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Granting society with LOw environmental impact innovative PACKaging

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Position paper:

Benefits of home compostable biodegradable materials for a sustainable food chain

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INTRODUCTION

The new EU directive on Single-use Plastics (SUP) has been ratified in May 2019. The directive proposes to ban some single-use plastics for a given list of applications, which is a significant advance to reduce the marine plastic littering. However, in the plastic definition of the directive, bio-based and biodegradable plastics are also included. Biopolymers that can degrade into new biomass (humus) and biogas in natural conditions without any restrictive environmental conditions (e.g. temperature and humidity) and in reasonable time are promising solutions for single-use applications such as food packaging.

Nowadays, the term "bioplastic" includes materials that are either bio-based or biodegradable or both. Hence, a bioplastic could be biodegradable without being bio-sourced, bio-sourced without being biodegradable or bio-sourced and biodegradable. "Biodegradability" itself is a notion that leads to confusion. The distinction should be made between biodegradable in natural conditions (e.g. in soil, that means fit for home compost) and biodegradable in industrial compost conditions (e.g. in controlled conditions of temperature, usually 58°C, and humidity). As a consequence, a global suspicion arises about the real sustainability of currently marketed bioplastics that casts away biodegradable materials (especially promising biopolymers still in development) from promising single-use plastics application. Commercially available "bio" packaging solutions are facing challenges in being considered as convincing "sustainable packaging". "Green washing" suspicion leads policy makers to ban all types of biodegradable materials as a whole in the SUP directive. In this debate weighing the pros and cons of the economic and environmental balance of currently marketed bioplastics, one key point is often omitted: the usage benefits of the packaging itself. The primary role of food packaging is to preserve food during storage, to ensure consumer safety, to reduce food losses by protecting the food product and to reduce food waste by providing proper portions in combination with e.g. resealability and appropriate information on storage conditions. For many food products, packaging has a clear benefit in terms of preservation that should not be forgotten in the discussion about substitution/reduction of fossil-based plastics.

To increase the sustainability of the food chain permanently, a sustainable food packaging must clearly and visibly fulfil the following three key pillars (1) to mitigate the negative burden of packaging resources (being made of renewable resources), (2) to increase the benefit of use by suiting the food requirements to preserve food quality and safety during storage and (3) to tackle the issue of plastic pollution due to waste littering (e.g. being biodegradable in natural conditions to solve the issues of the persistence of micro-plastics in our environment). In 2016, an estimated 87 % of the plastic that entered a mismanaged waste stream was leaked into nature and became plastic pollution. One-third of plastic waste becomes land or marine pollution.

This position paper aims at clarifying many debatable points related to bioplastics and biodegradability, especially the terminology and focuses on the benefits of biodegradable (in natural conditions) packaging material that can help the food sector entering the virtuous loop of the circular economy. Finally, recommendations (basic, strategic and tactical interventions) are proposed to help all stakeholders in the food packaging sector to align with the common goal of ending plastic pollution.

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WHAT DOES "BIODEGRADABLE" REALLY MEAN?

OVERVIEW AND CLARIFICATION OF THE DEFINITIONS (BIOPLASTICS, BIO-BASED RAW MATERIALS, BIODEGRADABLE/COMPOSTABLE, BIO-PACKAGING, RECYCLABLE)

The bioplastic term has been used inappropriately by stakeholders for decades, leading to considerable confusion and has resulted in total disrepute of bioplastics in public opinion and policy makers. This chapter aims to clarify the most important definitions related to the topic of the position paper.

Bioplastic refers to a variety of materials that "are either bio-sourced, derived from biomass, either biodegradable or features both properties". A bio-sourced (or bio-based) packaging can be partially or totally made of biomass, e.g. from dedicated crops such as sugarcane, corn, etc. or from organic waste and residues resulting from primary or secondary transformations, e.g. cellulose, ligno-cellulosic residues. A bioplastic can be also made of fossil resources and classified as biodegradable (e.g. PBAT), while bio-sourced bioplastics developed to substitute current plastics such as bio-PET, bio-PE, bio-PP are not biodegradable at all. A bioplastic could be biodegradable without being bio-sourced, bio-sourced without being biodegradable or bio-sourced and biodegradable!

Biodegradability refers to a process in which microorganisms convert the material into substances such as compost, carbon dioxide, methane or water through metabolic or enzymatic processes. The ultimate condition is the complete transformation of organic compounds into reduced simple molecules (such as carbon dioxide/methane, nitrate/ammonium, and water) and new biomass. Under aerobic conditions, carbon dioxide is the primary gas emitted while in the case of anaerobic conditions it is methane. The term "**biodegradable**" should always be associated with the type of medium (e.g. soil, water, *in vitro* medium), the conditions (e.g. temperature and humidity) and the duration of the biodegradation. For instance, among currently marketed bioplastics, PLA is always claimed as "biodegradable" while in reality, PLA is only industrially compostable (e.g. at 58°C and controlled conditions of humidity). Without this, PLA packaging, despite being made from renewable resources, is a plastic that will persist in our environment for a hundred years.

Biodegradable plastic means a plastic capable of undergoing physical, biological decomposition, such that it ultimately decomposes into carbon dioxide (CO_2), biomass and water and in accordance with European standards for packaging recoverable through composting and anaerobic digestion [Proposal of EU Directive on Single-use plastics, 2019]. As mentioned above, the label "biodegradable" must always have a clear sign of the environment, in which the test was performed. Alternatively, we support the idea of allotting the term "biodegradable" exclusively to those polymers, which exhibit full mineralization into CO_2, H_2O, biomass, and inorganic salts and in all kinds of natural environments within a reasonable time frame (and without producing toxic degradation products). Only these materials could then guarantee a minimal impact of plastics on the environment.

Composting is the process of biological decomposition of organic matter performed by microorganisms, mostly bacteria and fungi. Composting is the optimised implementation of the natural process of biodegradation and can be performed at industrial conditions with controlled temperature, or in home-compost (in soil, at ambient temperature), at aerobic or anaerobic conditions. Compostability is measured as the % of biodegradation (direct measurement of the CO_2 produced by microorganisms) combined with tests of fragmentation. Three kinds of biodegradability/compostability are considered: 1/ packaging products that conform to the 'compostable' criteria of the aerobic degradation standard EN 13432 are suitable for industrial composting (the tests simulate industrial scale composting conditions at high temperature), 2/ those that conform to the anaerobic digestion criteria are suitable for that method of organic recovery (EN 14995) and 3/

those that conform to the national "home compostable" standards at ambient temperature are suitable for composting in natural conditions with other organic bio-wastes without any preliminary sorting.

Compostability of packaging in industrial condition is certified according to the European Standard EN 13432, which does not cover home compostability. The existing EU standards and their nationally adopted versions mostly involve test methods that simulate industrial scale composting and anaerobic digestion. There are some certification schemes for home compostability, which are mainly based on EN 13432, and which require testing plastics according to the conditions prone to be found in home composting, like lower temperatures and longer times compared to conditions in industrial composting facilities.

- **Due to the confusion about the meaning of bioplastic and biodegradable material, there is a pressing need to clarify the related terminology. Standard terminology should be proposed by the scientific community and included in regulations and standards.**
- **The term of bioplastic must be avoided as it creates suspicion for the consumers as it does not highlight the real benefit of the "bio" prefix when associated with the term 'plastic'. The term 'biodegradable' must always be associated with conditions and duration.**
- **The terms of home-compostable or industrially-compostable must be preferred instead of the broad biodegradability term. These two processes should be clearly defined and understandable for the general public.**

The GLOPACK bio-based and biodegradable trays (Photo by Lorie Guilbert)

THE NEW EU SUP DIRECTIVE AND ITS CONSEQUENCES FOR THE FOOD SECTOR

The most important objective of the new EU directive on SUPs is to prevent and reduce the impact of certain plastic products on the environment, in particular on the aquatic environment, and human health as well as to promote the transition to a circular economy with innovative business models, products and materials. In this purpose, the directive bans a selection of SUP items that together account for 70% of the marine litter in Europe.

In the case of food containers, beverage containers, and bottles, these measures especially affect extended producer responsibility and awareness-raising measures. Member States shall encourage the use of sustainable alternatives to SUP where possible for materials in contact with food.

Reducing the amount of harmful plastic litter in the oceans and seas is the obvious target of this new directive which is undoubtedly of significant importance. We can nevertheless regret that in the definition of Plastics, all kinds of biodegradable plastics are also included without any exception; even materials that are biodegradable in the natural environment (soil, oceans, aquatic media) in a limited period of time (6-12 months). Banning all kinds of biodegradable plastics discounts a wide range of viable alternatives for a lot of single-use items; for example, biologically synthesized polyesters, such as Polyhydroxyalkanoates (PHA), which is made of various feedstocks such as agro-food by-products, residues and wastes are completely biodegradable into water and carbon dioxide at room temperature in less than 12 months in contrast to other commercially available bioplastics (PLA, PCL, etc.) and even in a marine environment.

CURRENT BARRIERS TO BE REMOVED TO ENHANCE MARKET UPTAKE FOR FULLY BIODEGRADABLE MATERIALS

When evaluating current barriers, it should be considered that these are the result of an economy and industry built on fossil-based, non-bio-degradable plastics which can be misleading and even limiting for biodegradable materials. Hence, current systems and their barriers should be seen as changing ones that, through systematic improvements, will evolve towards a better sustainable and circular economy. In this sense, eco-design is a very important strategy applying one or more of the following strategies: reduce, reuse, recycle, renew, remove, redesign. Finding an equilibrium between functionality, convenience and sustainability for food packaging is of utmost importance.

Lack of methodology and tools to identify alternative solutions

substitutions of oil-based plastic packaging by eco-friendly solutions (e.g. bio-based, or biodegradable or both) are generally focusing on the nature of the resource and the end-of-life issue but the improvement of the functional properties of the packaging is often overlooked. Some significant improvements can be achieved if the functional properties of packaging were defined as "minimum requirements". The calculation of these can be done by using predictive modelling tools. It is of utmost importance that requirements for food preservation are matched to appropriate packaging characteristics, resulting in an optimal packaging composition.

It is necessary to ensure the development of commercially available modelling tools and software such as e.g. the EcoBIOCAP tool; the first lab prototype of a multi-criteria decision software for modified atmosphere packaging of respiring fruits and vegetables; an argumentation-based tool for the management of conflicting viewpoints between preferences expressed by the involved parties. Such tools help to handle the complex decision making in the field of packaging materials and design, particularly at SMEs.

Adaptability to current industrial facilities

Mechanical and gas barrier properties are related to the requirements of the food industry and packaging machines. However, requirements of the food industry are based on what is known about the performance of the currently used plastic packaging and their packaging machines are not adapted yet to other types of material.

Biodegradable polyesters like PHA or PLA are around 2 to 4 times more expensive compared to conventional plastics used for food packaging. This is mainly because of the low volumes that are currently being produced and the *new* nature of the processing methods of biodegradable polymers, which are often more batch-like than the methods of production of their conventional counterparts. A new holistic approach becomes inevitable to overcome the issue. Developments of weight-reducing technologies like foaming or new packaging machines which accept new packaging materials types must be investigated.

Habits/Received ideas

For many food and packaging manufacturers, it's seemingly not possible to substitute their current oil-based plastic by an eco-friendly solution that could be less performant regarding flexibility and mechanical properties. One of the reasons can be that it is difficult for them to understand that another packaging material can also meet their needs. The challenge is to define exactly the gas- and water barrier parameters; using a packaging material with a reduced gas and/or water barrier could still lead to the same shelf-life. This, however, depends strongly on the type of packaged food product, its desired shelf-life and its transportation and storage conditions. To help in this identification of the acceptable barrier properties, modelling tools and software can be used to save time and money by reducing trial and error experiments.

There is a need to adapt waste management facilities

To the collection of all kinds of material, facilitate recirculation, and select appropriate waste management facilities. Clear labels shall indicate the nature of the packaging material to the consumers and in which bin it should be collected. Regarding revalorizations routes, composting is not well implemented in all 28-EU countries. Implementation of dedicated treatment facilities (recycling, composting) is dependent on the amount of waste to be treated. A minimum of 40 kT would be necessary to envisage the creation of a new value chain of collection and re-treatment.

Currently, the cost of plastic pollution, especially, long-term pollution by micro-plastics is not borne by the stakeholders. This is one of the reasons why alternatives such as biodegradable materials experience barriers to market. To improve that, it is necessary to demonstrate the economic and environmental "cost versus benefit" balance of biodegradable and home-compostable materials considering all externalities. Applying subsidies and taxes where appropriate should be considered to shift the demand away from conventional oil-based materials toward more sustainable solutions.

Need to improve data collection, sharing and interoperability in support of the development of new materials and their application in the food sector.

It is necessary to implement appropriate IT solutions to collect and integrate different types of data related to the topic of food contact materials, plastics, their application in the food sector and their effects on the environment and human health in a view of the FAIR (Findable, Accessible, Interoperable, Reusable) approach. This can support the development of new materials and the implementation of innovative solutions all along the food chain (including waste management, reduction of food losses, etc.) and effective communication strategies also regarding proper communication of the economic and social impact of the new solutions, thus finally effectively supporting the implementation of the SUP Directive.

RECOMMENDATIONS FOR STAKEHOLDERS

Fully biodegradable packaging materials, which may be potentially recyclable, provide a feasible, environmentally friendly alternative to SUP packaging. Concerted efforts are necessary to develop their technical readiness levels and increase consumer awareness.

RECOMMENDATIONS FOR POLICY MAKERS

- **Develop a generalised approach and standardises quantification and labelling of packaging benefits** for food and plastic waste reduction in agreement with specific actions of the EU on Food Losses and Food Waste, for instance, **Eco-guide** or Front of Package (FOP) labelling. FOP sustainable labels must be submitted to the representatives of EU member states and deployed in EU-wide harmonised (legal) framework to facilitate their standardisation of legibility, printing codification, etc. for effective implementation. Labelling about the material type and recycling guidelines should be very clear and easy to understand for the customers to waste materials could always get into the right recycling waste stream.
- **Revise legal requirements** and make the definition and labelling of naturally compostable, industrially compostable and "sustainable packaging" more precise: there should be a clear distinction between - home compostable and technical or industrially biodegradable plastics. The distinction should be a subject to mandatory information, especially to overcome consumers' misunderstanding of 'bio-based', 'biodegradable', 'bio- 'and 'bio-plastics' etc.
- **Set up an international collaboration** to manage packaging sustainability worldwide because isolated and scattered local actions lack efficiency to solve global issues such as marine plastic litter.
- **Standardise collection, sorting and recycling schemes on an international level.** Currently, there are too many differences between and within countries on which type of packaging is collected, sorted and recycled, furthermore, technologies and infrastructures are also different.
- **Assess and include the real costs of after-use externalities into the selling price** (e.g. greenhouse gas emissions, economic costs reliant to a short first-use cycle and impact on vital natural systems such as oceans and urban infrastructure). A tax on virgin plastic use should be imposed based on eco-modulation. Lower taxation or even subsidies should be considered to encourage the use of more bio-based (origin), recyclable, reusable or compostable materials.
- **Set up European and local regulatory and financial incentives** to favour sustainable packaging, either bio-based, for example through a rebate on Extended Producer Responsibility (EPR) contributions or other financial support mechanisms such as financial allowances for companies that include the use of sustainable packaging solutions.
- **Provide financial incentives** to the local communities to help them setting and scaling up home composting or alternatively bio-waste collection (industrial composting) and related after-use systems and infrastructure.
- Conduct **detailed environmental impact assessments** of biobased and biodegradable, home-compostable plastics and support more detailed measurements and research in this field which should be evaluated in comparison of fossil-based and non-biodegradable plastics as well as other packaging materials (e.g. paper).
- Increase efforts on developing standards, e.g. about the **biodegradability in the marine environment**. Biodegradability of biobased and biodegradable plastics in natural conditions should be investigated and evaluated not only in a general composting environment but also in marine environments.
- Promote the implementation of a multi-stakeholder **digital platform** supporting data collection and interoperability concerning the application of plastics along the food chain and supporting the common awareness of all the interested actors (researchers and new material developers, food and packaging manufacturers, consumers, policy makers)

RECOMMENDATIONS FOR INDUSTRIES (FOOD AND PACKAGING MANUFACTURERS), TECHNICAL CENTRES, PROFESSIONAL ASSOCIATIONS AND DISTRIBUTORS

- **Create incentives to help customers** make decisions in favour of a sustainable food packaging system to highlight the benefit of food and plastic waste reduction.
- **Develop and promote the use of a "Toolkit"** for packaging manufacturers and customers to support them in using innovative packaging solutions and creating sustainability labels for these packages. Make software tools and a database for decision-making in the field of food packaging widely available for worldwide industrial community.
- **Develop and deliver training sessions** for food and packaging industrials to help them to implement sustainable packaging solutions.
- Devise recommendations to policy makers that will set up guidelines for sustainability implementation in food packaging industries, including labels.

RECOMMENDATIONS FOR CONSUMERS

- Development of **dedicated dissemination activities** towards a large public to facilitate early-adoption of sustainable food packaging innovations by consumers, more targeted to the market demand and consumers' needs.
- Harmonise the definitions and terms related to "bio-packaging" for not only consumers but for everyone.

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