Alternative plastics and substitutes, specifically biodegradable plastics, as a solution towards tacking plastic pollution

Main messages

Alternative plastics and substitutes, specifically biodegradable plastics:

- can be manufactured using biological resources or fossil raw materials.
- break down under specific conditions seldom found in natural environments.
- should only be used when other options (reduce, reuse, repair, recycle) aligning with the principles of the circular economy and waste hierarchy are not feasible, and when the required sorting, collection and infrastructure is in place.
- have a unique assortment of sustainability obstacles and compromises that need comprehensive assessment and consideration before being introduced and supported through policy.

Background

Alternative plastics, including biobased, biodegradable, and compostable plastics, are seen as potential solutions to mitigate plastic pollution, potentially offering a more ecologically sound choice in contrast to fossil fuel-derived non-degradable plastics. However, the extent of their degradation in the natural environment is subject to debate.[1] There is a need for clarification regarding the usefulness and definitions, or lack thereof, surrounding these plastic types.

Assessing the complete life cycle

Biobased plastics, derived from biological resources, can be produced entirely or partially from non-fossil fuel based raw materials. However, it is crucial to note that being biobased does not automatically make them biodegradable or compostable. To ensure their environmental benefits extend beyond the reduction in fossil resource use, it is essential to assess the complete life cycle of biobased plastics, including factors such as land use change to produce raw materials, to ensure a positive overall impact.

Conditions for biodegradation

Plastics undergo weathering and fragmentation when they are exposed to UV radiation known as biodegradation; certain additives can slow this process. Complete biodegradation of plastic occurs when the polymer is entirely broken down into carbon dioxide, methane and water through microbial activity. Biodegradable plastics are designed to break down more rapidly under specific conditions, but these conditions are rarely found in the natural environment. Compostable plastics, a subset of biodegradable plastics, require proper collection and specialized industrial composting facilities with high temperatures (above 50°C) for complete breakdown.

Sustainability challenges of alternative plastics

Both biodegradable and compostable plastics can be manufactured from biological and fossil resources. These should only be used when other options aligning with the principles of the circular economy and waste hierarchy - reduce, reuse, repair or recycle - are not feasible. It is vital to recognize that these substitutes entail their own unique sustainability challenges and would require comprehensive assessment before being introduced or supported through policy

Advantages

- Biodegradable plastic may have a specific role that apply to particular circumstances, specific applications, controlled practices or in confined areas e.g. biomedical tools,[2] fishing gear[3] and agricultural practices.[4]
- Biodegradable plastic, accompanied by the necessary certified infrastructure, can help reduce contamination of traditional plastic recycling processes when used for items prone to food or organic waste contamination.

Disadvantages

- The usage of biodegradable plastic does not effectively reduce the amount of plastic pollution or mitigate environmental impacts.[5]
- Standards for biodegradability and composting are poorly defined, effectiveness varies in different environments and conditions, and most require industrial processing.[6,7]
- The informal and formal waste sector consider biodegradable plastics as impurities in traditional recycling and require separation from non-biodegradable plastics to maintain recycling quality.[8] Identifying biodegradable plastics is currently challenging and demands transparent certification,[9] clear communication with the public, separation-at-source, and appropriate collection and treatment.
- Labeling products as biodegradable may lead to increased littering behaviour, as individuals may perceive it as a technical solution that absolves them of personal responsibility.

The table below outlines alternative plastics and substitutes, specifically biodegradables, against the 13 options for elements as outlined in the Zero Draft of the Intergovernmental Negotiating Committee for a legal instrument to tackle plastic pollution, including in the marine environment.

Considerations for sustainability*		Alternative plastics and substitutes, specifically biodegradables...
Option 1 Primary plastic polymers		• do not reduce primary polymer production, but simply replace conventional polymer types.[10]
Option 2 Chemicals & polymers of concern		• contain toxic chemicals and additives similar to conventional plastics.[11]
Option 3 Problematic & avoidable plastic products	**a.** Problematic and avoidable plastic products, including short-lived and single-use plastic products	**a.** do not reduce problematic and avoidable plastic products applications.[12]
	b. Intentionally added microplastics	**b.** should not be applied to intentionally added microplastics, as biodegradability varies under different conditions and most require industrial processing.[13,14]
Option 4 Exemptions available to a Party upon request		• does not apply to legal exemptions.
Option 5 Product design, composition and performance	**a.** Product design and performance	**a.** are not designed to fit within a circular economy. As standards for biodegradability are poorly defined, effectiveness in breakdown varies in different environments. However, they may be designed for specific applications such as biomedical tools, fishing gear and agricultural practices.[15,16,17,18,19]
	b. Reduce, reuse, refill and repair of plastics and plastic products	**b.** do not support the waste hierarchy's reduce, reuse or repairable principles.
	c. Use of recycled plastic contents	**c.** not recycled into plastic material and thus cannot be considered truly circular.[20,21]
	d. Alternative plastics and plastic products	**d.** do not automatically equate to bioderived or sustainable. They can be manufactured from either fossil fuels or biomass. Full life cycle sustainability assessments are needed to ensure that net positive environmental, social and economic benefits are achieved.[22,23,24,25]
Option 6 Non-plastic substitutes		• do not automatically equate to bioderived or sustainable. Full life cycle sustainability assessments are needed to ensure that net positive environmental, social and economic benefits are achieved.
Option 7 Extended Producer Responsibility (EPR)		• need to be regulated through EPR as with conventional plastics.
Option 8 Emissions and releases of plastic throughout its life cycle		• do not reduce litter leaking into the environment and littered biodegradable plastics pose a chemical threat similar to conventional plastics.[26,27,28,29]
Option 9 Waste management	**a.** Waste management	**a.** require certification, separate collection and dedicated waste management infrastructure.[30,31,32,33]
	b. Fishing gear	**b.** may have a role in improving the design, use and waste management of fishing gear.[34]

Considerations for sustainability*		Alternative plastics and substitutes, specifically biodegradables...
Option 10 Trade in chemicals, polymers and products, and in plastic waste	**a.** Trade in listed chemicals, polymers and products	**a.** should undergo the same scrutiny, scientific rigour and regulations applied to other chemicals, polymers and products.
	b. Transboundary movement of plastic waste	**b.** should not be allowed to contaminate conventional plastic waste moving across boundaries. If transporting alternative plastics and substitutes, specifically biodegradables, the end market needs to have the industrial facilities to sustainably deal with the waste.
Option 11 Existing plastic pollution, including in the marine environment		• will not reduce the amount of existing plastic pollution present in the environment.
Option 12 Just transition		• can pose a problem for the waste sector, undermining a just and inclusive transition.
Option 13 Transparency, tracking, monitoring and labelling		• should apply transparency, tracking, monitoring and labelling, as with conventional plastics.

*Biodegradable plastics fragment and form microplastics.[35,36]
*Human health effects of biodegradable plastics, as with conventional plastics, are still to be fully defined.

Further reading

[9,30] Stafford, W. H. L., Russo, V., Oelofse, S. H. H., Godfrey, L., & Pretorius, A. (2022). Reducing Plastic Pollution: A Comprehensive, Evidence-Based Strategy for South Africa. Waste Research Development and Innovation Roadmap Research Report (Technical Report CSIR/SPLA/SECO/ER/2022/0050/A; Waste Research Development and Innovation Roadmap Research Report). CSIR.

UNEP 2015: UNEP (2015) Biodegradable Plastics and Marine Litter. Misconceptions, concerns and impacts on marine environments. United Nations Environment Programme (UNEP), Nairobi. https://wedocs.unep.org/handle/20.500.11822/7468

Directorate-General for Research and Innovation (European Commission). (2020). Biodegradability of plastics in the open environment. Publications Office of the European Union. https://data.europa.eu/doi/10.2777/690248

UNEP. (2021). From pollution to solution (Vol. 237, Issue 3169, p. 37). https://doi.org/10.1016/S0262-4079(18)30486-X