Waste as feedstock
Moderator: Doga ARSLAN
Bio-Based Industries
Joint Undertaking
Waste as feedstock

• Bio-waste is an important feedstock:
  • Available throughout the year as a feedstock for bio-based industries
  • No interference with food production and land use.

• The main R&D&I areas in expanding the utilisation of bio-waste (SIRA, 2017)
  1. Fostering a sustainable biomass supply to feed existing and new value chains
  2. Optimising efficient processing through R&D and pilot biorefineries
  3. Developing innovative products and speeding up market uptake of bio-based products
Waste as feedstock

• Projects VC waste: 10

- RIA Research and Innovation Actions
  - Development and validation of technology

- IA-DEMO Innovation Actions - Demonstration
  - Demo-scale production facility in Europe

- IA-FLAG Innovation Actions - Flagship
  - A first-of-a-kind application, large-scale production facility in Europe

CSA Coordination and Support Actions - no link to TRLs
Waste as feedstock: Presentations

1. Percal
2. Afterlife
3. Biorescue
4. Barbara
5. Indirect (cross VC)
6. Newfert
7. Polybioskin (cross VC)
8. Urbiofin
9. Embraced
10. Demeter

• Brief introduction with 3 slides
• Q&A session after the last presentation
• There is networking opportunities to visit booths and discuss
PERCAL

Chemical building blocks from versatile MSW biorefinery

(Grant Agreement 745828)

PERCAL will exploit Municipal Solid Waste (MSW) as feedstock to develop intermediate chemical products at high yield and low impurity level with huge industrial interest. These will be complementary to the bioethanol (current PERSEO Bioethanol® technology), to achieve a valorisation into:

1. Lactic acid (LA) to produce:
   - Eco-friendly ethyl lactate solvents by reactive distillation from lactic acid & bioethanol.
   - Hot-melt adhesives in combination with maleic anhydride by reactive extrusion.

2. Succinic acid (SA) as an intermediate building block to produce polyols for the polyurethane industry.

3. Biosurfactants by chemical and/or microbiological modification of protein and lipid fraction from remaining fraction of MSW fermentation.
PERCAL Concept & Technologies

What will be achieved

- Production up to 85% of potential fermentable sugars from MSW
- Turnover of fermentable sugar and LA purity over 90%
- Suscinic acid recovered with more than 99% purity over 90%
- Increased recovery from organic content of MSW 25%
- Yield of continuous reactive distillation process to produce ethyl lactate solvents 3.5 l/h
- Target of shear adhesion strength for lactic acid based hot melt adhesives 10 MPa

The solutions proposed consider the best production routes, plant controls, compliance with the regulatory framework and environmental impact as well as business and employment growth.
1. Improved yield of intermediate extraction/recovery from the organic content of MSW by 20% with respect to state-of-the-art or exceed 80% yield of intermediates.

2. Validated process by comparison of the resulting product yield with the one obtained from lignocellulosic biomass. The difference in yield should not exceed 10%.

3. Validated removal of inhibitors to such an extent that it allows cost-effective downstream processing.

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**Consortium:**

Institute ofMechanical Engineering and Control
Peral Project
ATB
Covestro
VISUM
Exergy
IMECAL
Aimplas
CMET
CENER
Hayat
Tbw Research
Perseo
Agricultural University of Athens
ABITech
Abeking & Rasmussen
AFTERLIFE
Advanced Filtration TEchnologies for the Recovery and Later conversion of relevant Fractions from wastewater

paolo@eggplant.it (Paolo Stufano - coordinator)  www.afterlife-project.eu
The Concept: chemicals & bio-plastics from wastewater

AFTERLIFE process

Wastewater Collection

4.2 M€
4 years

Purification

Pretreatment

Filtration (MF+UF+NF/RO)

Energy

Anaerobic digestion

Purification & evaluation of value added compounds

VFA production

PHA production

PHA recovery & purification

Processing

Recycling

PHA end products
The team: 15 partners from 7 Countries

5 RTD & Non-profit org.

10 SMEs
CHALLENGES

Each year, over **3 million tonnes of mushroom compost** is generated by mushroom production, thus creating **significant economic and logistical problems** for Europe’s farmers.

- Mushroom compost, prepared solely for growing mushrooms, is only suitable for one to three harvests;

- The compost is currently disposed of, even though it contains valuable components;

- The mushroom industry lacks adapted technological solutions to upgrade this compost into valuable products.
OBJECTIVES

• To demonstrate an innovative and resource-efficient biorefinery concept for mushroom compost conversion;

• To create valuable bio-based products from mushroom compost and other lignocellulosic feedstocks;

• To achieve a 20% overall cost-reduction in the enzymatic hydrolysis process;

• To reduce disposal costs for mushroom compost and generate a new income stream for mushroom producers.
BARBARA
Problem to overcome

1. **Technical barrier**: There is a lack of bio-based and biodegradable engineering materials
2. **Processes** are not adapted yet (in particular, additive manufacturing technologies → FFF)
3. Lack of quality generates a **poor perception**
4. There is **no value chain established** (specially for final parts and moulds and tools for hybrid manufacturing)

**Consortium**

It consists of 10 partners with complementing competencies, 5 of them industrial (FECOAM, CELABOR and TECNO as SMEs, NUREL and ACCIONA as Large companies) and 5 research and academics partners (KTH, UA, UNIPG, CRF and AITIIP)
**Biopolymer matrices** – Polysaccharides (hemicelluloses, starch ...)

Masterbatch formulations. Engineering polymers functional biopolymides & biopolymesters

**Additive Manufacturing (FFF)**

**Prototype parts Validation**

**Final parts with technical and aesthetical properties**

**Sectors:**
- Automotive
- Construction

**Connection with specific 3D printing CSAs of FOF programme (stakeholders)**

**Biomass Resources**

Extraction/modification bio-based components

**Formulations/processing**

Validation

**Biomass Resources**

Extraction/modification bio-based components

**Formulations/processing**

**MECHANICAL**
- Increase the bending, tensile strength, fatigue resistance (in a 40%)
- Enhancement of scratch resistance behaviour
- Change and control in the rheological properties

**THERMAL**
- Improvement of thermal, and structural degradation at high temperatures
- Target: 140°C

**AESTHETICAL/WELL BEING**
- Colour gamut and effects
- Transparency high performance colours
- Improvement of the wet rubbing fastness avoiding dye migration phenomena
- Improvement of the radiation exposures colour fastness from UV-Vis-NIR
- Controlled fragrance release
- Texturizing: cool touch and soft touch effects

**PROCESSING INNOVATIONS**

**FFF new heading device:**
- Control of temperature and pressure
- Control of layer thickness
- Surface activation (plasma) increasing layers adhesion
- Avoid anisotropy in the z-direction
- Enhancement od printing quality (lines and porosity)

**Tools and moulds for hybrid manufacturing**

4 new grades

**Biomass Resources**

Extraction/modification bio-based components

**Formulations/processing**

**Validation**

**NEW**

Biobased functionalised materials for FFF applications:

- New biopolymesters blends
- New biopolyamides blends

Agricultural biomass

Biopolymer matrices – Polysaccharides (hemicelluloses, starch ...)

Natural dyes & Biomordants Antimicrobials Essential oils

**Masterbatch formulations. Engineering polymers functional biopolymides & biopolymesters**

**Additive Manufacturing (FFF)**

**Prototype parts Validation**
The creation of Value Chains

Biobased building blocks

- Innovations in waste valorisation
- Engineering polymers: Innovations in material functionalization and integration

Materials functionalisation & integration

- CORN SIDE-STREAM BYPRODUCTS VALORIZATION AND PURIFICATION
- POMMEGRANTE, ALMONDS AND CARROTS AGRO-FOOD AND WASTE VALORIZATION AND PURIFICATION
- Biobased Polysaccharides
- Biobased Bioadditives
- ADDITIVE MANUFACTURING (FFF)
- PROTOTYPING

Current value chain

DIRECT FINAL PRODUCT PARTS
MOULDS & TOOLS FOR HYBRID MANUFACTURING

Generating two new biobased value chains
INDIRECT
Conversion of organic side-streams into multiple marketable products – BBI-InDIRECT project (11/2016-10/2017)

L. Bastiaens, J. Roels, M. Lopez, M. Uyttebroek, S. Sforza, G. Bruggeman

BBI stakeholders meeting, Brussels, 6-7/12/2017

2 research partners; 7 industrial partners (5 SMEs) from 4 countries: Italy, France, The Netherlands, Belgium

(BBI.R10-2015-call on ‘Innovative efficient biorefinery technologies’)
Scope InDIRECT project

In DIRECT project

Homogenisation by Insects

Biorefinery of insects + pre & post treatments

Lipids

Proteins

Carbohydrates & fibers

Minor compounds: Carotenoids, polyphenols, vitamins, ...

Cosmetics

Food

Feed

Chemistry

Agro

MARKETABLE PRODUCTS

DIRECT BIOREFINERY

SIDE-STREAMS

PRESS CAKES

MANURE

Grass

Green leaves

Fruits

Vegetables

Indirect Biorefinery

PRODUCT PROCESSING

MARKETABLE PRODUCTS

DIRECT BIOREFINERY

IMPROVE

VITO

IMPR, VITO

VITO

IMPR

VITO

VITO

IMPR, VITO

VITO

VITO

VITO

VITO

UNIVERSITÀ DI PARMA

UNIPR

NS (PRO)

nutrition sciences

INSTITUTE

Main focus indirect
General Objectives of InDIRECT

- Development of indirect cascading biorefinery processes for converting a variety of underspent side streams/residues into useful marketable products via:
  - Step 1: Homogenisation of the side-streams with insects
  - Step 2: Fractionation of the insect biomass into crude extracts
  - Step 3: Purification & conversion of compounds

- Development of direct biorefinery processes for a selection of underspent side streams/residues, for comparison with the indirect approach.

- Optimisation of the biorefinery processes to increase the conversion efficiency (product/ton biomass input) and maximise the values of the feedstock (euro/ton biomass input).

- Exploration of application areas of the extracted compounds for use in different sectors like feed, chemistry and food.

- Hereby taking into account the whole value chain and the associated economic, environmental, legal and practical aspects – lab to pilot.

- Needs & challenges addressed:
  - Management of waste as a resource
  - ‘accelerating innovation and market uptake of bio-based products’ (BBI vision paper)
  - Alternative source for proteins & antibiotics
NEWFERT
NewFert. Nutrient recovery from biobased waste for fertiliser production

(H2020-BBI-PPP-2014-1)
Main Outcome:

Recovery and valorisation of nutrients (N, P and K) from biobased waste streams for the fertiliser production

New family of Advanced Fertilisers:

- Efficient
- Profitable
- Environmentally friendly
- Safe
Results:

- >45 biobased materials analysed (10 selected for being tested within fertilisers processes)

- 3 biobased materials clusters:  
  a) Ashes  
  b) Struvites  
  c) Developed phosphate

- Pilot plant scale:  
  1. Phosphate production  
  2. Struvite from pig slurry  
  3. Biobased materials integration in NPK process

- Up to 25 % substitution rate from biobased materials
Key figures

- Call: BBI 2016.R07 – Biopolymers with advanced functionalities for high performance applications
- 3 years
- 12 partners
- 7 countries (Spain, Italy, UK, France, Germany, Belgium, Serbia)
- Budget: 4 M€ - ca. 3.4 M€ EC contribution
- RIA: Target TRL > 5
- 3 sectors:
New high performance bio-based skin contact materials

- **High performance prototypes**
  - > 90% bio-based, fully biodegradable and skin-compatible diapers and fem care products with a biopolymer-based superabsorbent core, enriched with antimicrobial and antioxidant functionalities to prevent skin reddening and inflammation.
  - > 90% bio-based, bioactive facial beauty mask, impregnated with formulations beneficial for the skin based on natural compounds.
  - > 90% bio-based, fully biodegradable nanostructured biocompatible non-woven tissue for use in wound dressings for bio-medical applications.

Bioplastics, biopolymers and natural compounds

- Antimicrobial
- Antioxidant
- Absorbency
- Skin compatibility

PolyBioSkin Innovations will improve waste management practices by focusing on organic and mechanic recycling as an alternative to incineration and landfiling, and continuity to the circular bio economy

The Union of Concerned Scientists estimates that 18 billion diapers end up in landfills every year.

WASTE MANAGEMENT

- Current Scenario
- PolyBioSkin Innovation

- Reduced environmental impact
- High renewable content
- Sustainable product end-life
Implementation

Road to PolyBioSkin

01 PHASE
- Laboratory Phase
  - Anti-microbial & anti-oxidant functionalities
  - Surface modifications of films
  - Biopolymer blends & composites
- Specification Phase
  - Specify target applications
  - Select Bio-based Raw Materials
  - Pilot-scale PHA production

02 PHASE
- Industrialisation and Impact Assessment
  - Prototypes
  - Validation
  - Scale-Up

03 PHASE
- Life Cycle Assessment and Risk Evaluation
  - Biodegradation assessment
  - Policy & regulatory aspects
  - Health & safety evaluation
  - Standards & certification
  - LCAs & LCAs

04 PHASE
- Dissemination, Exploitation, Management and Ethics Requirements
  - Value chain & business models
  - Project management & ethics
  - Requirements
  - Exploitation & commercialisation
  - Dissemination, communication, advocacy actions
  - PR management

05 PHASE
- Go to Market

END
URBIOFIN
Demonstration of an integrated innovative biorefinery for the transformation of Municipal Solid Waste (MSW) into new BioBased products (GA 745785)

**Objective**

The aim of the URBIOFIN project is to demonstrate the techno-economic and environmental viability of the conversion of 10 tonnes per day of the organic fraction of municipal solid waste (OFMSW) into:

- **Chemical building blocks**
  (bioethanol, volatile fatty acids, biogas)

- **Biopolymers**
  (short and medium chain polyhydroxyalkanoates, composites combining different PHAs)

- **Additives**
  (bioethylene, microalgae derived biochemicals)
The URBIOFIN project is aiming to deliver the following results:

- To demonstrate an enhanced valorization pathway of the entire organic fraction of MSW, as compared to the current valorization processes, by converting it into chemical building blocks, biopolymers and additives.
- To achieve a competitive price for the products derived by the URBIOFIN process.
- To prepare the market for future commercialisation by ensuring products comply with EU legislation for safety, quality and purity.
- To boost the uptake of the Urban biorefinery concept by offering a sustainable and economically interesting approach to valorise the OFMSW.
- To reduce GHG emissions and contribute to the shift from a linear to a circular bioeconomy.
The EMBRACED project intends to **demonstrate** in a relevant industrial environment a **replicable, circular, economically viable and environmentally sustainable** model of integrated biorefinery based on the **valorisation of the cellulosic fraction of Post-Consumer Absorbent Hygiene Products Waste** (in short AHP) towards the production of biobased building blocks, polymers, and fertilizers.
The biorefinery model

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 745746
Development of an innovative integrated biorefinery in Amsterdam:

- Demonstrate a replicable logistic AHP waste collection scheme based on the adoption of innovative business models (direct to customers services)
- Design and realize an innovative AHP waste based (demonstration) biorefinery train (10,000 t/year) in order to separate 3 different high purity grade fractions (plastic, cellulose, SAP)
- Multipurpose approach for the biorefinery in order to convert the AHP cellulosic fraction into different biobased products: building blocks, polyesters, PHB and fertilizers
- Development of profitable business cases, business models and business plans tuning the biorefinery model to different local conditions across EU
DEMETER
Demonstrating more efficient enzyme production to increase biogas yields

Grant Agreement n. 720714

Sandra Hinz
Brussels, 6-7 December 2017
Objectives

1. to improve and scale-up the enzyme-producing fermentation process to yield at least 20% more protein while retaining quality

2. to improve downstream processing of the fermentation broth leading to a cost reduction of at least 15%

3. to demonstrate the improved production process in a 15 000 L pilot plant

4. to demonstrate the industrial and economic feasibility to apply a cost-effective enzyme product in biogas plants

5. to develop a predictive model of the effect of enzyme addition on the biogas yield of a given fermentation process

6. to analyze the impact of the developed processes and products on environment and economy
Partners

Dupont
BioBased Europe Pilot Plant
Miavit
Deutsches Biomasseforschungszentrum
OWS
CiaoTech
Biomoer
Questions
thank you!