USABLE PACKAGING

Bio-based Industries Consortium

BBI JU

Horizon 2020 European Union Funding for Research & Innovation Grant #836884

Newsletter

Issue 1
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Welcome to the first Usable Packaging project newsletter

This newsletter aims to keep you up-to-date with the project's progress. We hope you find it informative and look forward to hearing from you with any questions and comments.

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Project overview

Launched in June 2019 in Valencia, Spain, the Usable Packaging project aims to develop a portfolio of new bio-based, compostable packaging materials for application in the food, clothing and pharmaceutical industries. The core objective of the three-year project, funded by the EU and governed by the Bio-Based Industries Joint Undertaking (BBI-JU) as part of the EU Horizon 2020 programme (under grant agreement 836884), is to dramatically reduce the use of environmentally-harmful fossil-fuel-based packaging by developing high performance bio-alternatives with adequate packaging properties.

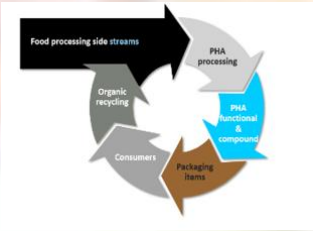

Fig.1 – *the Usable Packaging circular value chain*

Crucially, Usable Packaging partners are testing these materials to understand how they fit into end-of-life processes either biodegradation, composting or recycling through anaerobic digestion – so that they may be able to generate the feedstock and biogas needed to manufacture the next round of products – reducing further the impact of plastic waste on the environment and creating a sustainable, circular value chain. (see Fig 1)

A consortium of 25 partners representing businesses, universities, research centres, trade associations and other organisations from all over Europe are working together on the project, led by Spain's Consejo Superior de Investigaciones Cientificas (CSIC) and scheduled to end in May 2022. Each partner is tasked with delivering key elements of the process as Work Packages ranging from an assessment of the current packaging options to the development and testing of the new polymers, engagement with end-users and commercialisation (Fig 2)

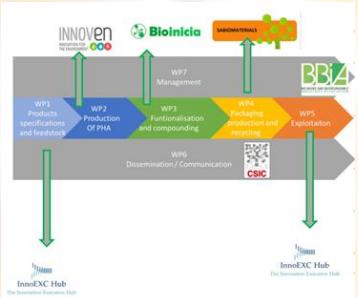

Fig 2 - Work Packages and lead partners

Project objectives

- The creation of bio-packaging solutions to cover a wide range of packaging needs for food, drinks, pharma and clothing, based on bioplastics with adequate physical and chemical properties.
- The development of bio-packaging solutions with clear end-of-life scenario options, with economic added value such as organic recycling intended for anaerobic digestion or composting or else re-digestion to obtain new virgin biopolymer (PolyHydroxyAlkanoate, PHA) in a closed cycle.
- The definition of new vertically integrated and circular value chains where food-processing by-products/residues and biogenic CO2 are transformed into compostable and recyclable bio-packaging, via low-environmental-footprint processes.

- The optimisation of PHA functionalisation to match requirements for end-use in packaging.
- The optimisation of the processes for transformation of functional PHA into packaging, including compounding functionalisation extrusion, blown film process, multilayer
- The production of adhesive layers to replace petrochemical peers, by on-line functionalisation thus overcoming the current main bottlenecks for bio-based multilayer films.
- The reduction of the environmental footprint of the plastic packaging sector.
- Considering emissions, while local feedstocks supply network is considered, avoiding negative C-footprint through long distance transportation.

Early achievements

Early achievements of the Usable Packaging project have included the development of PHA-based compostable straws, cutlery and plates by Spanish partners CSIC and Gaiker and Stakeholder Platform Member Ocenic Resins. The plates have successfully passed the test of repeated use by customers.

CSIC and Ocenic Resins have also worked with Bio-Mi of Croatia and Bioinicia of Spain to formulate and manufacture PHA based blown and cast films with 100% compostable content (Fig 3) and PHA functional coatings and interlayers with high gas barrier, adhesive and active properties such a oxygen scavenging, and antioxidant and/or antimicrobial performance, respectively (Fig 4) for obtaining multilayer barrier films of interest in among others bag in box, perishable foods preservation, etc.

Fig 3 - blown and cast films processing at Bio-Mi factory

Fig 4 - PHA functional coatings developed by CSIC, Ocenic Resins and Bioinicia

Work packages round-up

The Usable Packaging project is divided into seven Work Packages (WP), five technical, 1 focussed on communications, and one dedicated to the administration of the project - the aims of the WPs are as follows:

WP1 - Products specification and feedstocks	led by InnoExc (Switzerland) - deputy: Euromaterials (France)
WP2 - Production of PHA	led by Innoven (Italy) - deputy: Uniroma (Italy)
WP3 - Functionalisation and compounding	led by Bioinicia (Spain) - deputy: Sabio (Italy)
WP4 - Packaging production and recycling	led by Sabio (Italy) - deputy: Bio-Mi (Croatia)
WP5 - Exploitation	led by InnoExc (Switzerland) - deputy: BBIA (UK)
WP6 - Dissemination and Communication	led by BBIA (UK) - deputy: InnoExc (Switzerland)
WP7 - Coordination and Management	led by InnoExc (Switzerland) - deputy: BBIA (UK)

Deliverables for each WP are spread over the 36 months of the project. Below are updates from the WPs.

You can also watch the "**One Year On Webinar**" held in July which provides greater details on progress here

WP1 – Products specifications and feedstocks

Under this work package, partners have been tasked with establishing a "Database and scenario for environmental impact of Usable Packaging", drawing "Initial Technical Specifications for End Use Usable Packaging Portfolio" and reviewing "Feedstock Availability and Characteristics for the Production of Bio-polymers".

The methodology used for the Life Cycle Assessment of PHA material production was developed around five different stages of life: A - substrate production, including collection, storage and pre-processing, B - PHA fermentation, C - PHA downstream process, D - bioplastic moulding and E - bioplastic end-of-life.

Then the team established a catalogue of specifications for packaging products selected by Usable Packaging industrial partners. The portfolio contains cup, cutlery, plate, food tray commercialized by Sphere, flow pack for breads, tubes and bag for dry biscuits used by Barilla, Sonae's and Orogel's frozen food packaging, wine bags from Caviro, large bags for agricultural products used by PHR, nest and tub for pharma used by Ompi and blow molding bottles for Koruma. This catalogue provides the consortium with the primary key input necessary for the design of the packaging developed throughout the project.

Finally, they carried out an inventory of Agricultural Waste, Co-products and By-products (AWCB) available in Europe and specifically from the consortium industrial partners. AWCB types, sources and volumes were identified, revealing the large quantities and diversity of the materials available. The panorama includes the details and characteristics of AWCB generated by the project's industrial partners and main AWCB available in Usable Packaging consortium countries derived either from agriculture or industry. Their report also includes details on the supply chain constraints linked to specific types of AWCB, data on environmental, legal and economic constraints as well as current ways of valorizing the identified feedstocks. While the total AWCB volume from the industrial partners look big, it will be necessary to investigate the economic and environmental viability of using it.

An economic viability analysis was performed at it emerged that the cost structure of products is strongly dependent on the raw materials provided as feedstock, with excellent competitivity with state-of–the-art bio reach in case of side streams from bread and pasta production.

WP2 – Production of PHA

A main challenge of the Usable Packaging Project, investigated in WP2, is the development of innovative eco-efficient routes for the production of biopolymers, namely PolyHydroxyAlkanoates (PHA). These are a family of polyesters with tunable composition and properties, which give them the potential to be applied for a wide portfolio of applications as constituent of several bioplastics. Besides that, the great interest in the PHA relies on the fact that such biopolymers are three times "*bio*", being of biological origin, completely biodegradable in the environment (under both aerobic and anaerobic conditions) and can also be derived from renewable resources. Here, the idea is to exploit several types of food industry by-products as feedstock of the PHA-producing process by employing either mixed microbial cultures or axenic ones.

Currently, laboratory scale experiments are being performed in order to identify the optimal operating conditions to be then adopted at pilot scale, taking advantage of a previously developed plant. Also, main attention is being paid at establishing green procedures for PHA recovery from microbial cells and subsequent purification.

Partner NovaidFCT provided details of their research into PHA production with Anoxygenic Photosynthetic Bacterial Cultures, *"We are exploring an attractive photosynthetic-based route alternative to conventional heterotrophic PHA . production"*, explains Maria Reis. *"This innovative process uses light as the sole energy source (eliminating aeration needs and costs) and a CO_2-based feedstock, hence increasing process sustainability. CO_2 is provided as a stand-alone feedstock or in combination with organic acids like propionic, valeric acid (supplementation of odd numbered organic acids will enable the production of a PHA co-polymer with improved thermoplastic characteristics in comparison to the homo-polymer PHB produced with the solo use of CO_2).*

Results indicate that a photosynthetic mixed culture (PMC) operated under anaerobic illuminated conditions could be enriched in anoxygenic photosynthetic bacteria capable of fixating CO_2 using sulfide as an electron donor. In this case, the CO_2 is fixated into glycogen and PHA, with the glycogen being further used in dark periods for organic acids uptake and concomitant PHA production.

Currently, tests are focusing on the impact of sulfide limitations on the culture selection/stability and batch tests are being conducted to evaluate the effect of light/dark conditions and organic acids addition on the culture PHA accumulation performance. In near time experiments, other selection strategies based on carbon availability (feast and famine), nutrient limitation (N, P,) and transient illumination (dark/light) will be evaluated regarding their effectiveness in selecting a PMC with high PHA production capacity."

WP3 – Functionalisation and compounding
WP4 – Packaging production and recycling

These packages will build on the outcomes of the previous two.

WP3 is dedicated to the functionalisation of produced PHAs and their blending with other bio-polymers to obtain a portfolio of bio-based molecules for different purposes. The most suitable bio-based polymers identified in WP3 will be used as building blocks for packaging targets in WP4.

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WP4 is in fact the core WP in which the potential for Usable Packaging will be demonstrated. The biodegradability and recyclability of studied materials will be assessed against internationally accepted standards. WP4 will be the bridge between all the previous work packages. Its specific objectives are:

- assessing and retro-engineering the performance of packaging items
- realizing packaging items
- evaluating their behaviour in real conditions and assessing their end-of-life options
- determining environmental performance over their entire life cycle

WP5 – Exploitation

A crucial aspect of the Usable Packaging project development is the participation of external stakeholders to contribute their expertise, feedback on progress and ensure that the products that will emerge from the research meet the project's environmental objectives and are suitable for mainstream commercial exploitation. The responsibility for recruiting and engaging with those stakeholders, under Work Package 5 - Stakeholder Platform, lies with the UK's Bio-based and Biodegradable Industries Association (BBIA).

BBIA had set itself a target of recruiting 50 European organisations from various sectors to guide the Usable Packaging partners and was delighted to reach that goal within a few months of the project's launch. "*The interest in the Usable Packaging project and its value for society is reflected in the ease with which we were able to assemble over 50 stakeholders from 17 European countries to contribute to our work*", says David Newman, BBIA Managing Director.

"*We are very grateful for the support of these organisations which range from universities and research centres to consultancies, trade associations, cities, plastics manufacturers, waste management firms and major packaging and distribution companies. They come from all over Europe but also from beyond with a waste management business from Israel joining the platform. The level of interest is very encouraging and I'd like to take this opportunity to thank the consortium partners for helping us sign up these stakeholders whose input will be invaluable. We welcome more*!"

A first Stakeholder Platform workshop took place in Bologna in January 2020, during which three stakeholders' working groups were launched to help focus their involvement around three key themes:

- Industry perception of bioplastics
- public perception of bioplastics and waste management systems
- bioplastics and the circular economy

This meeting was followed by stakeholders' webinars in July and October 2020 to keep the conversation going despite Covid-19 restrictions.

Another objective of WP5 is to create a network with other relevant projects and share learnings and expertise to advance the Usable Packaging workstream. Projects Usable Packaging partners are engaging with include Bio4self and GO!PHA.

WP6 – Dissemination and communication

To ensure the short- and long-term chances of further exploitation of the outcomes of the Usable Packaging project, it is essential to share information about its aims and results to the widest possible audiences. This is the core objective of WP6. A Dissemination and Communication Plan was developed identifying those audiences and establishing a communication strategy to reach out to them in a targeted way.

In the past 18 months, this has been achieved with the launch of the Usable Packaging website and dedicated social network channels, including a YouTube channel; the production of flyers in multiple languages to reflect the diversity of the countries involved in the project; the issue of press releases highlighting early successes; and the participation, prior to the Covid-19 pandemic, to conferences, workshops and other physical events. To adapt to the constraints brought about by the pandemic, the Usable Packaging team has held webinars for both the general public and stakeholders. Scientific papers and video materials will also be published in the coming weeks (see *In other news* section).

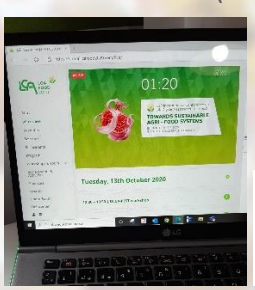
WP6 highlights include:

- Presence at the Kunsthoff Messe (Germany, October 2019)
- Presentations at the New Materials in Sustainable Packaging Workshop (Spain, November 2019)
- Stand at the BBI JU Stakeholders Forum (Brussels, December 2019)

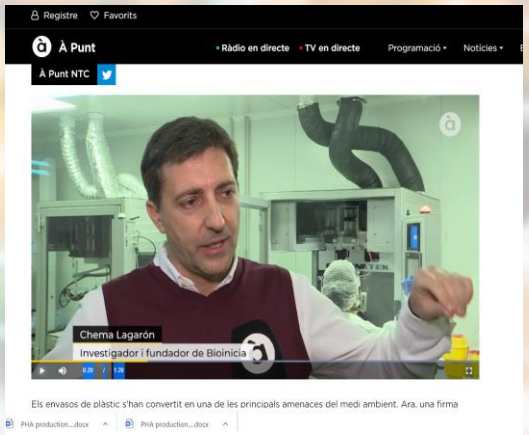
Gaiker presents at the New Materials in Sustainable Packaging Workshop

Usable Packaging stand at the BBI JU Stakeholders Forum

- a TV report on Spanish television on the production of the biodegradable material (February 2020)
- Poster presentation at the LCA Food Forum (online, October 2020)
- A video submitted to the Global Bioeconomy Summit in October 2020 (see *In other news* section)



USC presents the project at the online LCA Food Forum



Usable Packaging segment on Spanish TV featuring CSIC and Stakeholder Platform member Ocenic Resins

In other news

Universidade de Santiago de Compostela paper to be published in scientific journal

A scientific paper produced by the Universidade of Santiago de Compostela (Spain) been accepted for publication in the Chemical Engineering Journal, a leading journal for international research. Below is an abstract.

Title: Evaluation and optimization of the environmental performance of PHA downstream processing
Authors: Mateo Saavedra del Oso, Miguel Mauricio-Iglesias and Almudena Hospido

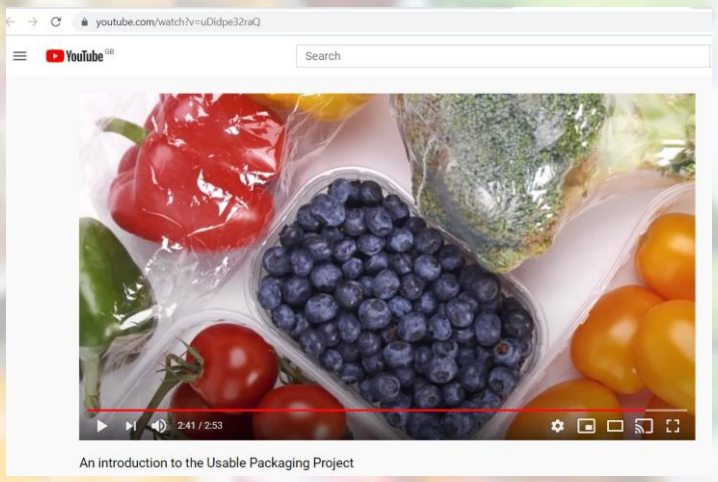
ABSTRACT

Biobased and biodegradable materials such as polyhydroxyalkanoates (PHA) have great potential as an alternative for conventional oil-based plastics in consumer goods and medical applications, but their total market share is still marginal due to their high production costs. Downstream processing, with high energy demand and significant requirements in oil-derived solvents and chemicals, has been identified as one bottleneck in the PHA value chain. Hence, a thorough study of the environmental performance of PHA recovery processes is essential to promote their applicability. This work provides valuable insights on PHA downstream processing environmental hotspots and how to optimize them accordingly. Eight PHA downstream alternative processes for both high-grade and low-grade purification are evaluated from a techno-economic and an environmental perspective, assessing scale-up possibilities and challenges. To reach this goal, both scenario definition and process design were supported by a systematic review of available PHA downstream methods and related life cycle assessments. Methods relying on solvent extraction require large amounts of energy for solvent recovery, and thus, their higher performance in impurity removal also entails larger costs and impacts in all categories, when compared to mechanical disruption or chemical digestion. Therefore, solvent extraction is only recommended for those cases where a higher quality is required, or solvents can be reasonably obtained from an integrated biorefinery. Chemical digestion can be optimized by adding a chemicals recovery unit, while mechanical disruption appears to be the most promising technology in terms of environmental performance. Through this technoeconomic and environmental assessment, it is proved that PHAs can be attractive materials for a sustainable bioeconomy if the process and product design incorporate life cycle assessment such as the developed in this work.

Usable Packaging submits video for presentation at the Global Bioeconomy Summit

A video introducing the Usable Packaging project was submitted for presentation at the Global Bioeconomy Summit held from 16 to 21 November 2020. Put together by Usable Packaging partner Innoven, it features interviews with Prof. Jose Maria Lagarón, Dr Fabiana Fantinel, David Newman and Anita Rizzini from Innoven, and can be found on the GBS2020 Media Corner.

It has now also been uploaded on the Usable Packaging website and the dedicated YouTube channel for use as a major dissemination and communication tool for Usable Packaging under WP6. You can watch the video here.



Acknowledgments

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