High value-added biobased materials derived from agricultural wastes for food packaging applications.

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Webinar training session on agricultural by-products valorisation through bio-refineries. Policy Makers.

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PhD in Industrial Engineering and Production (Universitat Politècnica de València, UPV), Master in Experimental Techniques in Chemistry (Universitat de València, UV) and Master in Plastic Materials and their Processing Technologies (Plastic technology center, AIMPLAS). Degree in Chemistry by Universitat de Valencia (UV). She has been visiting researcher in the National Institute for Materials Science (NIMS) in Tsukuba (Japan) and in the Institute of Polymer Science and Technology (ICTP-CSIC) in Madrid (Spain). Moreover, she has more than 8 years in the synthesis, modification and characterization of polymeric materials and nanofillers (microfibrillated cellulose-MFC, nanoclays, graphene derivatives...), especially in the preparation of biobased materials, blends and composite formulation to use in a wide range of applications (packaging, solid polymer electrolytes, automotive...). Currently, she is working as Project Manager in the Materials Packaging Systems Area of ITENE focused on the development and characterization of new biomaterials and composites for packaging applications.
ITENE is the reference research centre in packaging, transport and logistics.

25 years creating technological solutions through R&D

- 150 Professionals. 16% PhD.
- 93 R&D projects
- 7,150 m² of facilities
- 258 Innovation and technical assistance projects
- 767 Customers
- 532 Testing services performed
Which technologies do we work with?

- New advanced materials
- Nano-materials
- Packaging and packaging systems
- Integrated intelligent systems
- Circular economy & sustainability

We work with all the state-of-the-art technologies.
Facilities

PILOT PLANT
- Packaging
- New materials and processing
- Packaging production
- Modification and synthesis of additives
- Compostability assessment of packaging materials

LABORATORIES
- Chemical characterisation of materials
- Physical-mechanical characterisation of materials
- Microbiological analysis
- Nano-security
- Packaging assessment
- Approval of dangerous goods packaging

CENTRES
- Transportation simulation
Conclusions

AGRIMAX project’s objectives

Production of high-added value biomaterials from agricultural wastes

Validation of developed biomaterials in food packaging applications

Conclusions
AGRIMAX project’s objectives
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Main objective

- **Packaging materials** (biopolymers, biocomposites, biobased coatings, and active packaging)
- **Food** (additives, ingredients, natural flavourings, edible coatings, microbial growth media)
- **Agricultural materials** (biodegradable pots, mulching films, bio-fertilisers)

Flexible, multi-feedstock pilot processing plants

Two pilot plants in Spain and Italy processing waste from cereals, olives, potatoes and tomatoes.

Co-operative routes to commercialisation

Along with assessments of the environmental, social and economic sustainability of this approach, the project will develop business models for its full-scale commercial adoption by agricultural cooperatives.
Production of high-added value biomaterials from agricultural wastes
Production of high-added value biomaterials from agricultural wastes

Agricultural waste: Bran

- Wheat bran.

Products developed from wheat bran wastes:

- Mycelium based biopolymers.
- Phenolic acid-based biopolymers.
- Cellulose based coatings and bio-composites.
- Bio-active additives based on phenolic acids.
2/ Production of high-added value biomaterials from agricultural wastes

Agricultural waste: Tomato peels

**Agricultural waste:**

- Tomato peels.

**Products developed from tomato peels wastes:**

- Cutin-based bio-lacquer. SSICA.
Production of high-added value biomaterials from agricultural wastes

Agricultural waste: Olive wastes

Products developed from olive wastes:

- Bio-active compounds.
- Biocomposites based on natural fibers.
3/ Validation of developed biomaterials in food packaging applications
Validation of developed biomaterials in food packaging applications

Agricultural waste: Bran

- Wheat bran.

Product developed:

- Mycelium based biopolymers.

End application:

- Secondary packaging for luxury products.

Final properties:

- Good mechanical properties.
- Hydrophobicity.
- Home composting.
- Potential substitute of expanded polystyrene.
Validation of developed biomaterials in food packaging applications

Production of mycelium-based retail packaging materials from wheat bran

**PROCESSING TECHNOLOGY:**

1. Inoculation process
2. Base biobased blend
3. Growth step
4. Grinding step
5. Growth step in a mould
6. Demoulding and Inactivation
Validation of developed biomaterials in food packaging applications
Agricultural waste: Bran

**Agricultural waste:**
- Wheat bran.

**End application:**
- Rigid and flexible food packaging: trays, pots, thermoformed trays, pouches, films...

**Product developed:**
- Phenolic acid-based biopolymers.

**Final properties:**
- Good thermal properties.
- Good mechanical properties.
- Potential substitute of polyolefins.
Validation of developed biomaterials in food packaging applications

**Biopolymers from phenolic acid extracted from wheat bran**

**PROCESSING TECHNOLOGIES:**

- Compounding process
- Cast film extrusion (Flexible prototype)
- Injection moulding (Rigid prototype)
Validation of developed biomaterials in food packaging applications

Agricultural waste: Bran

- Wheat bran.

End application:
- Flexible high barrier packaging (coatings).
- Rigid and flexible food packaging.

Product developed:
- Cellulose based coatings and bio-composites.

Final properties:
- Good homogeneity and adhesion (coatings).
- Good barrier properties (coatings).
- Good thermal and mechanical properties.
- Potential substitute of multilayered structures, PET and polyolefins.
Validation of developed biomaterials in food packaging applications

**Incorporation of cellulose fibers as coatings for packaging materials**

**PROCESSING TECHNOLOGY:**

- MFC production from agricultural wastes
- Formulation of MFC based coatings
- Coating application onto PLA substrate
- Lamination process
Validation of developed biomaterials in food packaging applications

Incorporation of cellulose fibers on biocomposites for packaging applications

PROCESSING TECHNOLOGY:

Production of MFC from agricultural wastes → Drying of MFC by spray-drying → Compounding process → Production of rigid and flexible prototypes
Validation of developed biomaterials in food packaging applications

Agricultural waste: Bran

Agricultural waste:

- Wheat bran.

End application:

- Rigid and flexible food packaging for fresh and processed fruits and vegetables, fresh fish and meat, cereals and bakery products, nuts...

Product developed:

- Bio-active additives based on phenolic acids.

Final properties:

- Antioxidant activity.
- Antimicrobial activity.
- Good barrier properties.
- Potential substitute of current non biobased active additives.
Validation of developed biomaterials in food packaging applications

Incorporation of phenolic acid based active additives from bran in packaging applications

PROCESSING TECHNOLOGY:

Production of ferulic acid based active compound

Compounding process (blending step)

Injection moulding (Rigid prototype)

Cast film extrusion (Flexible prototype)
Validation of developed biomaterials in food packaging applications

Agricultural waste: Tomato peels

End application:
- Cans for legumes and tuna preserved in oil.

Product developed:
- Cutin-based bio-lacquer.

Final properties:
- Good adhesion, good thermal resistance to water and vapor, WACO porosity satisfactory for a good lacquer performance.
- Suitable for non-aggressive food products.
Validation of developed biomaterials in food packaging applications

**Incorporation of tomato cutin as coating for metallic packaging materials**

**PROCESSING TECHNOLOGY:**

1. Cutin purification
2. Bio-resin production
3. Bio-lacquer formulation
4. Application of bio-lacquer on metal substrates
Validation of developed biomaterials in food packaging applications

Agricultural waste: Olive wastes

Product developed:
- Bio-active compounds.

End application:
- Active flexible packaging for fresh and processed fruits and vegetables.

Final properties:
- Antioxidant activity.
- Antimicrobial activity.
- Good barrier properties.
- Potential substitute of polyolefins.
Validation of developed biomaterials in food packaging applications

Incorporation of bio-active compounds from olive wastes in packaging applications

PROCESSING TECHNOLOGY:

Coating technology

Blending technology (Cast film extrusion)
Validation of developed biomaterials in food packaging applications

Agricultural waste: Olive wastes

End application:
- Rigid packaging for cookies

Product developed:
- Biocomposites based on natural fibers.

Final properties:
- Good compatibility biopolymer/natural fibers
- Good mechanical properties
- Potential substitute of current materials for bakery products packaging.
Validation of developed biomaterials in food packaging applications

Biocomposites with potato and natural fibers from agricultural wastes for packaging applications

**PROCESSING TECHNOLOGY:**

Production of fibers from agricultural wastes → Compatibilization process: biopolymer/natural fibers → Compounding process → Production of rigid prototypes

Imagen SEM
4 Conclusiones

Production of high-added value materials

- Production of high-added value compounds from agricultural wastes.
- Production of natural additives with antimicrobial and antioxidant properties.
- Development of biopolymers and bio-based coatings from new and sustainable sources for packaging applications.
- Development of biocomposites based on natural fibres coming from agricultural wastes.

New knowledge

- Development of new biopolymers with improved mechanical and barrier properties.
- Use of microfibrillated cellulose (MFC) as coating for high barrier packaging applications.
- Valorization of cutin from tomato residues as base material to produce a more sustainable protective bio-lacquer for metallic packaging.
- Evaluation of the potential use of natural fibers to improve thermal, mechanical and barrier properties of biocomposites for food packaging applications.

Recovery outputs

- Access to new networking and links for new collaborative opportunities.
- To improve professional qualification of the partners.
- Possibility to carry out diffusion and dissemination activities of the obtained developments to all the components of the value chain of packaging sector.
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