BEYOND PLASTIC MED

REMOVE THE AMBIGUITIES SURROUNDING BIOPLASTICS

BeMed Business Club Methodology Sheet - January 2022

1. Agreeing on definitions

Bioplastics

Bioplastics are a wide range of materials and products that are biosourced and/or biodegradable and/or compostable.[1]

Bio-based plastics

Biobased plastics are thermoformable polymeric materials produced from biomass (such as sugarcane, corn, rice or potato starch, agricultural co-products)[2,3] regardless of their biodegradability properties. Today, we are able to reproduce all types of petroleum-based plastics from biomass in the laboratory.[6,7]

Biodegradable plastics

These are plastics that can be degraded within a reasonable time by living organisms - in particular micro-organisms - into water, CO2, methane (CH4) and possibly into non-toxic residues (e.g. biomass). The biodegradability properties are therefore independent of the raw material used to produce the plastic.

Compostable plastics

Refers to a plastic that can be composted: according to the ADEME definition, composting is a process of aerobic transformation (i.e. in the presence of oxygen) of fermentable materials (which can enter into fermentation) in controlled conditions of temperature, pressure and/or in the presence of micro-organisms. It produces a stabilised fertilising material, rich in humic compounds, known as compost. It is accompanied by the release of heat and CO2.[8] In France, compostable plastics are defined by the NF EN and 13432TF-51800 standards (see section4).

Beware of frequent confusion

Biobased does not necessarily mean biodegradable...

For example, bio-PE, bio-PPT, bio-PP... have the same properties as their petroleum-based counterparts and are not biodegradable.

...and biodegradable does not necessarily mean biobased!

There are biodegradable petroleum-based plastics.

2. Understanding the biodegradation process

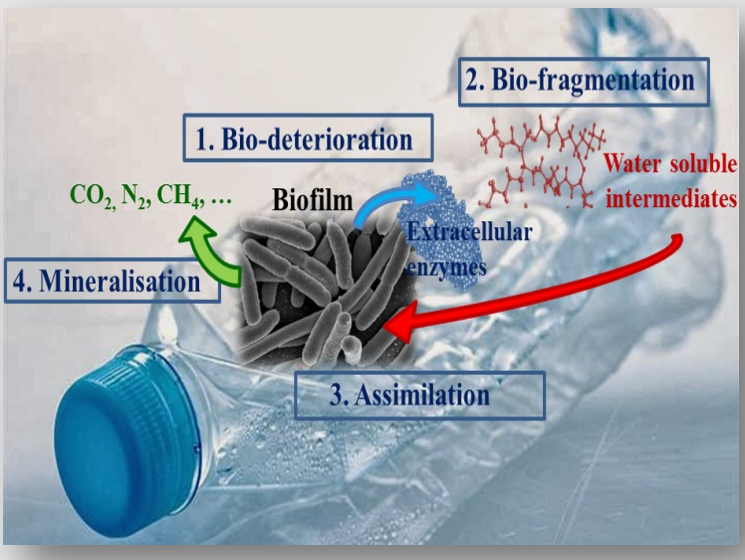
A succession of 3 phenomena of different origins

1. Physics
Plastic breaks down and decomposes under the effect of natural elements (sun, waves, wind, etc.)

2. Chemical
When the plastic is already fragmented, chemical phenomena occur (e.g. hydrolysis in the case of polyesters) [9]

3. Biological
Finally, biological degradation takes place.
The latter is itself carried out in stages4 (see below)

Focus on the stages of the biological phenomenon of biodegradation



3.1 Bio-deterioration
Bacteria ('microbial biofilm') settle on the plastic degraded in the previous stages.

3.2 Bio-fragmentation
Bacteria break down plastic polymer chains into smaller and smaller pieces until they become fragments called 'monomers'.

3.3 Assimilation
The resulting monomers are assimilated by the bacteria.

3.4 Mineralization
Plastic is transformed into biomass and CO2, N2, CH4...

Thus, biodegradation is influenced by the physico-chemical (temperature, humidity, pH) and microbiological (quantity and nature of the micro-organisms) **parameters** of the environment in which it occurs. [10] Biodegradation will therefore not have the same speed whether it takes place at sea, on the ground, or in industrial compost.

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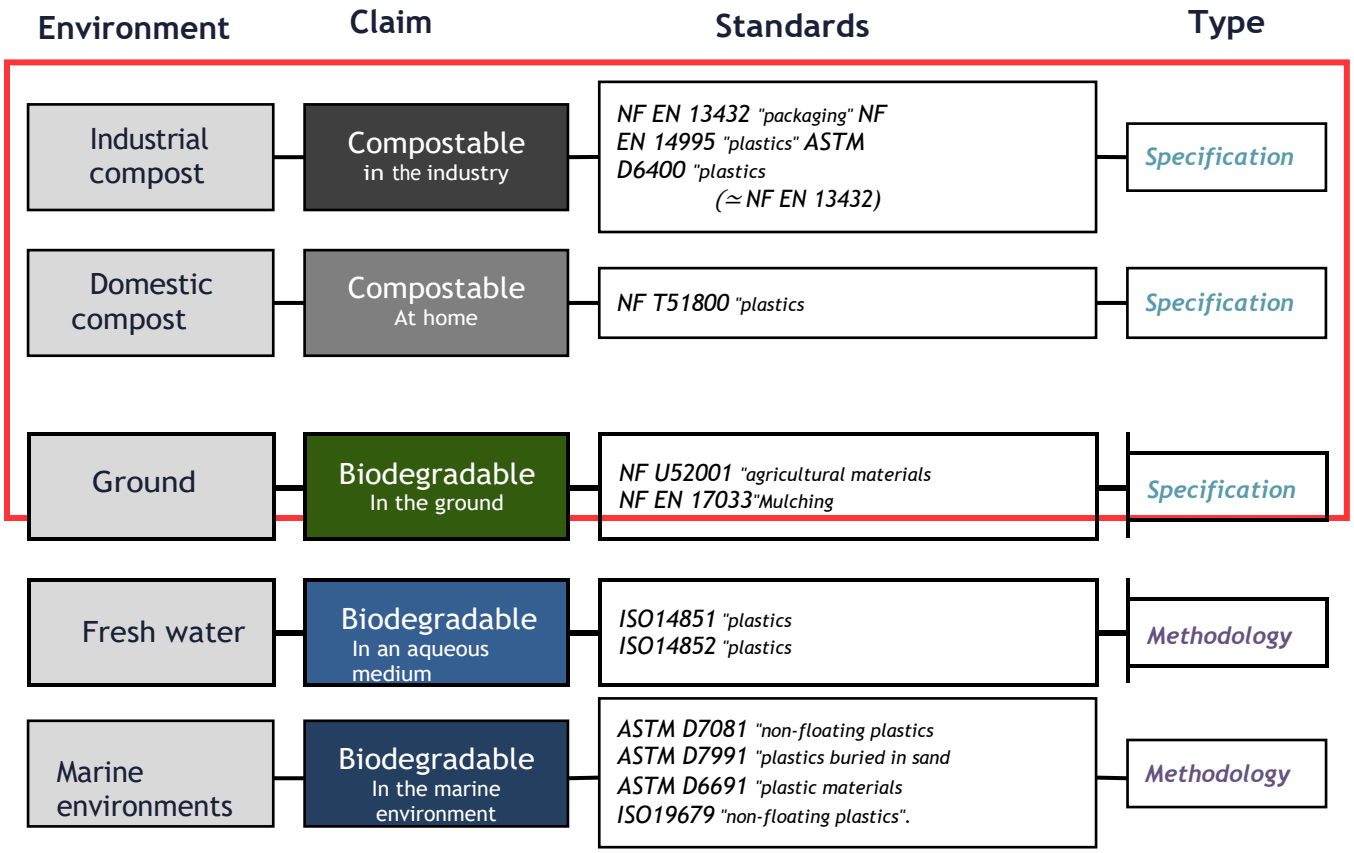
3. Measuring biodegradability

Biodegradability can be measured either by laboratory tests (in vitro) or by field tests (in situ) in soils or composts. Biodegradability at sea is only measured in the laboratory.

Standards for measuring biodegradability are of two types:

- **The methodological standards** specify how the test should be carried out (i.e. the measurement protocol)
- **The specification standards** specify, in addition to the measurement protocol, the criteria that the product must meet to be considered biodegradable (ecotoxicity, absence of heavy metals, etc.).

All these standards are listed in the table below, which classifies them according to the natural environment to which they apply and according to their type (methodology or specification). There is currently **no specification standard for the marine environment**. However, work is underway to fill this gap.



4. Knowing what is compostable

In France, what is compostable under industrial conditions is defined by standard NF EN 13432 and what is compostable in the domestic context is defined by standard NF T51-800, which takes up standard NF EN 13432 by relaxing certain criteria to take into account longer composting cycles due to a lower biodegradation temperature (around25 °C).[1112]

Thus, not all biodegradable plastics are necessarily compostable: for this, they must meet the criteria of the NF EN 13432 (compostable in industrial conditions) and/or NF T-51800 (compostable in the domestic context) standards.

STANDARD	NF EN 13432	NF T51-800
C1 - Composition	The standard sets a maximum level of acceptable volatile solids, heavy metals and fluor in the initial material.	Same as
C2 - Quality and ecotoxicity	The quality of the final compost must not be altered by the added packaging materials and must not be harmful to the environment. The standard requires ecotoxicological tests to be carried out on the final compost and requires a performance >90% of that of the control compost.	Same as
C3 - Disintegration	**Within 12 weeks of testing,** at least 90% of the material must pass through a 2mm sieve (i.e. <10 % rejection threshold).	**Within 6 months of testing,** at least 90% of the material must pass through a 2mm sieve (i.e. a rejection threshold of <10%).
C4 - Biodegradability	The bioassimilation threshold (see page2, steps3.3and3.4) must be >90 % in total **within months.6**	The bioassimilation threshold must be >90% in total **within months.12**

5. Qualifying the statement on bioplastics

Biodegradable plastics

As biodegradation is not systematic, the priority remains to reduce their use, to be careful about the materials chosen and to avoid them ending up in the environment.

Biodegradation depends on the parameters of the environment in which it occurs (temperature, quantity and nature of the micro-organisms, etc.). There are now many bacteria identified in research laboratories that are capable of biodegrading polymers. However, the laboratory conditions in which the biodegradation properties of these bacteria are measured are not those of the marine environment.

Bio-based plastics

High production costs

This is due to the cost of raw materials, their processing, but also the cost of upstream research and the amortisation of investments.

Poorly understood environmental impacts

A full life-cycle analysis of biobased materials is needed to establish their overall environmental performance.

Problematic end-of-life management

As with petroleum-based plastics, eco-designed biosourced plastics should be developed.

Competition for agricultural land

The production of biosourced polymers currently mobilises very few agricultural resources because the volumes produced remain low.[13] However, the risk of competition for food resources in the future if the use of biopolymers becomes widespread must be taken into consideration. To avoid this issue in the long term, research is currently focusing on the production of 2nth or ith3 generation biopolymers from diversified resources that do not compete with food crops. These include lignocellulosic biomass (wood, co-products or waste from agriculture or wood) and non-food vegetable oils (castor oil or residues from the production of other oils) in the case of the second generation. Biobased polymers of the third3 generation are derived from sugars and oils produced by microorganisms (non-food resources that can be cultivated above ground): algae, bacteria, fungi, yeast, etc.

Annexes

Contact

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Sources

1 Source: European Bioplastics, Glossary.
2 EUR-Lex GREEN PAPER On a European Strategy on Plastic Waste in the Environment
3 Note: 1"Biobased" refers only to the renewable origin of the resource and not to end-of-life management or organic growth. Note: 2if the material is not %100 biobased, the percentage should be added before (e.g. "30% biobased plastic)".
4 Glossary of the ADEME, the French Environment and Energy Management Agency.
5 EUR-Lex Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions
6 EUR-Lex GREEN PAPER On a European Strategy on Plastic Waste in the Environment
7 Speech by Nathalie Gontard INRAE
8 ADEME definition, recalled in the Sphere information report2019, available here.
9 Sphere Report, 2019
10 Dussud & Ghiglione2014 ,2018 . Jacquin et al. 2019
11 Definition from the Sphere information report2019, available here. (page22)
12 Definition from the Sphere information report2019, available here. (page23)
13 Details available here: https://www. sphere. eu/wp-content/uploads/ /Rapport-SPHERE-FRAN-DEF201907. pdf