



# NEW BIO-BASED FOOD PACKAGING MATERIALS WITH ENHANCED BARRIER PROPERTIES

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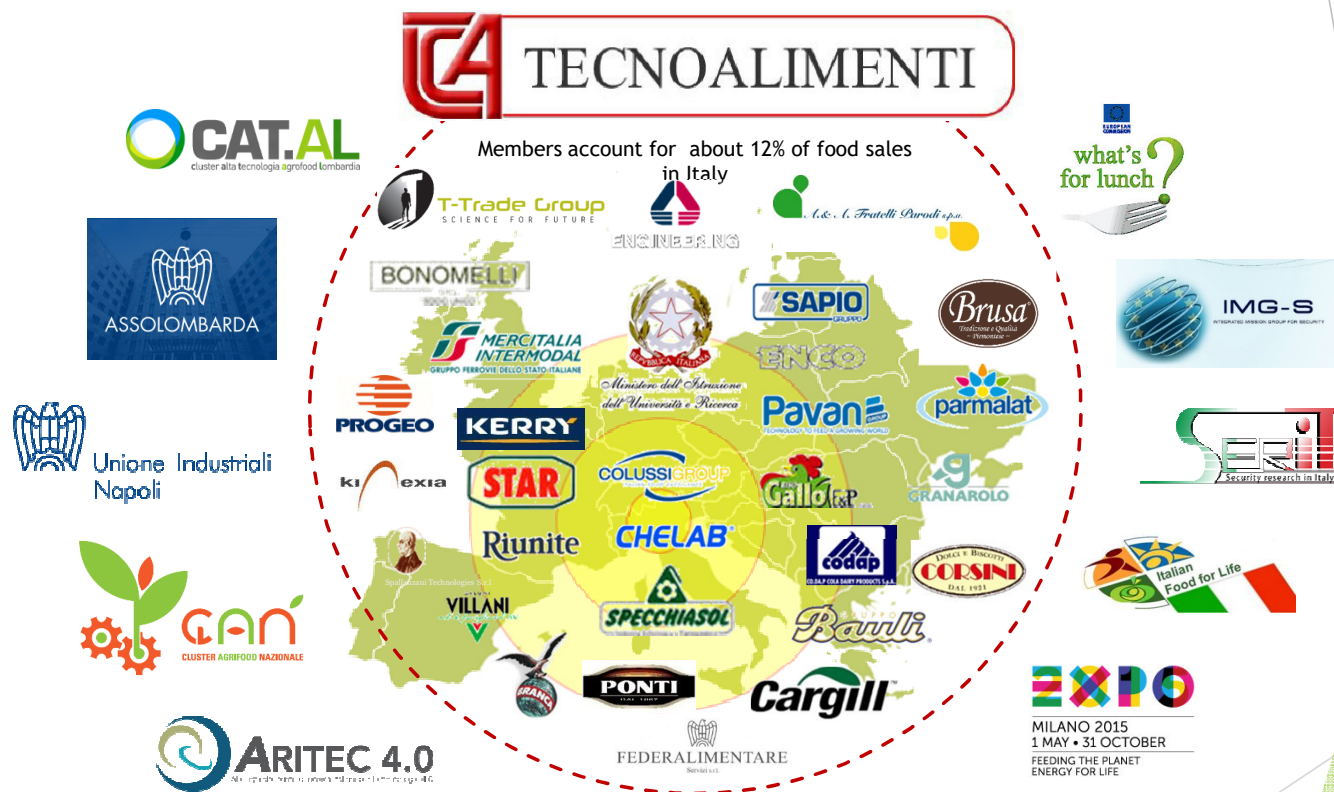


Milan, Italy

AFTERLIFE BBI WORKSHOP ON BIO-BASED POLYMERS  
29 March 2021, on-line event

# Tecnoalimenti S.C.p.A.

31 food industrial members and the Italian Ministry of Research



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# THE PILLARS OF TCA

## 40 years of experience

Established in 1981

## NO PROFIT CONSORTIUM

- Research and Technology Organisation (RTO)

## INDUSTRY LED

- Innovation for business in industry

## FOCUSED ON TECHNOLOGIES

- Delivering technological innovation ⇒ Inter-companies co-innovation  
Own research & innovation activities





Horizon 2020  
European Union Funding  
for Research & Innovation



## Overview

Project title: **New bio-based food packaging materials with enhanced barrier properties (BioBarr)**

*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 745586*

Research and Innovation Action (RIA), financed 100%

Duration: 54 months (June 2017-November 2021)

4 European Countries involved: Italy, Spain, Denmark, Finland





## **APPROACH:**

**FROM INDUSTRIAL NEEDS TO THE PROJECT  
IDEA AND PARTNERSHIP**



Major functions or considerations of **food packaging**:  
containment, protection, communication, functionality, production  
efficiency, environmental impact and consumer safety/regulation

### NEEDS COLLECTED BY INDUSTRY FOR INNOVATION IN FOOD PACKAGING

- **LONGER (PRODUCT) SHELF-LIFE** competitiveness, reaching new markets  
< wastes
- **MORE SUSTAINABLE** reducing food losses/waste and delivering a sustainable option
- **FUNCTIONALITY**



## **LONGER SHELF-LIFE** means...

- TO MAINTAIN SENSORY PROPERTIES
- NOT SUPPORT THE GROWTH OF UNWANTED MICRO-ORGANISMS OR MOULDS

Barrier protection against oxygen, water vapour, dust, etc is often required by industry. It depends on the specific food product.

## **MORE SUSTAINABLE** means...

- TO MOVE TOWARDS **BIO-BASED SOLUTIONS**
- ... PAYING ATTENTION TO THEIR **END-OF-LIFE**





## **FUNCTIONALITY** means...

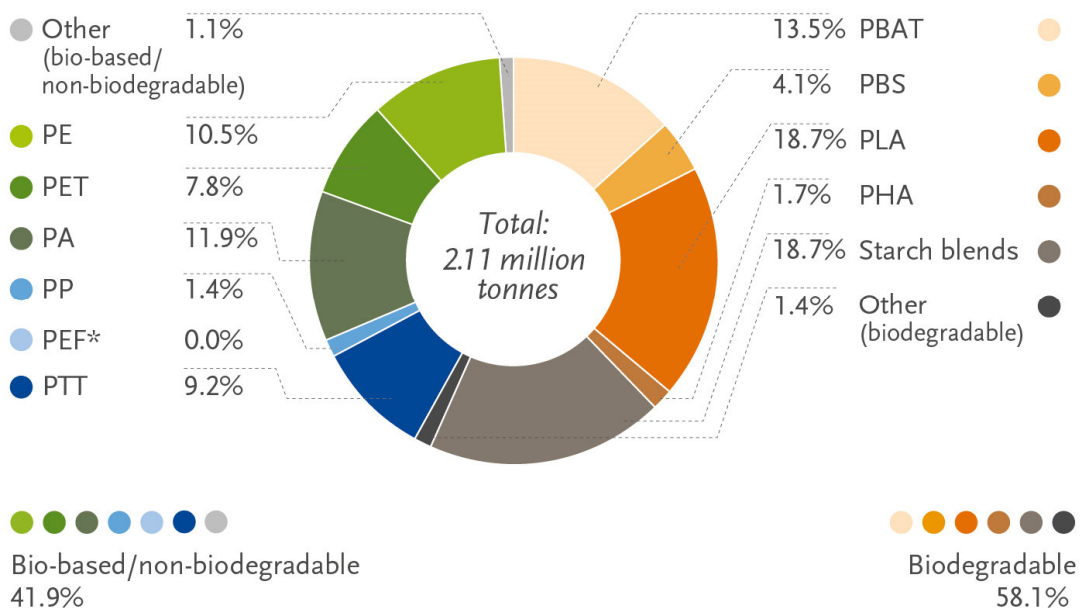
- A lot of research is addressed to include into the package Oxygen absorbents.
- Modified atmospheres or controlled atmospheres are largely used in the food industry.

Another approach can be to **work only on the packaging material barrier properties**, approach selected by the project





## Global production capacities of bioplastics 2020 (by material type)



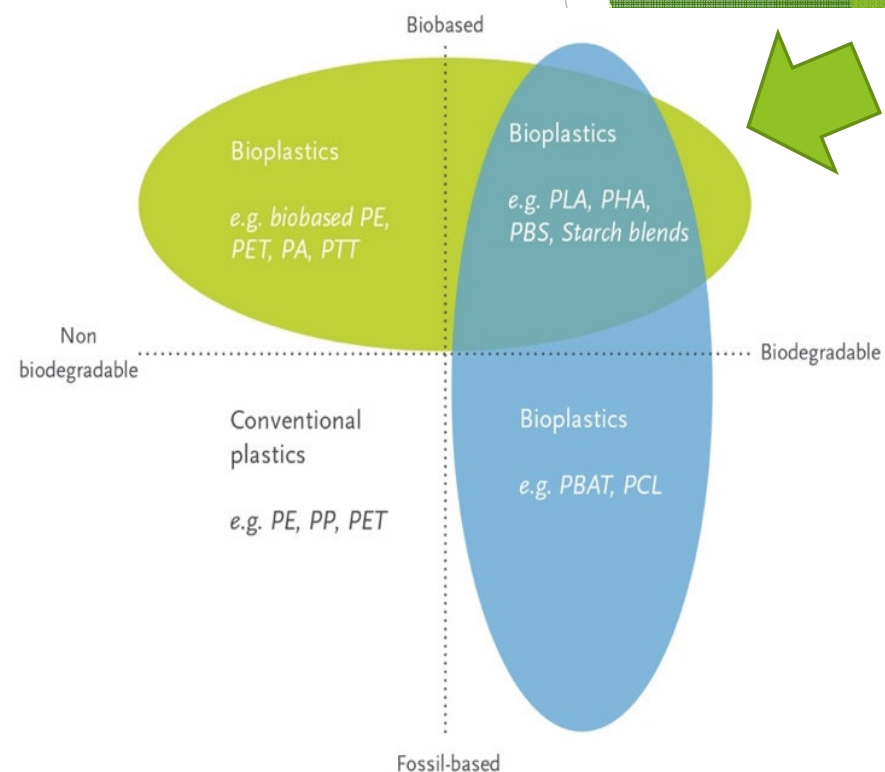
\*PEF is currently in development and predicted to be available in commercial scale in 2023.

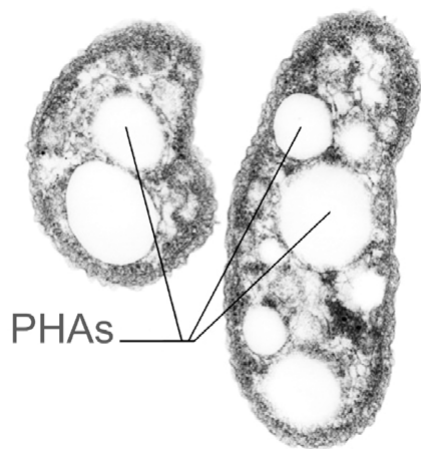
Source: European Bioplastics, nova-Institute (2020)

More information: [www.european-bioplastics.org/market](http://www.european-bioplastics.org/market) and [www.bio-based.eu/markets](http://www.bio-based.eu/markets)



Source: <http://www.european-bioplastics.org>





Polyhydroxyalkanoate PHAs are **100% bio-based** and fully biodegradable plastic materials; thanks to their excellent balance of physical, thermal and mechanical properties they can be considered as the best candidates for traditional oil-based plastics replacement.

Bio-on PHAs is **100% biodegradable** both in soil and water, fresh and sea water: non forced biodegradability!

PHAs production:

- uses agricultural by-products, co-products and waste materials
- apply completely natural processes such as fermentation

## Challenges

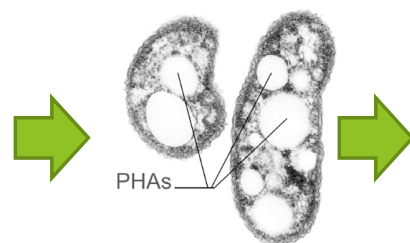
- interventions of **functionalisation** [which mainly consist in applying an additional thin layer of another material on top of the biobased films (*Peelman et al., 2013*) in order to optimize functional properties and increasing PHA barrier properties, but maintaining all its peculiarities and advantages]
- each innovative technological element has to be integrated in the new food packaging developed in *BioBarr* applying an entirely biodegradable process





# Concept

...FROM SUGAR BEET MOLASSES  
AND JUICES, SUGAR CANE  
BY-PRODUCTS, POTATO WASTE,  
CRUDE GLYCEROL FROM  
BIODIESEL, ETC...  
THROUGH FERMENTATION...



PHAs  
polyhydroxyalkanoates



Development of a new **bio-based**, **biodegradable** and high-performances food packaging material by enhancing **barrier functionalities** to the biopolymer PHAs and by validating the new packaging material in a food industry environment





## Main goal

- ▶ **BioBarr** concerns the development of new bio-based and biodegradable food packaging materials by enhancing barrier functionalities to the biopolymer PHAs (polyhydroxyalkanoates) and by validating the new material in the food industry environment.
- ▶ As a matter of facts, the expected outputs constitute the point of start for a technologically advanced, environmental sustainable and reproducible food packaging generation.



## Partnership



*icimen*  
*due* S.R.L.

Kao Chimigraf

 Tampere University



Technical University  
of Denmark







# The development process (1)

Biobased material production, extrusion and film making

PHA  
production  
and  
compounding



PHA film making



Tampere University





# The development process (2)

Functionalisation and Printing

Lamination &  
Coating treatments

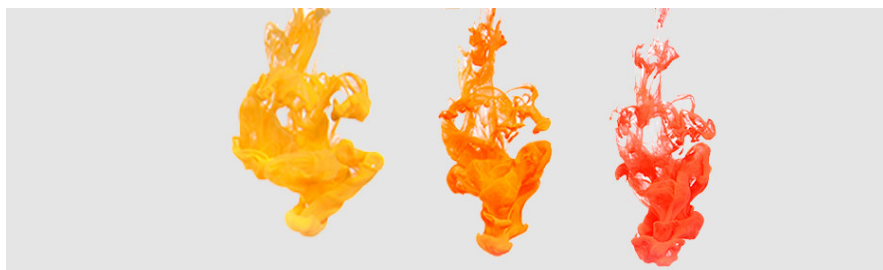
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*due* S.R.L.



Icimendue

Inking & Printing Tests

Kao Chimigraf



Kao Chimigraf





## The development process (3)

Validation in real conditions (end-user)



Industrial member of







Undisputed environmental added value, but...  
**are bioplastics able to answer the  
current market needs and requirements?**

### CURRENT CONSTRAINTS / HESITATIONS and OBJECTIONS:

PRICE	Costs of biopolymers and bioplastics are still much higher than conventional plastics. The present small niche market does not allow sufficient returns
AMOUNT	Available still in reduced quantities compared to the market requests
PERFORMANCES	Properties of bioplastic and biopolymers are not yet fully comparable to oil based material, mechanical and/or functional properties of the bio-based packaging products shall be further developed against the current state-of-the-art in the field
PROCESSING	Possible problems with the existing equipment
SAFETY	Not all the biopolymers have been already approved for food contact



## Lines of development of the Project - ONGOING

- ✓ **Processability assessment and development of flexible films for food packaging applications**
- ✓ **Surface treatments**
- ✓ **Development of new bio-based and eco-friendly inks for printing**
- ✓ **Shelf-life assessment**
- ✓ **LCA**
- ✓ **Cost-benefits analysis**
- ✓ **Value Chain Analysis**



## ✓ WHAT EMERGED IN THESE YEARS

### Formulative development



- Different grades developed
- Optimization of biopolymers for specific applications, in line with what happened with "traditional" polymers.
- Reduction of costs, through:
  - *Improvements in the production lines*
  - *Use of wastes/co-products for producing biopolymers at competitive prices*

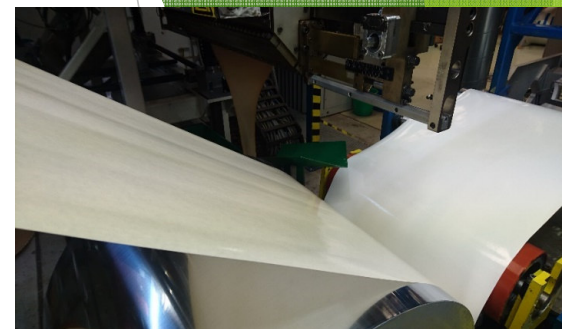




## ✓ WHAT EMERGED IN THESE YEARS

**Good processability**

- Compatibility both with blown extrusion equipment and (co)extrusion coating and lamination line, for obtaining flexible films
- The PHA compound properties impact directly the setting of the used equipment
- The process parameters of the equipment used must be adapted to the specific properties of the compound, *e.g. screw speed, melt pressure, melt temperature, film temperature, and line speed, in order to produce optimised films*
- Can be processed through the typical technologies of thermoplastics
- Able to be handled and rolled-up
- Can be produced in different thicknesses (25-70 micron)





## ✓ WHAT EMERGED IN THESE YEARS

**Feasible sealing and packing**



...sealed through a hand thermal sealing machine

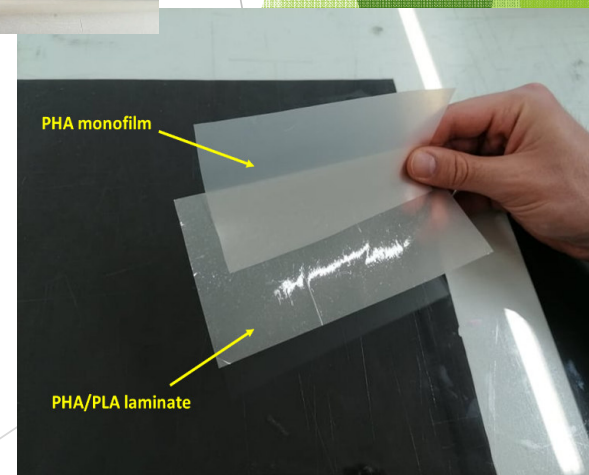
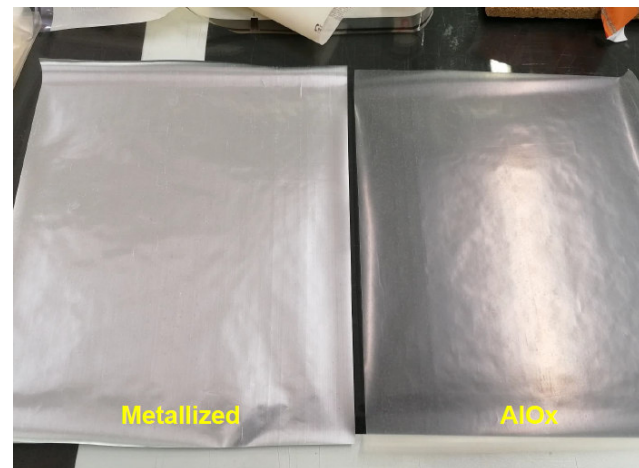
**...and acceptable esthetical appearance of the film**



## ✓ WHAT EMERGED IN THESE YEARS

**Suitable for coating treatments and lamination**

- The PHA compound properties impact directly the functionalisation trials (= adhesion of the thin layer)
- Corona pre-treatment needed (improving the performances in terms of lamination and printability)
- Multi-layers solutions feasible







## ✓ WHAT EMERGED IN THESE YEARS

1. Optimization of existing compostable water based ink with substitution of some current formulation components and replacement of the standard organic pigments with others more biodegradable

2. Setting up of a completely new bio-based and compostable ink, able to be printed on PHA materials



**Good  
printability**



Traditional solvent-based inks



Compostable inks (CHIM) for flexo



## ✓ WHAT EMERGED IN THESE YEARS

**General compliance of the new developed bio-based material intended to be in contact with food, in accordance with Regulations (EC) No 1935/2004 and (EU) No 10/2011**



e.g. Test in a migration cell



## ✓ WHAT EMERGED IN THESE YEARS

### Compliance to biodegradability std

Lab scale tests on biodegradability were carried out, following already established standards, where the material undergoes intense biological treatment, simulating industrial organic waste treatment process in aerobic digestion conditions (according to ISO 14851). The validation criteria for the biodegradability testing is that, at least 90% of the test material has to be biodegraded within a period of 6 months, when biodegradation is defined according to Specifications Standard EN 13432. A “high” biodegradability results is a good evidence that the test substance will be biodegradable in wastewater treatment plants, anaerobic digesters and in many natural anaerobic environments. The biodegradability tests performed indicate that the pass level criteria (>90%) is fulfilled in all film samples, which indicates inherent biodegradability.





## ✓ Still in progress...

- Mechanical and barrier properties of the finished product
- Printing process validation at industrial level
- Compostability assessment
- Validation in industrial facilities (food end-user involvement for trials in real conditions)
- Shelf-life and acceptability studies
- Process-based life cycle assessment (LCA), cost-benefit analysis (CBA) and VCA



## Conclusions

- New grades of PHAs biopolymer are being developed along the BioBarr project with improved performances that can expand the market for these materials in the packaging sector.
- **BioBarr is experimenting their application in the food sector**; if we consider that food packaging accounts for almost 50% of total packaging waste (Vimal Katizar, 2017), the impact of such project's outcomes for the future is evidently huge.
- In perspective, with the optimization of processes and with an adequate scale-up (several investments are underway that should lead to a wider availability), thanks to a significant cost reduction PHAs biopolymers could to become competitive also from the economic point of view.
- Biopolymers that can replace successfully traditional plastics already exist: this is the case of PHAs. Obviously the process conditions must be optimized, investments are needed, but the road is marked and uphill.



**Stay tuned!**

Website: <http://www.biobarr.eu/>

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