



## ECOFUNCO: Agri-food biomass valorization for production of sustainable multifunctional coatings on plastic and cellulose substrate GA 837863





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This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 837863. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

















# **Outline**

- The Project figures & the Consortium
- Ecofunco strategies
- Agri-food Biomass
- KPIs
- Achieved and Expected impacts









- Highly performing, economically and environmentally sustainable biobased coating for plastic and cellulosic substrates
- 17 Partners, 39 months, started 1<sup>st</sup> May 2019-31 July 2022
- 8 Countries (Italy, Spain, UK, Belgium, Germany, Croatia, Turkey, Israel)
- Partners 6 RTO, 9 SME, 2 Large Enterprises
- 5.5 Million euro (4.6 Million Euro BBIJU contribution)

#### **Consortium**





#### **Strategy**









Sustainable and efficient extraction of molecules from biomass

Oxygen barriers comparable to conventional barrier materials (e.g. Ethylene vinyl alcohol-Copolymer, G-Polymer)

Hydrophobicity comparable to polypropylene (PP) and polyethylene (PE),

Significantly improve the shelf life of food products by a significant factor depending on the type of food selected



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#### KPI2. New cross-sector interconnection in bio-based economy



Food residues (shrimps, mushrooms for chitin, chitosan) or the crop residues used in the project:

tomatoes, legumes, sun flower seeds, melon, leading to valuable molecules for the production of functionalized materials.

Products are being obtained, leading potentially to the demonstration of a high number of individual circular value chains.





- Use of biobased resources derived from by-products of food and agro-industrial sector
- Extraction of protein, cutin, chitin and bio-based functional molecules.
- Green chemistry, innovative technologies
- Microwave, ultra sounds, carbon dioxide



Alkaline hydrolysis

Cutin









**EXTRACTION** 

SFE-CO<sub>2</sub>

#### **Extraction**





Extraction of the cutin from tomato by-products (peels)

Several tests performed to find the most suitable time and temperature conditions, considering a scale up perspective.



Yield of the extraction process achieved 40% wt/wt

## **Biorefinery**



Food waste providers of European origin were identified, For example Cutin mainly produced in Italy (Virginio Chiesa farm) from tomato skin (BBIJU Demo AGRIMAX GA 720719)



European Bio-based products in the EU Bio-based products and biofuels: • represent roughly €57 billion in annual revenue involve 300,000 jobs -based materials such as crops or fibres are used in a range of products such a construction materials, furniture and chemicals. They can also be used to produce energy in the form of **biofuels**.





Toma paint spin off https://www.it.tomapaint.com/

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Active biomolecules and macromolecules ,such as microbial cellulose, cutin, protein, chitin and chitosan, are extracted or produced from by products or waste of the agro-food sector. Innovative and green technology for extraction and production.

Biomass suppliers seeing new opportunities for their waste and by-products

Production of paper-based materials with enhanced barrier and hydrophobic properties, connecting paper industries with agriculture, food-feed sectors



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KPI5. New bio-based materials: bio-based coatings applied on plastic and cellulose substrates showing improve barrier and anti-microbial properties.

#### 1<sup>st</sup> CONFERENCE ON GREEN CHEMISTRY & SUSTAINABLE COATINGS

#### **Coatings on Plastics and cellulose**

Coating on cellulose substrates tissue paper or cardboard with suspensions of chitin, chitosan, nano fibrils of chitin for anti microbial properties.

Coating in cellulose with cutin for hydrophobic properties

Coating on plastic films, based on either compostable or soil

Biodegradable substrates (biopolyesters based)

- Coating with lupine extracted proteins
- Coating with cutin
- Coating with chitin
- Assembling of multi layers



#### **Prototypes production**















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## **Prototypes production - coatings**





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**Barrier Function** Material Function Mechanical Aroma Packaging Optica Gas Materials Vapour Thermal Antimicrobial Processability Sustainability







Oxygen barriers comparable to conventional barrier materials (e.g. Ethylene vinyl alcohol-Copolymer, G-Polymer) and hydrophobicity comparable to polypropylene (PP) and polyethylene (PE), and significantly improve the shelf life of food products by a significant factor depending on the type of food selected.





#### Inline monitoring of coating application





To study the distribution of the applied coatings on bioplastics substrates monitored by Hyperspectral imaging (HSI). To study the thickness of the coatings applied on bioplastics substrates

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- i) Use of biobased resources derived from by-products of food and agro-industrial sector, and of bio-based functional molecules.
- ii) Highly performing, economically and environmentally sustainable bio-based coating for plastic and cellulosic substrates
- iii) Food packaging based on tray (at least two trays coated) and 3 films with 3 different coating (total of 9 films validated on ham and perishable food such as meat etc)
- Tableware (paper plate and paper cup) and personal care cellulose-based prototypes (wipes), coated with ECOFUNCO formulated and validated at pilot level with the aforementioned materials. At least four demonstrators selected and validated (a plate, a cup, two types of wipes) by LUCENSE and its associated industrial members.

TRL progress from 2-3 to TRL 5 in the project.



- Food packaging based on tray (at least two trays coated) and 3 films with 3 different coatings (total of 9 films validated on ham and perishable food such as ham, cheese, fresh pasta), including multilayer structures and flexible packaging.
- Tableware (paper plate and paper cup) and personal care cellulose-based prototypes (wipes), coated with ECOFUNCO formulated and validated at pilot level with the aforementioned materials. At least four demonstrators selected and validated (a plate, a cup, two types of wipes).
  - Paperboard box containing facial tissues, with the functions to protect tissue, increase shelf life and promote an antimicrobial as well as anti-oxidant activity. The tissue should have compatibility with skin, anti-oxidant and anti-inflammatory properties. Packaging paper is a paperboard, both in virgin and recycled cellulose, with grammage of 280 g/m<sup>2</sup>, currently on the market. Tissue paper is a 3 plies facial tissue in virgin cellulose, with each ply of 15 g/m<sup>2</sup> for a total grammage of 45 g/m<sup>2</sup>

#### **Achieve TRL 5**

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Biomolecules from agro-food biomass, with green and innovative methods assessed for extraction and purification, converted in coatings for cellulose and plastic substrates can generate consumers products such as table wares, non-woven tissues, trays, coated with either protein, chitin, cutin or mix of the three, with barrier to gas, moisture and anti-microbial activity.

The KPI8 related to validate at least one new and improved processing technology reflecting the 'TRL gain' since the start of the project, is reflected in inline image monitoring, innovative extraction methods for biomolecules form biomass, and innovative coatings based on cutin, protein, and chitin never applied together on plastic or cellulose.

#### **ISSUES:**

- Gas barrier by crosslinked protein coatings,
- Cutin colour and odour, sticky,
- Scale up of Hot melts and coatings with multi materials (Chitin, cutin, proteins), Adhesion on plastic



Compostable substrates (BIOMI, TIPA, PLABIO) Layers of: Protein Cutin Chitin







- Higher cost of innovative processes not yet optimised
- Get a regular, reliable delivery of biomass feedstocks
- Personnel with relevant training and expertise
- Adapt production lines to the bio-based materials
- Achieve comparable performances (or better) versus petro-based with moderate cost increase
- Have proper recognition of the benefits for transition to circular economy (fair LCA, support for extra costs, support from legislations)

#### Website









## ECOFUNCO PARTNERS

