditional plastics. That means they contain many chemical additives; yet, even less is known about the potential toxicity of those chemicals than the ones in conventional plastics. The term bioplastic also sows confusion, and in some cases deliberate greenwashing, which makes it difficult to know whether a particular product is better for the environment.

How then, do environmentally conscious restaurant owners, institutions, and consumers determine whether a product labeled “biobased” or “compostable” is actually preferable to a traditional plastic alternative or to a non-plastic alternative? This report provides an overview of the bioplastic materials currently on the market, the voluntary standards that govern their design, and the scientific research findings to date on their safety to help individuals make that evaluation. It also covers the waste management issues associated with bioplastics and provides a checklist to guide decision-making.

Recent research on bioplastics’ safety is not promising. It shows that some bioplastics may be even more toxic than conventional plastics because their product formulations contain new, unidentified chemicals. At the same time, research also shows that some bioplastic formulations are not toxic and that formulations within a given material type can vary significantly. Knowledge of a given bioplastic's chemical composition is necessary to evaluate its potential environmental and human health impacts, but manufacturers guard that information closely.

The lack of federal standards defining and regulating bioplastics not only encourages greenwashing, but also creates significant waste management challenges. U.S. manufacturers can elect to follow voluntary industry standards developed by the American Standards Testing Material (ASTM), but not all do. Moreover, the fact that certification programs in the United States, Europe, Australia, and New Zealand are run by trade associations or advocacy organizations that represent bioplastics manufacturers, creates significant conflicts of interest. For example, the board of the U.S.'s lead certifier of compostable packaging, the Biodegradable Products Institute (BPI), includes executives from some of the country's most powerful petrochemical companies, including BASF, Eastman Chemical Company, TotalEnergies Corbion, and Danimer Scientific. Companies certifying their products through BPI also pay an annual membership fee that gives them a voice on the organization's standards and procedures committee, a technical committee overseeing the validation process for BPI's certification mark.

The end-of-life management of "compostable" products is fraught with challenges, partly due to the lack of mandatory standards. Compostable foodware is not designed for backyard compost bins and — with rare exceptions — can only be composted in commercial composting facilities. Most communities across the country do not have access to these kinds of facilities. Furthermore, even if residents did have access to them, most commercial and municipal composters in the U.S. do not accept compostable packaging due to concerns about residual debris or chemical contamination in their final soil product. Organic farmers are one of their main customers, and they clearly do not want to purchase compost contaminated with microplastics or chemicals like PFAS.[1]

Additionally, "compostable" foodware is typically more expensive than conventional foodware. Costs vary widely by vendor but can range anywhere from double to six times the price of conventional plastics. For example, a 16-ounce PET or polypropylene cup can cost between $45 to $94 per 1,000, whereas "compostable" PLA cups can cost up to $190 per 1,000. Business owners should call local restaurant supply companies to do their own price comparisons.

---

[1] Maine Organic Farmers and Gardeners Association, comment letter to the National Organic Standards Board regarding Docket # AMS-NOP-23-0075, April 3, 2024.

In short, bioplastics come with many challenges. While the plastics and packaging industries push the narrative of swapping out one type of plastic for another, that would be shortsighted. The best option is to turn off the spigot for single-use plastics of all kinds, whether conventionally produced or made with plant-based materials.

It's important to note that single-use plastics account for nearly half of all plastics produced. Whenever possible, eliminating single-use plastics and finding an alternative means to deliver a product is the best choice. Reuse systems that deploy returnable or refillable containers are an ideal solution. Many case studies show that reuse saves businesses money over disposable products. A growing network of reuse organizations and startups can help food businesses and institutions evaluate potential alternatives to find the best fit. ReThink Disposable, for example, provides free consulting and waste audits.

To expand reuse opportunities across the country, policymakers must mandate and fund reuse infrastructure through legislation like packaging reduction bills, often referred to as extended producer responsibility (EPR) laws and (container deposit laws ("bottle bills") that incentivize the recovery of bottles and cans. (EPR is a policy tool that makes producers legally and financially responsible for mitigating the environmental impacts of their products and packaging. Learn what's required to ensure an EPR policy is effective through the Beyond Plastics/Just Zero fact sheet.)

Eliminating single-use plastic, swapping plastic for a reusable or refillable system, or replacing plastic with a more sustainable paper or cardboard product should all be considered before turning to bioplastics. When plastics are truly necessary and cannot be eliminated, biobased polymers may sometimes be preferable due to the devastating environmental, human health, and environmental justice impacts associated with fossil fuel-derived plastics; but that should be evaluated on a case-by-case basis and requires the disclosure of a product's complete chemical composition.

Any bioplastic product must be carefully vetted. Business owners and consumers should ask suppliers and manufacturers to disclose both the content of their products and any testing or third-party certification, such as by GreenScreen Certified, proving that their products do not contain harmful chemicals. Compostable products must additionally be certified compostable in a home/backyard composting situation. Business owners and consumers must further ensure there is a commercial compost facility nearby that will actually accept the waste products as many do not. Ultimately, the packaging industry needs to focus on designing materials that are non-toxic and better for the planet, and policymakers need to pass laws requiring them to do so.

Table of Contents

BEYOND PLASTICS

Checklist for Restaurants and Others to Ask Suppliers of Their Products:

	Yes	No
1. Are you sure you can't replace the plastic with a reusable product?	☐	☐
2. Are you sure you can't replace the plastic with paper or cardboard?	☐	☐
3. If plastic is the only option, do you have products that are not derived from fossil fuels? (Bioplastics derived entirely from fossil fuels create similar problems as regular plastic.)	☐	☐
4. Is the product free of polylactic acid (PLA)? (PLA products are typically made from corn or sugar crops and may also contain toxic chemicals.)	☐	☐
5. Is it certified by GreenScreen, Cradle to Cradle, or USDA BioPreferred?	☐	☐
6. If it's not certified by an independent group, can you tell me what chemicals it contains?	☐	☐
7. Is it free of PFAS?	☐	☐

Next Steps for Businesses to Consider:

8. Will your business establish a separate collection bin for biodegradable/compostable products?	☐	☐
9. Does your area have a commercial composting facility where the material can be sent?	☐	☐
10. Will your waste hauler bring the source-separated compostables to a commercial composting facility, and is there an extra cost for that?	☐	☐

The Plastic Pollution Crisis

Global plastic production has surged from 15 million tons per year in 1964 to more than 450 million tons per year today.[2] Cumulatively, from 1950 to 2017, the world produced over 10 billion tons of plastic,[3] much of it designed to be used just once and thrown away. Every minute, in fact, 1 million plastic throwaway bottles are purchased around the world, while up to 5 trillion plastic bags are used annually, according to the United Nations Environment Programme.[4]

Under business as usual, plastic production is forecast to increase by 70% by 2040 in comparison to 2020,[5] with roughly half of that designed for single-use products.

Plastics do not biodegrade, are very difficult to recycle, and create numerous environmental and human health impacts. Over 16,000 chemicals can be used in the manufacture of plastics to enhance their performance. In the U.S., less than 6% of plastics are recycled,[6] even after decades of consumers following the chasing-arrow system. Millions of tons of plastics clog our landfills, beaches, oceans, waterways, air, and soil. An estimated 33 billion pounds (15 million metric tons) of plastic enter the ocean every year — roughly the equivalent of dumping two garbage trucks full of plastic into the ocean every minute.[7]

In the environment, plastics break up into smaller and smaller pieces that eventually become tiny particles called microplastics and nanoplastics. These particles have been found in honey, beer, salt, tea bags, fruit, vegetables, seafood, meat, and many plastic packaged foods. Unsurprisingly, scientists are also finding microplastics in our blood, organs, brains, breast milk, placentas, and testicles, and have linked them with heart attacks and stroke,[8] as well as with gastrointestinal problems and potentially with diseases related to hormone disruption.[9]

---

[2] Gert-Jan M. Gruter, Using carbon above the ground as feedstock to produce our future polymers, *Current Opinion in Green and Sustainable Chemistry,* Vol 40, April 2023.
[3] Allan T. Williams and Nelson Rangel-Buitrago, The past present and future of plastic pollution, *Marine Pollution Bulletin*, 176 (113429), March 2022. https://www.sciencedirect.com/science/article/abs/pii/S0025326X22001114
[4] https://www.unep.org/interactives/beat-plastic-pollution/
[5] OECD, Towards Eliminating Plastic Pollution by 2040, A Policy Scenario Analysis, November 2023.
[6] Beyond Plastics and The Last Beach Cleanup. The Real Truth About the U.S. Plastics Recycling Rate. May 2022. https://static1.squarespace.com/static/5eda91260bbb7e7a4bf528d8/t/62b2238152acae761414d698/1655841666913/The-Real-Truth-about-the-US-Plastic-Recycling-Rate-2021-Facts-and-Figures-_5-4-22.pdf
[7] Forrest et al. Eliminating Plastic Pollution: How a Voluntary Contribution From Industry Will Drive the Circular Plastics Economy, *Frontiers*, September 25, 2019. Accessed on June 4, 2024: https://www.frontiersin.org/articles/10.3389/fmars.2019.00627
[8] Raffaele Marfella, M.D., Ph.D., Francesco Prattichizzo, Ph.D., Celestino Sardu, M.D., Ph.D., Gianluca Fulgenzi, Ph.D., Laura Graciotti, Ph.D., Tatiana Spadoni, Ph.D., Nunzia D'Onofrio, Ph.D., and Giuseppe Paolisso, M.D. Microplastics and Nanoplastics in Atheromas and Cardiovascular Events, *N Engl J Med* 390 (10) pp 900-910, March 6, 2024.
[9] Claudia Campanale, Massarelli C, Savino I, Locaputo V, Uricchio VF, A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health, *Int J Environ Res Public Health*. 2020 Feb; 17(4): 1212.

Plastics production, from fossil fuel extraction and processing to transportation, creates toxic air and water pollution, with low-income communities and communities of color bearing the burden of that pollution.[10] The U.S. plays a significant role in the global plastic pollution problem, generating more plastic waste than any other country.[11] In fact, the U.S. plastics industry currently produces the equivalent emissions of 116 average-sized coal-fired power plants and is on track to exceed greenhouse gas emissions from coal-fired power in this country by 2030.[12]

Clearly, there is an urgent need for alternative materials and solutions to combat the global plastics crisis.

Bioplastics Myths: An Overview

The packaging industry touts bioplastics as a solution to the plastics crisis, claiming they break apart faster in the environment, are made from safer materials, and have smaller carbon footprints than traditional plastics. But they've yet to live up those claims.

Currently, bioplastics represent less than 1% of the global plastic market. Production capacity is expected to grow from 2.2 million metric tons today to 7.4 million metric tons by 2028,[13] but it will continue to remain a sliver of conventional plastics production. Not surprisingly, packaging accounts for over half of biobased plastic production.[14]

In theory, bioplastics should produce fewer greenhouse gas emissions than traditional plastics because there is no net increase in carbon dioxide emissions when carbon is extracted from a renewable plant source. However, their climate benefit is undermined[15] by the increased use of fertilizers and pesticides, as well as forest burning to clear land for corn or sugarcane production. Emerging newer-generation bioplastics made from feedstocks like food waste, algae, and mushrooms, however, show promise for having both lower carbon footprints than traditional plastics and fewer negative consequences.[16]

Additionally, some view bioplastic food packaging as essential to keeping food waste out of landfills, where it breaks down anaerobically, or without oxygen, and produces methane gas, a

[10] Environmental Integrity Project, Feeding the Plastics Industrial Complex, March 2024.
[11] Law K, Starr N, et al. (2020) The United States' Contribution of Plastic Waste to Land and Ocean. *Science Advances* 6: 44
[12] Jim Vallette, The New Coal, Plastics and Climate Change, Beyond Plastics, October 2021.
[13] Bioplastics global production capacity 2022-2028, by type, Statista, May 2024.
[14] Valentina Siracusa and Ignazio Blanco, Bio-Polyethylene (Bio-PE), Bio-Polypropylene (Bio-PP) and Bio-Poly(ethylene terephthalate) (Bio-PET): Recent Developments in Bio-Based Polymers Analogous to Petroleum-Derived Ones for Packaging and Engineering Applications, *Polymers (Basel).* 2020 Aug; 12(8): 1641.
[15] Rosenboom, JG., Langer, R. & Traverso, G. Bioplastics for a circular economy. *Nat Rev Mater* 7, 117–137 (2022).
[16] Jodi Helmer, Can Food Waste be Transformed into Biodegradable Plastic? *Food Print,* November 2020.

powerful global warming gas. Landfills are the third-largest producer[17] of methane gas in the U.S., and some states are passing laws to reduce food waste, such as by increasing composting. The idea is that compostable foodware will help deliver food scraps to industrial compost facilities; however, as discussed in the section, Waste Management, there are many obstacles to this.

Claims about safer materials and faster ability to break apart are discussed in detail in the sections "Chemical Additives, What Do We Know?" and "Waste Management Options and Availability," but first it's important to understand what is meant by bioplastics because there is a lot of confusion about what they are.

Bioplastics Basics: Learning the Terminology

Bioplastics, sometimes referred to as "biopolymers," are defined as plastic materials that are partly or entirely derived from renewable plant materials, are biodegradable, or are both. That broad definition, plus a lack of regulations, gives manufacturers a wide berth to claim that their products are "plant-based," "biodegradable," or "earth-friendly."

Although many consumers believe that all bioplastics biodegrade, or disintegrate in the environment, not all do. Many also assume that bioplastics are always made from plant materials; but some, like polybutylene adipate terephthalate, or PBAT, are made entirely from fossil fuels. The industry calls such materials "bioplastics" because they have been engineered to eventually biodegrade, even though they're made from petroleum products.

All bioplastics start with a polymer, just like traditional plastics. Polymers are substances made from long chains of repeating chemicals. They are nature's building blocks, and can be derived from petroleum products, plant materials, or both.

The Three Types of Bioplastics

There are three main types of bioplastics, although the industry typically groups them into two camps based on whether they're biodegradable or not:

1. **Biobased plastics** are built from polymers derived partly or fully from plants — such as sugarcane, sugar beet, and molasses — but they do not biodegrade. These include biobased polyethylene (bio-PE), biobased polypropylene (bio-PP), and biobased polyethylene terephthalate (bio-PET), which is used by some beverage companies. These

[17] EPA, Basic Information about Landfill Gas. https://www.epa.gov/lmop/basic-information-about-landfill-gas#

bioplastics are sometimes considered “drop-ins” for fossil-fuel-based plastics because they have been engineered to function exactly as traditional plastics do.

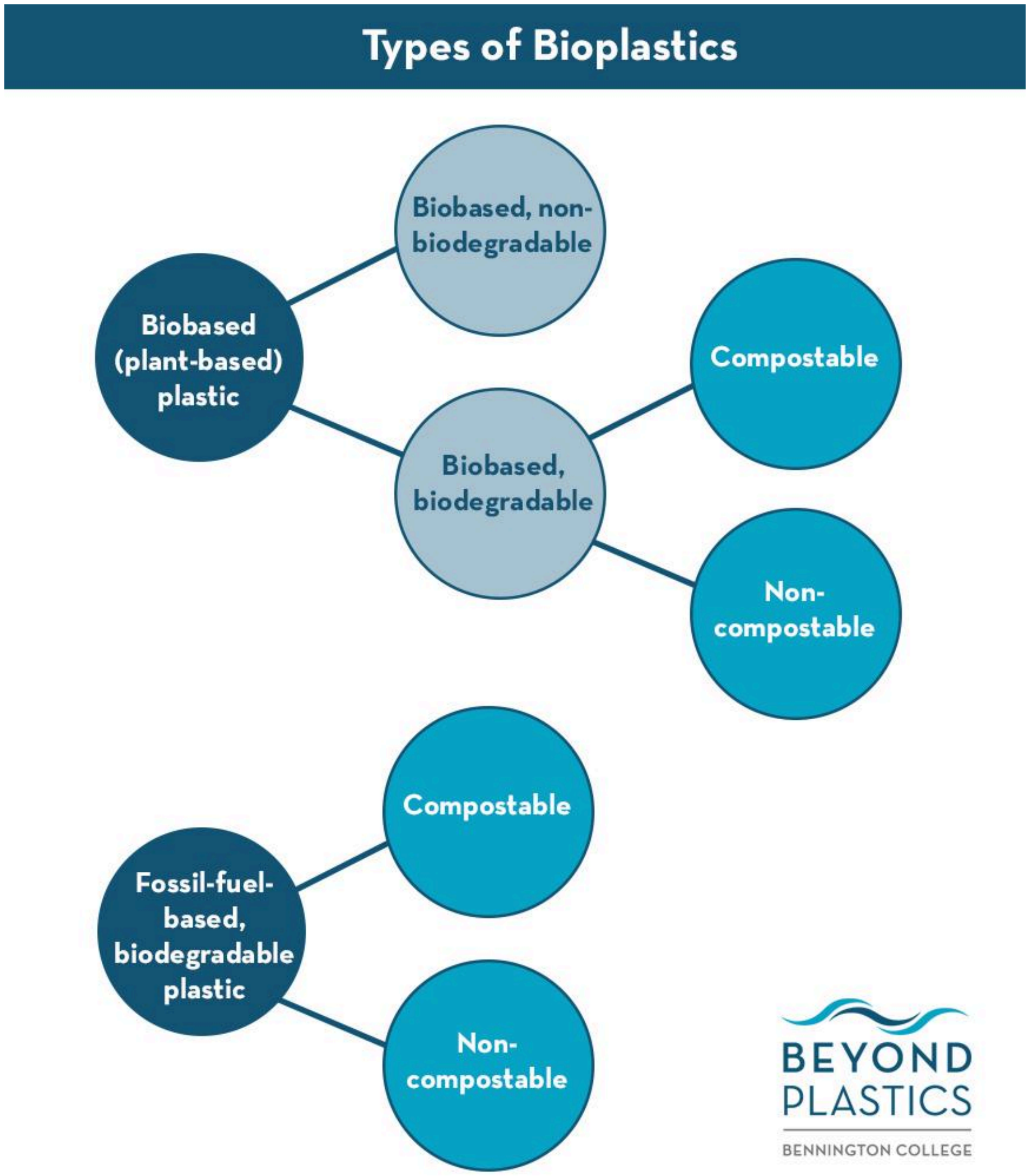
2. **Biobased, biodegradable bioplastics** have the ability to break apart in the environment. The most common is polylactic acid, or PLA, which is made from a polyester derived from starches like corn, cassava, beets, and sugarcane. PLA is widely used in compostable foodware, cutlery, and bags. Polysaccharides derived from seaweed and polymers made from mycelium are two more emerging biodegradable biobased bioplastics. Cellulose-based bioplastic fibers used for textiles, paper, and construction also fall into this category, as do bioplastics made from polyhydroxyalkanoate (PHA) and polybutylene succinate (PBS). The industry refers to PHA and PBS as “third-generation” bioplastics because they are typically derived from alternative feedstocks that have lower carbon footprints, including agricultural byproducts, food waste, yeasts, waste oils, and bacteria.
3. **Fossil-fuel-based, biodegradable plastics,** such as PBAT, are derived entirely from petroleum products. These bioplastics are engineered to biodegrade. They are used for mulch films in agriculture, compostable refuse bags, and, increasingly, for plastic cutlery.

Biodegradable Versus Compostable

“Biodegradable” and “compostable” are distinct terms that are often used interchangeably when it comes to plastic, but they are not the same. ***Biodegradable plastic*** refers to a product that can break apart by natural processes in the environment, but without a specific timeline. Depending on the product, it can take days or weeks to centuries, depending on the material and the environment.

In contrast, ***compostable plastic*** refers to a product’s ability to be broken apart by microbes under controlled conditions (for oxygen, temperature, and moisture) at a commercial compost facility. Certified compostable bioplastics are engineered to fully decompose within 12 weeks in a commercial composting facility.

All compostable items are therefore inherently biodegradable, but not all biodegradable bioplastics can be composted.



The lack of specificity around the term "biodegradable" leads many to argue that it is a meaningless and misleading designation that should not be used for bioplastics, especially since most biodegradable bioplastics are meant to be composted, not disposed of in a landfill. What's more, even conventional plastics eventually biodegrade, it just takes 500 to 1,000 years. Studies have found that products labeled as biodegradable can take many months to years to actually disintegrate in the environment, and that specific environmental conditions affect the rate of degradation.[18] One study found that biodegradable plastic bags were still fully intact after three years of being buried in the soil.[19]

Looking deeply into the issue, researcher Adele Folino concluded that "the available literature often demonstrates that biodegradation in real environmental or [waste treatment] plant conditions is lower than expected and sometimes negligible."[20]

Table 1: Bioplastics Overview: Type, Origin, and Function*			
Bioplastic Type	**Polymers**	**Derived From**	**Uses**
Biobased, Biodegradable	• Polylactic acid (PLA) • Polyhydroxyalkanoate (PHA) • Polybutylene succinate (PBS) • Polyhydroxybutyrate (PHB) • Polybutylene adipate terephthalate (PBAT) • Cellulose- and lignin-based fibers • Seaweed polysaccharides • Mycelium • Chitin/protein-based polymers	• Starches from corn, cassava, sugarcane, beets, etc. • Agricultural and forestry byproducts, food waste, algae, yeasts, and bacteria, • Agricultural and forestry products and wastes • Bamboo • Kelp • Fungi • Crab shells	• *PHA/PHB:* packaging and tableware • *PHB/PLA:* agricultural mulch films • *PHB:* surgical sutures and drug delivery systems • *PLA:* foodware and shopping bags • *PBAT*: shopping bags, disposable medical supplies, films, and 3-D printing
Biobased, Non-Biodegradable	• Bio-polyethylene (bio-PE) • Bio-polyethylene terephthalate (bio-PET) • Bio-polyvinyl-chloride (bio-PVC) • Bio-polyurethane (bio-PU) • Polyamides, or nylons Polytrimethylene (polyesters)	• Sugarcane ethanol • Corn • Vegetable oils from various plant seeds, such as castor, cotton, rapeseed, jatropha, palm, and soybean	• *Bio-PET:* soda bottles • *Bio-PA:* automotive industry • *Bio-PVC:* construction industry • *Bio-PE:* food packaging, consumer goods • *Bio-PTT:* fabrics, automotive, carpets

[18] 5 Gyres, Better Alternatives 3.0, November 2023.
[19] Alan Williams, Biodegradable Bags Can Hold a Full Load of Shopping Three Years After Being Discarded in the Environment, University of Plymouth, April 29, 2019.
[20] Adele Folino, Domenica Pangallo, Paolo Salvatore Calabrò, Assessing bioplastics biodegradability by standard and research methods: Current trends and open issues, *Journal of Environmental Chemical Engineering*, 11 (2) 2023, 109424.

	• Polyterephthalate (PTT)		
Fossil-Fuel-Based, Biodegradable	• Polybutylene succinate (PBS) • Poly-e-caprolactone (PCL) • Polybutylene adipate-co-terephthalate (PBAT) • Poly-butylene succinate-co-butylene adipate (PBSA)	Petrochemicals	• Mulch films in agriculture • Garbage bags • Single-use cutlery

** Note: Not a complete list of bioplastics on the market.*

Bioplastics Regulations and Certifications

There are currently no federal standards that define or regulate bioplastics, biodegradable, or compostable products. U.S. manufacturers can choose to follow voluntary, industry standards developed by the American Standards Testing Material (ASTM) and the International Organization for Standardization (ISO), but not all do. In addition, the United States Department of Agriculture has developed a voluntary standard certifying the content of biobased products called BioPreferred, but manufacturers are not required to verify nor disclose the amount of plant-based materials contained in their products.

Several ASTM standards (ASTM D6400, D6868, D5338) govern compostability and labeling of compostable products. They essentially boil down to requiring products to fully decompose within 12 weeks under controlled conditions in a commercial compost facility. A material is considered fully decomposed if less than 10% of it remains after passing it through a 2-millimeter sieve. However, the 2-millimeter sieve means that microplastics and nanoplastics may remain in compost. Materials are additionally screened for various toxins, including heavy metals and pathogens, but the screening does not include a full spectrum of potential chemical additives, such as PFAS.

ASTM has a test for biodegradation (D5526) that measures a plastic's ability to break apart in a landfill environment over six months.[21] But there is no ASTM label certifying that a product is biodegradable. Products are instead given a carbon conversion percentage — the percent of original material that converts to carbon over the test period.

[21] ASTM International, Standard Test Method for Determining Anaerobic Biodegradation of Plastic Materials Under Accelerated Landfill Conditions.

ASTM runs a certification program for manufacturers as do several other organizations, including the Biodegradable Products Institute, or BPI, which is the largest group in the U.S. certifying compostable products following ASTM's standards. BPI also has some of the most powerful petrochemical companies on its board of directors — more on that in a bit. BPI additionally requires products to be PFAS-free (as PFAS have been widely used in food packaging for their ability to repel grease and water) and tests for soil toxicity, using a method developed by the Organization for Economic Cooperation and Development (OECD). Products certified by BPI must be labeled BPI-certified. BPI does not certify products for home composting.

In Europe, the European Bioplastics Association owns a certification program run by TÜV Austria (Belgium)[22] and DIN CERTCO (Germany).[23] It is similar to BPI, but also follows rules developed for Europe. Products sold in the U.S. may contain TUV labels "OK Compost Industrial" or "OK Compost Home." The Australasian Bioplastics Association certifies products sold in Australia and New Zealand.

Some states — including California, Washington, and Colorado — require manufacturers to adhere to ASTM standards if they are marketing their products as compostable, and they impose penalties if manufacturers fail to do so. But most states do not require products to be certified, which leads to rampant greenwashing (deceptive advertising designed to convince consumers that a product is environmentally friendly.) Manufacturers are free to label products as biodegradable or compostable without meeting any standards. Moreover, many develop lookalike products deliberately intending to confuse consumers, which leads to a lot of contamination at industrial compost facilities.

Finally, the U.S. Food and Drug Administration (FDA) must approve any materials that come into contact with food, which includes evaluating the chemicals used in packaging and containers. The FDA rarely bans chemicals from food packaging; although earlier this year, it announced that manufacturers will no longer be allowed to use PFAS on fiber-based food packaging, such as wrappers and cartons. The FDA has not yet eliminated PFAS in all food contact materials. A dozen states have enacted bans or phaseouts of PFAS in food contact materials, and some of these encompass more than fiber packaging.[24]

The limitations of both the FDA's and ASTM's standards led the Center for Environmental Health and Clean Production Action to develop an independent, third-party chemical screening and certification program for single-use foodware products. The GreenScreen Certified Standard prohibits more than 2,000 chemicals of concern, including endocrine-disrupting chemicals like

[22] TUV Austria, homepage.
[23] DIN CERTCO, homepage.
[24] Jeffrey Hunter, Andrea Driggs, Aubri Margason, Sara Cloon, Unpacking PFAS Food Packaging Regulations in the US, *Packaging Digest*, September 19, 2023.

bisphenols, phthalates, parabens, and organotin compounds, and chemical classes like PFAS. Thus far, only two manufacturers, Eco-Products Inc., and NatureWorks LLC, have certified their products or raw materials through the GreenScreen Standard; nevertheless, it offers a promising pathway for ensuring that bioplastic and compostable alternatives do not contain harmful chemicals of concern beyond the ASTM standard.

Is the Fox Guarding the Henhouse?

Certification programs in the United States, Europe, Australia, and New Zealand are all run by trade associations or business advocacy organizations that represent bioplastics manufacturers, posing a major potential conflict of interest. For example, at the time of writing this report, BPI's board of directors included executives from nine major bioplastics manufacturers; two consumer brands that use bioplastic packaging, PepsiCo and Amy's Kitchen; and two commercial composters. BPI's board also included executives at some of the most powerful companies in the petrochemical industry, including BASF, Eastman Chemical Company, TotalEnergies Corbion, and Danimer Scientific, as well as executives from four large bioplastics or pulp and paper companies, including NatureWorks, Novamont, Pactiv Evergreen, and Georgia-Pacific. Notably, there are no independent scientists, government officials, or other neutral board members.

For an independent certification body, BPI's board composition therefore appears to represent many clear conflicts of interest. In fact, it's telling that, at the time of writing this, the BPI website's listing of board members is arranged in alphabetical order by the name of the company each board member represents rather than by the individuals' first or last names.

- Renaud des Rosiers, Amy's Kitchen
- Jeanette Hanna, BASF Corporation *(Note: Jeanette Hanna is the Biopolymers North American Market Development Manager at BASF.)*
- Melissa Tashjian, Compost Crusader
- Keith Edwards, Danimer Scientific
- Mounir Izallalen, Eastman Chemical Company
- Wendell Simonson, Eco-Products Inc.
- Peg Hoks (President), Georgia-Pacific
- Shannon Pinc, NatureWorks LLC

- Paul Darby, Novamont North America
- Lynn Dyer, Pactiv Evergreen
- Sri Narayan-Sarathy, PepsiCo
- Derek Atkinson, TotalEnergies Corbion BV
- Justen Garrity, Veteran Compost DC

Companies that certify their products through BPI pay the organization certification and membership fees. Becoming a member gives companies a vote on several committees, including the standards and procedure committee, a technical committee that oversees the validation process associated with BPI's certification mark. Companies with certified products can therefore influence how BPI sets its standards.

BPI does not do the actual testing of products. It requires manufacturers to use an independent lab that it has approved. To date, BPI has approved 33 labs that are a mix of private companies and university research units that are accredited by ASTM. Testing takes up to six months for both degradation and compostability. PFAS-free certification is achieved by: 1) safety data sheets that show no fluorinated chemicals, 2) test results from a BPI-Approved lab showing a maximum of 100ppm total organic fluorine. 3) A statement of no intentionally added fluorinated chemicals, signed by the manufacturer. An independent technical reviewer tests the materials and reviews lab results to determine whether they pass all of the requirements for certification.

Chemical Additives: What Do We Know?

Bioplastics may be marketed as safe and environmentally benign, but they are typically made using the same processes as traditional plastics, which means they may also contain harmful chemical additives.

Plastic production starts with polymers that are created from plant materials, petroleum products, or a combination of the two. Chemical fillers, additives, plasticizers, and dyes are then added to give the plastic the desired qualities, such as flexibility, heat-resistance, or waterproofness.[25] Because these additives are not chemically bonded to the polymer material, they can leach out of the final product.[26]

---

[25] Hahladakis J, Velis C, et al. (2017) An Overview of Chemical Additives Present in Plastics: Migration, Release, Fate and Environmental Impact During Their Use, Disposal and Recycling. J Hazard Mater. 2018 Feb 15.
[26] Muncke, J. (2021) Tackling the Toxics in Plastics Packaging. *PLOS Biology*.

Studies[27] show that these additives are likely more worrisome than the polymers. Knowing the chemical composition of each bioplastic is therefore key to understanding its impacts on environmental and human health. Unfortunately, manufacturers are not required to disclose that information.

Some manufacturers are seeking to create packaging and other products without toxic chemicals. Some companies, for example, create mycelium products, which they say contain no toxic chemicals. Mycelium products are a suitable replacement for extruded polystyrene foam (commonly known as polystyrene), but they are not yet durable enough to be used for foodware or some packaging.

Toxicity of Bioplastics' Chemical Additives

A few studies have been conducted on the potential toxicity of chemical additives used to manufacture bioplastic products, but more research is critically needed.

A 2020 study[28] by lead author Lisa Zimmerman found that bioplastics were just as toxic and, in some instances, *more* toxic than conventional plastics. Researchers evaluated the toxicity of 43 common bioplastics consumer products — including cups, films, coffee capsules, and bags — and compared them to that of conventional plastics. The researchers extracted chemicals from the products and from nine different starting materials — including PLA, PHA, PBS, PBAT, Bio-PE, Bio-PET, starch, cellulose, and bamboo — and tested them for three indicators of toxicity. Additionally, they attempted to identify the chemicals in the plastics.

The results showed that two-thirds of the 43 extracts — including the cellulose and starch materials — induced baseline toxicity, or the ability to harm a wide range of organisms in the environment. Bamboo and Bio-PE samples showed the lowest toxicity. Six of 10 Bio-PE samples did not induce any toxicity at all. Eighteen of the 43 samples induced oxidative stress, which measures a chemical's ability to disrupt metabolic processes or create DNA-damaging free radicals. About a quarter of the samples demonstrated the ability to disrupt hormones, with one Bio-PE sample showing the greatest hormone-disrupting capacity. PLA induced the highest and broadest toxicological response. Unsurprisingly, the final products were more toxic than the raw materials.

---

[27] Claudia Campanale, Massarelli C, Savino I, Locaputo V, Uricchio VF, A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health, *Int J Environ Res Public Health*. 2020 Feb; 17(4): 1212.
[28] Lisa Zimmermann, Andrea Dombrowski, Carolin Völker, Martin Wagner, Are bioplastics and plant-based materials safer than conventional plastics? In vitro toxicity and chemical composition, *Environment International*, 145, December 2020, 106066.

The researchers also found a large number of chemical “features” in each sample, with starch, cellulose, and Bio-PE containing the greatest number of chemical features — more than 19,000 each. Although the researchers could not identify many of the substances, they found that 270 chemicals were present in both the bioplastics and conventional plastics, such as N,N'-1,4-Butanediyldihexadecanamide, a plasticizer.

“Our results imply that chemicals inducing unspecific toxicity are prevalent in all types of biobased and/or biodegradable products, especially in those made of the natural polymers starch and cellulose,” the authors concluded, noting further that, “Very little is known in terms of the chemical safety of bioplastics, that is the identity of compounds present in the material and their (mixture) toxicity as well as the human exposure to these compounds.”[29]

A 2019 study[30] focused on PLA that was conducted by some of the same researchers found that PLA showed high baseline toxicity, or the ability to affect a wide range of organisms in the environment. At the same time, it found that some of the traditional plastics did not have toxic properties.

A third study published in October 2023,[31] by lead author Tiantian Wang, compared the toxicity levels of compostable bioplastics bags to conventional plastics and investigated whether photodegradation and composting affected toxicity. The researchers extracted chemicals from intact bags and tested for the effects of photodegradation and composting in the laboratory, but not under field conditions.

Their results were startling. Comparing four bioplastics bags made from PBAT and starch to four conventional plastics made from PET, LDPE, and recycled PE, they found that the chemicals extracted from the compostable bags were more toxic to cells in test-tube laboratory experiments than the chemicals extracted from the virgin and recycled plastics. The authors concluded that the high toxicity found in the compostable materials was likely due to the addition of new, as yet unknown, plasticizers to improve the bioplastic bags’ performance. They called for further investigation into the formulations of bioplastics.

---

[29] Zimmermann L, Dombrowski A, et al. (2020) Are Bioplastics and Plant-Based Materials Safer Than Conventional Plastics? In Vitro Toxicity and Chemical Composition. *Environment International*. Volume 145.

[30] Lisa Zimmermann, Andrea Dombrowski, Carolin Völker, Martin Wagner, Are bioplastics and plant-based materials safer than conventional plastics? In vitro toxicity and chemical composition, *Environment International*, 145, 2020, 106066.

[31] Tiantian Wang, Mahboubeh Hosseinzadeh, Alice Cuccagna, Rakhat Alakenova, Paula Casademunt, Alcira Reyes Rovatti, Amparo López-Rubio, Cinta Porte, Comparative toxicity of conventional versus compostable plastic consumer products: An in-vitro assessment, *Journal of Hazardous Materials,* Volume 459, 2023, 132123.

The researchers also found that incomplete photodegradation and composting increased the toxicity of the residual bioplastic material. Exposure to sunlight can change the chemical composition of plastics. Also, as bioplastics break apart, they release chemicals. Any remaining plastic particles could therefore contain more chemicals than the intact product, according to the researchers.

The study concluded that plastic residues remaining in final compost could be a significant source of pollutants to the environment, and that these findings highlighted “the importance of investigating the effects of degradation mechanisms, such as sunlight and composting on the toxicity of bioplastics.” In addition to the environmental impacts of microplastics particles in compost, it’s logical to conclude that the risks will extend to wildlife and to humans as toxic chemicals make their way through the food chain.

Soil Health and Marine Environment Impacts

Wang’s study on compostable bioplastics is one of a handful focusing on the impact of bioplastics on soil or the marine environment. Most studies have focused on the environmental impacts of traditional plastics, and microplastics in particular.

A 2021 review[32] of the limited science on bioplastics’ effects on soil found negative impacts in some measures of soil health but not in others and called for further research. The author found that “bioplastics cause changes in soil chemical composition and structure, and consequently may contribute to the disturbances in water balance and cycle in the soil environment.” The author also noted “both inhibitory and stimulating effects are observed in relation to roots and stems growth and that nanoparticles of bioplastics are able to accumulate in plant organs.”

A 2022 study[33] investigated the effects of three types of biodegradable (not necessarily compostable) plastics on plant growth and on the production of carbon dioxide and nitrous oxide in the soil. The bioplastics included non-woven fabric sheets, laminate sheets, and cups made of either PLA, polybutylene-succinate, polybutylene adipate terephthalate, or a combination of these materials. Researchers incubated the bioplastics in soil for four weeks and found that, depending on the material type, the bioplastics inhibited plant growth, and increased greenhouse gas production. They concluded that further long-term experiments on other forms of bioplastic are necessary.

---

[32] Ewa Liwarska-Bizukojc, Effect of (bio)plastics on soil environment: A review, *Science of The Total Environment*, Volume 795, 2021, 148889.

[33] Inubushi, K., Kakiuchi, Y., Suzuki, C., Sato, M., Ushiwata, S. Y., & Matsushima, M. Y. (2022). Effects of biodegradable plastics on soil properties and greenhouse gas production. *Soil Science and Plant Nutrition*, *68*(1), 183–188.

A study[34] focused on microplastics found that fewer perennial ryegrass seeds germinated when exposed to fibers or PLA microplastics, as well as to conventional HDPE plastics. The authors concluded that microplastics and synthetic fibers manufactured of both PLA and HDPE can affect the development of ryegrass, the health of rosy-tipped earthworm, and basic soil properties, with potential further impacts on soil ecosystem functioning.

The 2020 Zimmermann study also looked at possible impacts of the chemicals extracted from bioplastics on soil and plants[35] and found that PLA chemical extracts induced genotoxicity in onions, and negatively affected nitrogen activity in soil bacteria. Chemicals extracted from starch-based bags meanwhile affected plant germination. PHB and PBAT chemical additives reduced survival of an aquatic organism.

Other studies show that bioplastics marketed as biodegradable can become persistent once they move into water, especially marine environments.[36] PLA in particular was found to linger in the marine environment for over 400 days. Natural and regenerated cellulose fibers in contrast were no longer visible after 35 days. A study by 5 Gyres[37] similarly found that products labeled biodegradable did not break apart in the environment. The researchers placed 22 bioplastics products — including film, utensils, straws, compostable bags, and baby wipes — in marine and terrestrial environments in three different states. This study also highlighted that thickness matters, with thinner materials fragmenting more easily.

Most of the above studies researched what happens to materials labeled as biodegradable when they are improperly disposed of — that is, left in the environment to decompose. Studies of materials designed for composting show mixed results. A recent field study by the Composting Consortium[38] found that eight of nine composters studied had no detectable amounts of compostable packaging in their finished compost, but the study did not look at microplastics, which could well remain. A meta-review of research[39] by the University of Vermont found widespread microplastic contamination in compost materials, though traditional plastic particles were more predominant than biodegradable plastic particles.

---

[34] Bas Boots, Connor William Russell, and Dannielle Senga Green, Effects of Microplastics in Soil Ecosystems: Above and Below Ground, *Environmental Science and Technology ,* 2019 *53* (19), 11496-11506.

[35] Lisa Zimmermann, Andrea Dombrowski, Carolin Völker, Martin Wagner, Are bioplastics and plant-based materials safer than conventional plastics? In vitro toxicity and chemical composition, *Environment International*, 145, 2020, 106066.

[36] Sarah-Jeanne Royer ,Francesco Greco, Michaela Kogler, Dimitri D. Deheyn, Not so biodegradable: Polylactic acid and cellulose/plastic blend textiles lack fast biodegradation in marine waters, *Plos One.* May 24, 2023

[37] 5 Gyres Science to Solutions, Better Alternatives 3.0, A Case Study on Bioplastic Products and Packaging, November 2023.

[38] Composting Consortium, Don’t Spoil the Soil: The Challenge of COntamination at Composting Sites, February 2024.

[39] Porterfield, K. K., Hobson, S. A., Neher, D. A., Niles, M. T., & Roy, E. D. (2023). Microplastics in composts, digestates, and food wastes: a review. *Journal of Environmental Quality*, 52, 225–240.

A German study found[40] that biodegradable bags contained large amounts of microplastics less than 1 millimeter in size that could remain in soil for a long time, and cautioned against widespread use of the bags without further research. Another German study[41] found that fertilizer from compost facilities contained large quantities of biodegradable plastics. In contrast, Spanish researchers found no debris[42] less than 5 millimeters in size from biodegradable plastics in compost collected from different facilities.

More research is clearly needed before compostable bioplastics can be considered safe for soil ecosystems.

Waste Management Options and Availability

Bioplastics are touted as a "circular economy" solution, or a way to reduce waste, minimize the use of virgin materials, and keep resources recirculating throughout the economy. The Biden-Harris administration, in fact, set a goal that by 2043 the nation will use 90% "recycle-by-design" polymers from biobased feedstock instead of conventional plastics.[43] But there are huge challenges to managing bioplastics at their end of life.

Researchers suggest that industrial composting and anaerobic digestion are the best options for managing biodegradable bioplastic waste, while recycling and landfilling are not desirable.[44] Just like conventional plastics, bioplastics are made from many different materials, making them almost impossible to recycle. Bioplastics' lower thermal stability also doesn't lend well to mechanical recycling because heat easily degrades the polymers and diminishes the quality of the recycled product.[45]

Landfilling is not a preferable option because it leads to methane gas emissions and defeats the purpose of switching to bioplastics in the first place. Because most municipalities have neither

---

[40] Recycling organic waste: biodegradable bags not currently recommended, Research News, Fraunhofer-Gesellschaft, October 4, 2023.
[41] Christian Wißler, Fertilizers from composting plants contain large quantities of biodegradable plastics, *Phys.org,* June 29, 2022.
[42] Carlos Edo, Francisca Fernández-Piñas, Roberto Rosal, Microplastics identification and quantification in the composted Organic Fraction of Municipal Solid Waste, *Science of The Total Environment,* Volume 813, 2022, 15190.
[43] Fact Sheet: Biden-Harris Administration Announces New Bold Goals and Priorities to Advance American Biotechnology and Biomanufacturing, March 22, 2023. Accessed on June 7, 2024: https://www.whitehouse.gov/ostp/news-updates/2023/03/22/fact-sheet-biden-harris-administration-announces-new-bold-goals-and-priorities-to-advance-american-biotechnology-and-biomanufacturing/
[44] Ghada Atiwesh, Abanoub Mikhael, Christopher C. Parrish, Joseph Banoub, Tuyet-Anh T. Le, Environmental impact of bioplastic use: A review, Heliyon, Volume 7, Issue 9, 2021.
[45] Gioia C, Giacobazzi G, et al. (2021) End of Life of Biodegradable Plastics: Composting Versus Re/Upcycling. ChemSusChem.

commercial composting facilities nor curbside collection, a lot of compostable packaging and carryout containers end up in a landfill or incinerator anyway.

Composting Bioplastics

Only a fraction of commercial composters accept and process bioplastics packaging. There are multiple reasons for this. First, the industry is not a monolith. Operations range from small municipal facilities processing wastes outdoors in large piles called windrows, to large indoor operations with sophisticated controls for maintaining temperature, oxygen, and moisture conditions. More technologically advanced operations are more likely to accept bioplastics materials because they are better equipped to handle them.[46]

Yard waste remains the primary feedstock processed by composters, according to a recent survey[47] by the U.S. Composting Council. About half of composters accept food scraps, but only 46 out of 173 industrial composters report accepting compostable food packaging along with food wastes. (The survey has a margin of error of 6% to 11% due to its small sample size.)

Many composters don't want to process compostable food packaging because they are concerned that chemical contamination and incomplete biodegradation will negatively impact the quality of their compost, as well as their bottom lines. PFAS in food packaging is a particularly big concern. Food packaging and compostable serviceware may, in fact, be the largest contributors of PFAS in food waste, according to a 2021 EPA report,[48] although fish and meat are also significant contributors. In one study, researchers found that compost containing biodegradable food packaging contained PFAS levels up to 20 times higher than compost made from manure or from separated food waste mixed with grass clippings and livestock bedding.[49] These issues were laid out in a 2019 letter written by Oregon composters titled, "A Message From Composters Serving Oregon: Why We Don't Want Compostable Packaging and Serviceware."[50]

Many composters also don't accept bioplastic packaging because organic farmers are one of their main markets and current USDA rules[51] don't allow certified organic farms to use compost derived in part from bioplastics packaging. Moreover, most organic farmers are strongly against allowing compostable packaging in their compost. Organic farmers, especially in Maine, are

---

46 U.S. Compost Council, Report on Composting Practices in the U.S., February 2024.
47 U.S. Compost Council, Report on Composting Practices in the U.S., February 2024.
48 Environmental Protection Agency, Emerging Issues in Food Waste Management: Persistent Chemical Contamination, August 2021.
49 Caleb P. Goossen, Rachel E. Schattman, Jean D. MacRae, Evidence of compost contamination with per- and polyfluoroalkyl substances (PFAS) from "compostable" food serviceware, *Biointerphases*, Vol 18 (3), May 2023.
50 A Message From Composters Serving Oregon: Why We Don't Want Compostable Packaging and Serviceware. (2019) Oregon.gov.
51 Department of Agriculture, National Organic Program, final rule, 65 FR 80548, Dec 21, 2000.

scarred by PFAS contamination of soil resulting from decades of spreading sewage sludge on farm fields. At least 68 Maine farms have had at least one sample exceed a current PFAS screening level, and half of them have at least one residential or agricultural water source that tested above Maine's maximum contamination level of 20 parts per trillion.[52]

Maine's organic farmers worry that compostable packaging will introduce another source of PFAS. "We absolutely must not intentionally add plastics to compost just to dilute the escalating problem of plastic waste," wrote the Maine Organic Farmers and Gardeners Association in a letter[53] to the USDA's National Organic Advisory Board. "We need to turn off the taps of synthetic pollutants rather than use organic compost as a method of diluting and spreading the problem."

Additionally, poor labeling, outright false marketing, and customer confusion about which bioplastic products are truly compostable leads to a lot of non-compostable plastic waste ending up at composting facilities. Composters must therefore invest substantial resources in removing traditional plastic waste from compostable materials. Removing contaminants accounts for as much as 21% of their operating costs, according to a February 2024 study[54] by the Composting Consortium. The study also found that plastics contamination was a problem, regardless of whether a facility accepted compostable packaging or not.

The many issues involved in composting bioplastics led Ulli Volk, deputy head of waste management and material flow management at Vienna Waste Management in Europe, to state:

> *"Bioplastics do not add any value to composting and do not contribute to humus buildup. Unlike biogenic waste, bioplastics contain no nutrients and are worthless for both the composting process and the end product."[55] And further, that "regardless of their certificate, bioplastics are not desirable in composting. What composters really want are the food scraps; the bioplastic is collateral damage."*

Anaerobic Digestion

---

[52] Maine Organic Farmers and Gardeners Association, comment letter to the National Organic Standards Board regarding Docket # AMS-NOP-23-0075, April 3, 2024.
[53] Maine Organic Farmers and Gardeners Association, comment letter to the National Organic Standards Board regarding Docket # AMS-NOP-23-0075, April 3, 2024.
[54] Composting Consortium, Don't Spoil the Soil: The Challenge of COntamination at Composting Sites, February 2024.
[55] Bioplastics and Composting: Not a Love Match, Waste Management World, Mar 15, 2023.

The U.S. has 109 "stand-alone" biogas[56] facilities that convert food waste into methane gas that is then either pumped into natural gas pipelines or used to create electricity. There are also a growing number of anaerobic digesters on dairy farms in the U.S. that convert food and animal wastes into biogas, and a fertilizer, or "digestate," that can be spread on farm fields.

Research shows, however, that bioplastics have low biodegradability under anaerobic conditions.[57] They don't break down well in anaerobic digesters and can therefore interfere with the normal function at biogas facilities. Should anaerobic digestion anticipate receiving a higher volume of bioplastics, some retrofitting would have to occur in order to achieve acceptable biodegradation standards.

Research also shows that the digestate or fertilizers produced at biogas facilities have high levels of microplastics, including biodegradable microplastics.[58] Biogas facilities often use de-packaging machines to remove any plastic wrapping — including bioplastics — from food to avoid both fertilizer contamination and mechanical problems. Any recyclable materials are removed, but the rest is landfilled. Sending bioplastic food packaging to an anaerobic digester defeats the very reason for using it in the first place.

Home Composting

Most bioplastic products cannot be composted in a backyard compost bin because the products have not been engineered for that. While some products, especially bags, may be certified "OK Compost Home" by TUV, home composters should still beware of these materials because they may contain toxic chemicals that could contaminate their composted soil.

Table 2: Industrial Composting Guidance

Concerns	Proceed With Caution	Solution
Contamination, degradability, and toxicity	"Certified Compostable" label	Only accept products that will add value to soil and meet the facility's composting standards

[56] Update On Stand-Alone Food Waste Digesters, Biocycle, May 7, 2024.
[57] Adele Folino, Domenica Pangallo, Paolo Salvatore Calabrò, Assessing bioplastics biodegradability by standard and research methods: Current trends and open issues, *Journal of Environmental Chemical Engineering*, 11 (2) 2023, 109424.
[58] Porterfield, K. K., Hobson, S. A., Neher, D. A., Niles, M. T., & Roy, E. D. (2023). Microplastics in composts, digestates, and food wastes: a review. *Journal of Environmental Quality*, 52, 225–240.

Table 3: Home Composting Guidance		
Concerns	**Proceed With Caution**	**Solution**
Toxicity and degradability	"Home Compostable" label	Compost only traditional yard and food waste to improve soil health

Considerations for Policymakers

The Federal Trade Commission Should Update and Expand Its Green Guides

Federal law prohibits anyone from utilizing deceptive acts or practices that impact commerce. This is a very broad prohibition that the Federal Trade Commission (FTC) is responsible for enforcing. This prohibition has been interpreted to mean that one cannot make false or misleading claims about the environmental qualities or attributes of products or packaging, including claims about their recyclability and composability.

The FTC developed its "Green Guides" in 1992 to explain what they view as acceptable and unacceptable environmental marketing claims. The Green Guides are not federal regulations, they're merely interpretations the agency uses when enforcing that broad prohibition on unfair or deceptive acts impacting commerce. However, in practice, the Green Guides have become the defacto national standard for evaluating whether a marketing claim about a product or packaging is legal or not. Courts use them when addressing lawsuits on this topic and companies use them to determine how they should market and label their products.

The FTC last updated its Green Guides in 2012. In that time, there have been significant changes in both consumer perception of and behavior related to environmental marketing claims. Given the public's increasing concerns about climate change, environmental degradation, and plastic pollution, consumers are increasingly interested in purchasing products with minimal environmental impacts.

Unfortunately, the Green Guides do not currently define the various terms related to the many different types of bioplastics we've covered in this report. In addition, the section of the Green Guides dealing with compostability is quite brief and too vague: "Marketers should qualify compostable claims if the product can't be composted at home safely or in a timely way.

Marketers also should qualify a claim that a product can be composted in a municipal or institutional facility if the facilities aren't available to a substantial majority of consumers.[59]"

The FTC launched a public comment period earlier this year and held a public meeting in Washington, D.C. to discuss updates to its Green Guides but there is no information about when the updated guides will be finalized. We call on Lina M. Kahn, Chair of the Federal Trade Commission to update the Green Guides this year to strengthen and clarify the terminology related to compostability and to add a new section defining requirements for the various terms used to market bioplastics to minimize confusion and aid consumers in evaluating the claims made about various products. Businesses and consumers should not have to wait multiple years for this important guidance.

More Data Needed! Conduct a Federal Study

In order to make informed recommendations and regulations, more data is needed about the potential health and environmental impacts of the various types of bioplastics. We encourage the U.S. Environmental Protection Agency's Office of Research and Development to undertake a comprehensive study examining the impact of bioplastics on both soil quality and the toxicity loading of soil.

Push for Full Transparency

As we've noted multiple times in this report, there is currently not enough information available to government agencies, elected officials, and consumers about the chemical composition of the various bioplastics products available on the market. This lack of transparency makes it impossible for anyone to make informed decisions about the safety or lack thereof of these products. We encourage elected officials to rectify this situation by introducing and passing effective legislation requiring companies to disclose the chemical composition of their products.

Be Aware of BPI's Efforts to Weaken Composting Regulations

In 2023, BPI petitioned the USDA's National Organic Standards Board (NOSB) to amend its rule governing compost to allow for bioplastics as a compost feedstock.[60] The NOSB guides the agency's standard setting for its National Organic Program (NOP). BPI argued in its petition that "state policies to incorporate [bioplastic] materials into its economy conflict with the NOP

---

59 https://www.ftc.gov/system/files/documents/public_events/975753/ftc_-_environmental_claims_summary_of_the_green_guides.pdf

60 Memorandum to the National Organic Standards Board. October 11, 2023 FROM: Jennifer Tucker, Ph.D. Deputy Administrator National Organic Program (NOP) SUBJECT: Work Agenda Request: Compost Production for Organic Agriculture.

regulations developed in the late 1990s that restrict organic compost feedstocks to "plant or animal materials" and exclude novel materials that are compostable." BPI pointed to food waste diversion laws in California and Washington in particular. A provision in California law would ban the sale of compostable packaging in the state not allowed by NOP as of January 1, 2026. BPI also cited the urgency of cutting methane gas emissions from landfills.

But allowing bioplastic packaging as a feedstock for compost intended for organic farms is misguided. The research shows that these materials are not benign in the soil environment. The National Organics Coalition, a network of farmer groups and retailers, strongly opposes the petition. In written comments to the NOSB,[61] the coalition said that organic farming "operates under the precautionary principle" and "there is no need, other than pressure by industry, to include synthetic compostable packaging in compost feedstocks."

The coalition wrote further that allowing bioplastic packaging as a feedstock would "lower our standards on compost, which would result in a contaminated input, cause market disruption for those selling truly acceptable compost, and lower the consumer confidence in the organic label." NOSB is reviewing the petition and will likely require further investigation before issuing a decision. Consumers should be aware that if the BPI prevails, "organic" compost bought at garden stores may one day be derived from feedstocks that include bioplastics packaging.

Conclusions and Recommendations

The most effective alternatives to single-use plastics are:

1. Reducing plastic packaging; and
2. Switching to reuse-and-refill systems.

Reusable containers made from ceramics, stainless steel, and glass produce three to 10 times less carbon dioxide emissions[62] than single-use bioplastics over their lifetimes while decreasing the volume of plastic waste going to landfills. These containers are also not harmful to human health. A growing web of reuse organizations and startups can help food businesses navigate potential alternatives. ReThink Disposable, for example, is a program of Clean Water Action that provides free waste audits and consulting to restaurants, institutions, and nonprofit meal programs in Minnesota, California, Pennsylvania, New Jersey, and New England. Private companies should invest in analyzing their own ability to make these shifts.

---

[61] NOC Comments to the National Organic Standards Board Spring 2024, April 29 – May 1 Milwaukee, WI.
[62] Miriam Gordon, Reuse Wins: The environmental, economic, and business case for transitioning from single-use to reuse in food service, Upstream, June 2021.

When plastic is absolutely necessary and cannot be eliminated, biobased polymers without any toxic chemical additives are generally preferable to polymers derived from fossil fuel products because of the devastating environmental, human health, and environmental justice impacts associated with fossil fuel production. However, this must be evaluated on a case-by-case basis and may be difficult to determine due to manufacturers' refusal to disclose the chemical composition of their products.

But just because a polymer is biobased does not mean that it is safer or better for either the environment or human health. As noted earlier, research shows that some bioplastics may be even more toxic than conventional plastics because their product formulations contain new, as yet unidentified chemicals whose safety has not been proven. Research also shows that there is variability within material types. In the Zimmermann study, six out of 10 Bio-PE products tested did not contain toxic chemicals but one had the highest endocrine-disruption potential of all the products studied.[63]

The good news is that this shows not everything is toxic and that it may be possible to make bioplastics that are safe for the environment and for people. The bad news is that it's not currently possible to say whether one bioplastic is better than another or to be confident that the properties of products are consistent in the absence of clear definitions and regulations. Product formulations matter, and that information must be disclosed to consumers.

Manufacturers need to disclose the additives in their bioplastic product formulations in order for the public to identify which bioplastics may be safer. Hiding behind trade secret issues makes such actions highly unlikely. Alternatively, manufacturers can screen their products through GreenScreen Certified, Cradle to Cradle, or another independent certifying group to assure the public that their products do not contain harmful chemicals. Ultimately, in addition to embracing reuse and refill systems, more manufacturers need to invest in innovating non-toxic, non-plastic packaging, such as mycelium-based products.

In the meantime, the upshot is that **bioplastics are not a quick and easy solution to single-use plastics**. Each product must be carefully investigated for its potential to harbor toxic chemicals. Business owners should call local restaurant supply companies to acquire information about various products' chemical composition and possible certifications for biodegradability and compostability. Anyone interested in using bioplastics products must also ensure that their community's waste-management systems can handle those materials as intended at the end of their life. Reusable containers — ideally made from ceramics, stainless steel, or glass — are the best solution.

[63] Zimmermann L, Dombrowski A, et al. (2020) Are Bioplastics and Plant-Based Materials Safer Than Conventional Plastics? In Vitro Toxicity and Chemical Composition. *Environment International*. Volume 145.

Acknowledgments

This publication was made possible through the generous support of the **Long Ridge Foundation**. Through its philanthropy, the Long Ridge Foundation is contributing to a more equitable society where individuals and communities have access to the resources needed to thrive.

Beyond Plastics thanks Dawn Henry (Beyond Plastics), Eve Fox (Beyond Plastics), Kat Hughes (Bennington College), and Melissa Valliant (Beyond Plastics) for assisting in developing this report.

Cite this publication as: Demystifying Compostable and Biodegradable Plastic: Do Safe and Sustainable Options Exist? Beyond Plastics, July 2024.