european bioplastics

BACK GROUND

OCT 2015

"OXO-BIODEGRADABLE" PLASTICS AND OTHER PLASTICS WITH ADDITIVES FOR DEGRADATION

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Bioplastics are a broad family of materials that are either biobased, biodegradable, or both. The term “biobased” describes the basis of a material being fully or partly derived from biomass. The term “biodegradable” refers to the inherent property of a material that, with the help of naturally occurring microorganisms such as bacteria, fungi, and algae, is converted back into water, carbon dioxide and biomass.

European Bioplastics (EUBP), the industry association representing the interests of bioplastics including bioplastics that are certified as biodegradable/compostable, distances itself from additive-mediated conventional plastics such as so-called “oxo-degradable” plastics. The technology of additive-mediated fragmentation entails that a conventional plastic is combined with special additives, which are purported to promote the degradation of the product. Yet, the resulting fragments remain in the environment and do not biodegrade as defined in internationally accepted industry standards such as EN 13432 for industrial composting.

Products made with additive-technology and available on the market include film applications such as shopping bags, agricultural mulch films and, most recently, certain plastic bottles. Experts from the plastics industry, waste management, and environment protection voice serious concerns about these products not meeting their claimed environmental promises.

In this paper, EUBP aims to outline the issues and questions concerning additive-mediated conventional plastics in order to support consumers, retailers, and the industry in identifying unsubstantiated and misleading product claims.

TERMS, CLAIMS, AND STANDARDS

European Bioplastics strongly differentiates between naturally occurring biodegradation and biodegradation promoted by additives.

Bioplastics: biodegradable and compostable plastics

Biodegradability is an inherent property of a material or product resulting from the action of naturally occurring microorganisms, such as bacteria, fungi, and algae. The process produces water, carbon and biomass as end products. No additives are needed and no fragments remain in the environment. In case of composting, biodegradation takes place under specified conditions.

Clear, verifiable, and acknowledged standards for biodegradability and compostability already exist for more than a decade, such as ASTM D6400, ASTM D6868, EN 13432, or ISO 17088. According to ISO 17088, for instance, full biodegradation of the material in less then six months must be proven. The European norm EN 13432 for industrial composting of plastics even requires a 12-week composting cycle. Additive-mediated conventional materials do not biodegrade as defined in these standard specifications. Hence, in order to distinguish “truly” biodegradable from additive-mediated fragmentable plastics, consumers and retailers simply need to look out for corresponding specifications and labelling on the product. The “Seedling” for example is such a label that proves the material is certified according to the EN 13432 standard.

compostable

THE SEEDLING LOGO (EUROPEAN BIOPLASTICS TRADEMARK) IS A LABEL FOR COMPOSTABLE PACKAGING CERTIFIED ACCORDING TO EN 13432.

The term “biodegradable” by itself is not more informative than the adjective "tasteful" used to advertise food-products. If adhering to sound environmental communication standards as laid down in ISO-standards (ISO 14020 series on environmental labels and declaration), a timeframe and information on the environment need to be provided, as is the case with products carrying the Seedling logo.

Additive-mediated conventional plastics: "oxo-degradable" plastics
Producers of pro-oxidant additives claim their products to be "degradable", "biodegradable", "oxo-degradable", or " oxo-biodegradable". These products are made from conventional plastics and supplemented with specific additives in order to mimic biodegradation. In truth, however, these additives only facilitate a fragmentation of the materials, which do not fully degrade but break down into very small fragments that remain in the environment – a process that would be more accurately described by the term "oxo-fragmentation". Claims of "oxo-degradability" might sound appealing, yet, they are misleading as they cannot be verified due to the absence of a standard specification i.e. an explicit set of requirements to be satisfied by the product. A self-imposed standard for oxo-degradation merely sets out the parameters on how to test the degradation process, not, however, the results or even criteria for passing the test of degradation. There is currently no internationally established and acknowledged standard or certification process that proves the success of oxo-degradation. Without verifiable proof or certification for the claim, the term "oxo-degradable" is just an appealing marketing term.

Additive-mediated conventional plastics: "enzyme-mediated" plastics
Enzyme-mediated plastics are not bioplastics. They are conventional plastics (e.g. Polyehtylene) enriched with small amounts of organic additives. The degradation process is supposed to be initiated by microorganisms, which consume the additives. It is claimed that this process also expands to the PE, thus making the whole material degradable. Currently, there are no scientifically reliable test results for enzyme-mediated plastics that provide evidence for biodegradability or compostability. Likewise, there is no documentation of enzyme-mediated plastic fulfilling the criteria of the standard EN 13432. Not even the basic principle of enzyme-mediated degradation has been scientifically explained or proven in any publicly available document.

Additive-mediated conventional plastics cannot biodegrade as defined in industry accepted standard specifications such as ASTM D6400, ASTM D6868, or EN 13432.

THE DEGRADATION PROCESS – FRAGMENTATION IN DISGUISE

In the case of oxo-degradable plastics, additives are incorporated in conventional plastics such as Polyethylene (PE), Polypropylene (PP), Polystyrene (PS), Polyethyleneterephtalate (PET) and sometimes also Polyvinylchloride (PVC) at the moment of conversion into final products. These additives are based on chemical catalysts, containing transition metals such as cobalt, manganese, and iron, which cause fragmentation as a result of a chemical oxidation of the plastics' polymer chains triggered by UV irradiation or heat exposure. In a second phase, the resulting fragments are claimed to eventually undergo biodegradation.

In addition to the additives that trigger the fragmentation process, "oxo-degradable" plastics include stabilizers, which are added to limit the unwanted fragmentation of the polymer chains whilst the plastic is still in use. However, the stabilizing effect of the additives is limited. Research studies have concluded that "even with some content of stabilizing additives, PE film [with "oxo-degradable" additives] loses its mechanical properties rather fast, especially when exposed to sun-light."[1] For this reason, different storage conditions would be required in order to prevent premature ageing and loss of mechanical properties.

A recent study on the "Evaluation of Biodegradation-Promoting Additives for Plastics" conducted at Michigan State University and published by the American Chemical Society in February 2015 confirmed, that the claims of biodegradation-promoting additives, including oxo-fragmentation additives, of rendering conventional fossil-based polymers biodegradable are false.[2] The research found no evidence that any of the additives tested promoted and/or enhanced biodegradation of PE or PET polymers. The authors of the study concluded: "Anaerobic and aerobic biodegradation are not recommended as feasible disposal routes for non-biodegradable plastics containing any of the five tested biodegradation promotion additives."

Fragmentation of additive-mediated plastics is not the result of a biodegradation process but rather the conversion of visible contaminants (the plastic waste) into invisible contaminants (the fragments). The resulting fragments will remain in the environment.[3] This cannot be considered a feasible manner of solving the problem of plastic waste.

[1] *Koutny M., Lemaire J, Delort A.-M. (2006, p. 1244), Biodegradation of prooxidant films with prooxidant additives, Chemosphere 64, pp. 1243-1252.*
[2] *Evaluation of Biodegradation-Promoting Additives for Plastics: Susan Selke, Rafael Auras, Tuan Anh Nguyen, Edgar Castro Aguirre, Rijosh Cheruvathur, and Yan Liu; School of Packaging, Biosystems and Agricultural Engineering, Michigan State University, United States; published in Environ. Sci. Technol., 2015, 49 (6), pp 3769–3777.*
[3] *Narayan, Rahmani, Biodegradability - Sorting Facts and Claims, in bioplastics magazine, Vol 01/2009, p 29.*

Fragmentation is not the same as biodegradation

In case of truly biodegradable bioplastics, regardless whether they are made of biobased or fossil recourses, biodegradability is an inherent property of a material or product. These materials degrade fully into water, biomass, and CO_2. The process of biodegradation depends on the environmental conditions such as location, temperature, humidity, and on the material or application itself.

Bioplastics that have been certified biodegradable and compostable according to EN 13432 or EN 14995 fulfil the technical criteria in industrial composting plants. These plants provide controlled conditions (humidity, aeration, temperature) for quick and safe compost production. During the process the organic matter including biodegradable and compostable plastic products is converted to CO_2, water and biomass. Compost is used as a soil improver and can in part also replace mineral fertilisers.

In 2013, the association Plastics Europe commissioned Organic Waste Systems (OWS) to carry out a comparative study on the "benefits and challenges of bio- and oxo-degradable plastics". The results clearly stated that "oxo-degradable plastics do not meet the requirements of industrial and/or home compostability set out in various established standards" and recommended to use terms such as "thermo- or photo-fragmentable plastics" instead of "oxo-degradable" plastics.[4]

END-OF-LIFE OPTIONS AND WASTE MANAGEMENT PROBLEMS

Additive-mediated fragmentation increases the problem of microplastics in the environment

Additive-mediated conventional plastic products such as "oxo-degradable" plastics have been promoted as a solution to the problems of littering and microplastics whereby they supposedly biodegrade in the natural environment. In fact, such a concept risks increasing littering instead of reducing it and, what is more, leave tiny fragments in the environment and worsen the problem of microplastics even further.

Companies offering additive-mediated conventional plastic materials promise a "quick solution" to countries that have no or nearly no waste management infrastructure, but this promise comes with great dangers to the environment. If these additive-mediated fragmentable plastics are littered and end up in the landscape, they start to disintegrate due to the effect of the additives that trigger the breakdown into fragments, which remain in the environment.

Fragments attract hazardous substances and pollute the (marine) environment

Studies, amongst others by the US National Oceanic and Atmospheric Administration, have shown that these fragmented plastics can accumulate toxic chemicals such as PCB, DDE and others from the environment and act as transport medium in marine environments.[5] Such persistent organic pollutants in the marine environment were found to have negative effects on marine resources.[6]

Oxo-fragmentation and biodegradation must not be promoted as excuse to litter!

The United Nations Environment Programme (UNEP) stresses that littering is a problem of irresponsible behaviours and must be resolved by raising environmental awareness and by the establishment of appropriate waste management systems.[7] Neither biodegradation nor additive-mediated fragmentation should be used as an excuse to carelessly discard plastics in the environment.

European Bioplastics advocates a more responsible communication about suitable waste management options for specific products and materials. Accepted standards for industrial composting, for example, already exist and are indicated by corresponding labels. Additionally, standards for the correct conditions and timeframes for home composting are currently being developed. In case of marine biodegradation, an issue that is currently much debated, research projects are still at the very beginning and even though first successes are reported, verifiable standards won't be available in the near future.

Composting is not a feasible end-of-life option for additive-mediated conventional plastics

Since additive-mediated conventional plastics do not meet the criteria of the standards for organic recycling, collection and recovery schemes for organic waste are prone to suffer from the input of additive-mediated materials.[8]

[4] *Benefits and challenges of bio- and oxo-degradable plastics – A comparative literature study by S. Deconinck and B. De Wilde, performed for Plastics Europe (August 2013).*
[5] *Moore C. (2008). Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. Environmental Research 108(2), pp. 131-139.*
[6] *Yuki Mato et.al. (2001), Plastic Resin pallets as a transport medium for toxic chemicals in the Marine Environment, Environmental Science and Technology, 35(2), pp. 318-324.*
[7] *United Nations Environment Programme (2009, p. 215). Marine Litter – A Global Challenge, www.unep.org/regionalseas/marinelitter/publications/docs/Marine_Litter_A_Global_Challenge.pdf, Publication Date: June 9, 2009. Accessed on June 19, 2009.*
[8] *California State University, Chico Research Foundation (2008). Performance Evaluation of Environmentally Degradable Plastic Packaging and Disposable Food Service Ware – Final Report. www.ciwmb.ca.gov/Publications. Publication Date: November, 8, 2008. Accessed on June 19, 2009.*

In 2005, the Italian Antitrust Authority, for example, sanctioned a retailer distributing "100% degradable" shopping bags made with PE supplemented with pro-oxidant additives.[9] Only products and materials that are certified according to internationally accepted standards such as EN 13432 or equivalent are feasible for organic recycling or (industrial) composting.

Additive-mediated conventional plastics can contaminate conventional plastic recycling streams

One of the preferred and environmentally feasible waste management options for used plastics, including bioplastics, is mechanical recycling. But if additive-mediated conventional plastics enter these recycling schemes, they can potentially hamper or even contaminate the stream. In practice, these plastics are conventional plastics that incorporate additives, which affect their chemical stability. When ending up in waste recycling streams together with other plastics, they insert their degradation additives to the recyclate feedstock. As a consequence, the recyclates may be destabilised, which will hinder acceptance and lead to reduced value. The European Plastics Recyclers Association (EuPR) and the Association of Postconsumer Plastic Recyclers (APR) therefore warn against oxo-degradable additives.[10,11]

LEGISLATIVE MEASURES AGAINST ADDITIVE-MEDIATED FRAGMENTABLE PRODUCTS

European Bioplastics strongly supports legislative proposals to enforce responsible (marketing) claims concerning the end-of-life of products and materials.

During the amendment process of the EU Directive on Packaging and Packaging Waste at the end of 2014/beginning of 2015, "oxo-degradable" plastics were nearly banned in Europe. However, before following through with this important, environmentally responsible step, the European Commission decided to first assess the impact of the use of "oxo-degradable" plastic bags on the environment. The assessment and legislative conclusions are expected in 2017. In summer 2015, the French government positioned itself as a pioneer in this discussion by banning "oxo-degradable" plastics as of 2017.

[9] *Italian Official GAZETTE No. 2, 30 JANUARY 2006.*
[10] *Association of Postconsumer Plastic Recyclers (APR) and the National Association for Plastic Container Resources (NAPCOR) express concerns about degradable additives. www.plasticsrecycling.org/article.asp?id=50. Publication Date: February 12, 2009. Accessed on June 19, 2009.*
[11] *European Plastics Recyclers, OXO degradables incompatibility with plastics recycling. www.plasticsrecyclers.eu/press. Publication Date: June 10, 2009. Accessed on June 9, 2009.*

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European Bioplastics e.V.
Marienstraße 19/20
10117 Berlin
Phone: +49 (0) 30 284 82 350
Fax: +49 (0) 30 284 84 359
info@european-bioplastics.org
www.european-bioplastics.org