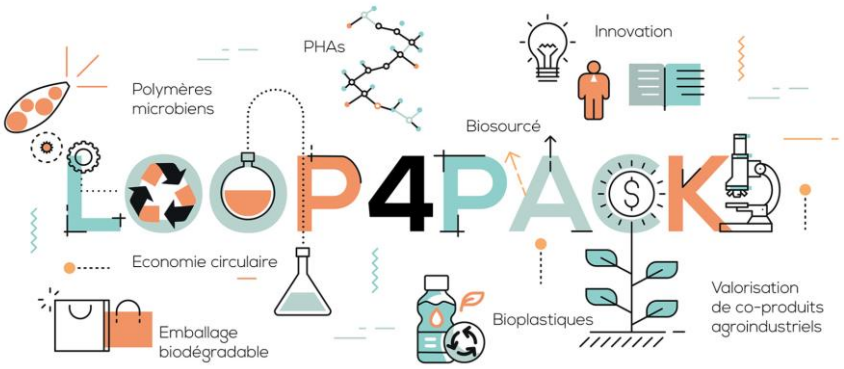


LOOP4PACK - Sustainable bioplastics from agro-industrial residues to close the packaging loop

grant agreement N# ANR-19-CE43-0006

Start date of the project: 1/11/2019

Deliverable D4.3

Cartography of characteristics needed for new packagings

Planned delivery date (as in proposal): 01/05/20 (M6)
Actual submission date: 01/06/20 (M7)

Task: T4.2. Product/market assessment
Coordinator: Estelle Grousseau (Partner 1: UM), estelle.grousseau@umontpellier.fr
Task leader: Frédéric Merle (Partner 3 : Mc Cain/Euramaterials)

Dissemination level: PU (Public)
Version: V2

Table of content

Document Informations

Authors

Partner	Organization	Name	email
3-McCain	Euramaterials	Frédéric Merle (FM)	frederic.merle@euramaterials.eu

Revision history

Version	Date	Modified by	Comments
0	06/05/20	Frédéric Merle	Internal version
1	20/05/20	Pierre Gondé	V1 validated by task leader, sent to all partners
2	20/07/22	Estelle Grousseau	Modification of dissemination level to Public for online publication on the project website and of the task leader Pierre Gondé => Frédéric Merle

Dissemination level

PU	Public	**X**
CO	Confidential, only for members of the consortium (including the ANR Services)	

Introduction

This deliverable aims at collecting data that will constitute essential inputs for the next workpackages 2 and 3 and the production of tailored PHA materials for developing new packaging compatible with food contact.

Before realizing packaging items and assess their behavior in real conditions of use and end-of-life, it is essential to understand perfectly actual specifications of packaging used today by food companies.

The first focus is made on McCain case-study as a the key industrial partner of the project, the selected item being Packaging for frozen fries distributed to consumers through large retail stores.

Then a review of alternative but very close applications is made namely frozen food packaging, fresh food packaging and trays. Target these markets will potentially enlarge the diffusion of materials developed in the project through the retail food sector. This review could be realized through EuraMaterials interviews of final users (members and non-members) and technical data base on existing packaging.

Finaly a benchmarking of existing solutions gives an overview of what is already available on the market, their specification and prices (when available) and the gaps yet to be filled to comply with end user needs.

Mc Cain specific needs

Needs tables

Description of packaging
Packaging description: PE based films *The way consumers use it*: kept at -18ºC until the best before date is attained. *Its expected service life:* single use packaging *Key features appreciated by consumers:* resistance of the packaging. *Key features appreciated by industries;* ability to print on the packaging; resistance at all point of the value-chain (production, logistics, home storage)
Present end of life of the packaging:
Single use packaging with consumers advised to put it in the plastics recycling container (when possible)
Description of the content:
French fries Expected shelf life is 24 months.
Regulations:
Complies with all known food regulations
Technical requirements of the packaging in relation to the content:
Packaging must protect content from water and ice. Micro perforation in the bag
Technical requirements in relation to closure technology:
Top and bottom sealed.
Technical requirements related to appearance:
Printability is key. Transparency is not an issue.
Figures expected for new packagings :

Improved recyclability/compostability

Supplier Technical specifications

LDPE film

Caractéristiques	Units	Measures	Methodology	Conditions
Thickness	microns	70		
Weight	g/m²			
Wetting tension	dynes/cm			
Permeability				
Water vapour	g/m²/24h	NA	ASTM F1249	
Oxygène (Oxygen)	g/m²/24h	NA	ASTM D 3985	
Mecanical				
Tear strenght	N/mm²	>20	DIN EN ISO 527	MD
		>20		CD
Dart drop (f50_method)	g/µm	>=5	DIN EN ISO 527	
Elongation at break	%	>500	DIN EN ISO 527	MD
	%	>500		CD
Friction		0.15-0.25	DIN EN ISO 8295	Inside/inside 0.15(+/-0.1) Ouside/outside 0.25 (+/-0.1)
Thermic				
Sealing range	°C	Broad		
Hot tack	N/15mm	≥ 10	DIN 55529	

Price of 1.3€ / kg

Review of needs for new packaging and their characteristics

Flexible frozen Food Packaging

1. *Needs table*

Description of the typical packaging / exemple of frozen vegetables
Packaging description: PE based films (PEBD, PE/PE) *The way consumers use it*: kept at -18ºC until the best before date is attained. *Its expected service life:* single use packaging *Key features appreciated by consumers:* resistance of the packaging. *Key features appreciated by industries;* ability to print on the packaging; resistance at all point of the value-chain (production, logistics, home storage)
Present end of life of the packaging:
Single use packaging with consumers advised to put it in the plastics recycling container
Description of the content:
Frozen vegetables. Expected shelf life is 8-10 months.
Regulations:
Reg. (EC) N.º 2023/2006 22 December + Reg. (EC) 282/2008 27 March Reg. (EC) No 1935/2004 27 October Reg. (EU) No 10/2011 14 January + changes (Reg. No 202/2014 3 March; Reg. (UE) No 1183/2012 30 November, Reg. No 321/2011 1 April; Reg. No 1282/2011 28 November; Reg. No 2015/174 5 February; Reg. (EU) nº 2016/1416 24 August, Reg. (UE) 2017/752 28 April and Reg. (UE) 2018-79 18 January). Also Directive 2007/68/CE 27 November.
Technical requirements of the packaging in relation to the content:
Packaging must protect content from water and ice. Content is packed under modified atmosphere.
Technical requirements in relation to closure technology:
Top and bottom sealed.

Technical requirements related to appearance:
Printability is key. Transparency is not an issue.
Figures expected for new packagings :
Improved recyclability/compostability

2. *Exemple of supplier technical specifications*

Film PEBD White, opaque, laminated

vizelpas Flexible Films	FICHA TÉCNICA DEPARTAMENTO QUALIDADE E SEGURANÇA ALIMENTAR	Elaborado por: Maria Costa REV: 10 Data: 03/07/2018

Caractéristiques	Units	Measures	Methodology	Conditions
Thickness	microns	50	ASTM D 6988	
Weight	g/m²	46.2	ASTM D 6	
Wetting tension	dynes/cm	≥38	ASTM D 2578-84	
Permeability				
Water vapour	g/m²/24h	=<11	Theoretical value	
Treatment	Corona			
Printing	Flexography / Exterior of packaging			

Flexible fresh food packaging

1. *Needs table*

<table>
<tr><td> 


</td></tr>
<tr><td>Description of the typical packaging / exemple of frozen vegetables</td></tr>
<tr><td>Packaging description: PE based films, PP, OPP
The way consumers use it: kept at 4ºC until the best before date is attained.
Its expected service life: single use packaging
Key features appreciated by consumers: resistance and transparency of the packaging.
Key features appreciated by industries; adapted oxygen and water barrier, ability to print on the packaging; resistance at all point of the value-chain (production, logistics, home storage)</td></tr>
<tr><td>Present end of life of the packaging:</td></tr>
<tr><td>Single use packaging with consumers advised to put it in the plastics recycling container</td></tr>
<tr><td>Description of the content:</td></tr>
<tr><td>Fresh vegetables. Expected shelf life is 5-10 days.</td></tr>
<tr><td>Regulations:</td></tr>
<tr><td></td></tr>
<tr><td>Technical requirements of the packaging in relation to the content:</td></tr>
<tr><td>Packaging must protect content from oxygen and water.
Content is packed under modified atmosphere.</td></tr>
<tr><td>Technical requirements in relation to closure technology:</td></tr>
<tr><td>Top and bottom sealed.</td></tr>
<tr><td>Technical requirements related to appearance:</td></tr>
</table>

Printability is key. Transparency is key.
Figures expected for new packagings :
Improved recyclability/compostability

2. *Exemple of supplier technical specifications*

Film OPP provided by

multisac
FLEXIBLE PACKAGING

Caractéristiques	Units	Measures	Methodology	Conditions
Thickness	microns	35		
grammage	g/m²	31,9		
Wetting tension	dynes/cm	≥38	ASTM D 2578-84	
Permeability				
Water vapour	g/m²/24h	1,2	ASTM F1249	23°C-100%HR
Oxygène (Oxygen)	g/m²/24h	1050	ASTM D 3985	23°C-0%HR
Optical				
Gloss	%	82	ASTM D 2457-90	Gard (45°)
Haze	%	2,8	ASTM D 1003-88	Gard (2,5°)
Mecanical				
Tensile strenght	N/mm²	130	ASTM D 882-91	MD
		290		TD
Elongation at break	%	220	ASTM D 882-91	MD
%		60		TD
Elasticity Modulus	N/mm²	2000	ASTM D 882−02	MD
		3800		TD
Friction		0,3	ASTM D 1894-90	MD
Thermic				
Sealing range	°C	105 - 140		
Resistence to welding	g/cm	≥ 200		(130°C,1'',1bar)
Dimensional stability	%	≤ 3		120°C 5mn
Printing	Flexography / double-sided with anti-fogging interior			

Food Tray

1. *Needs table*

Description of the packaging:
Good Strength and stability For hot and cold food.
End of life of the packaging:
Single use packaging with consumers throwing it directly in the bin (often soiled)
Description of the content:
The food tray is used to feel food with temperature from 0°C to 120°C. The shelf life of the tray with food is few days up to 1 week.
Regulations:
Food contact ability : EU 10/2011
Technical requirements of the packaging in relation to the content:
The food is not usually packed under vacuum or under modified atmosphere
Technical requirements in relation to filling, processing, packing procedures at industry level and transportation to destination:
The food tray after filling the food maybe thermo sealed with transparent PP film
Technical requirements in relation to closure technology:
Thermo sealing
Technical requirements in relation to handling and use of packaging by consumers:
The film should be peelable .
Technical requirements related to appearance:
The food tray can be transparent or opaque. Printable or adding masterbatch to have colored food tray.

Suggestions about novel packaging:
Compostable food tray that holds up like conventional plastic food tray and will degrade quickly. The food tray should be microwavable

2. *Technical specifications*

Technical specification for PP for reference :

TYPICAL PROPERTY VALUES

Revision 20191230

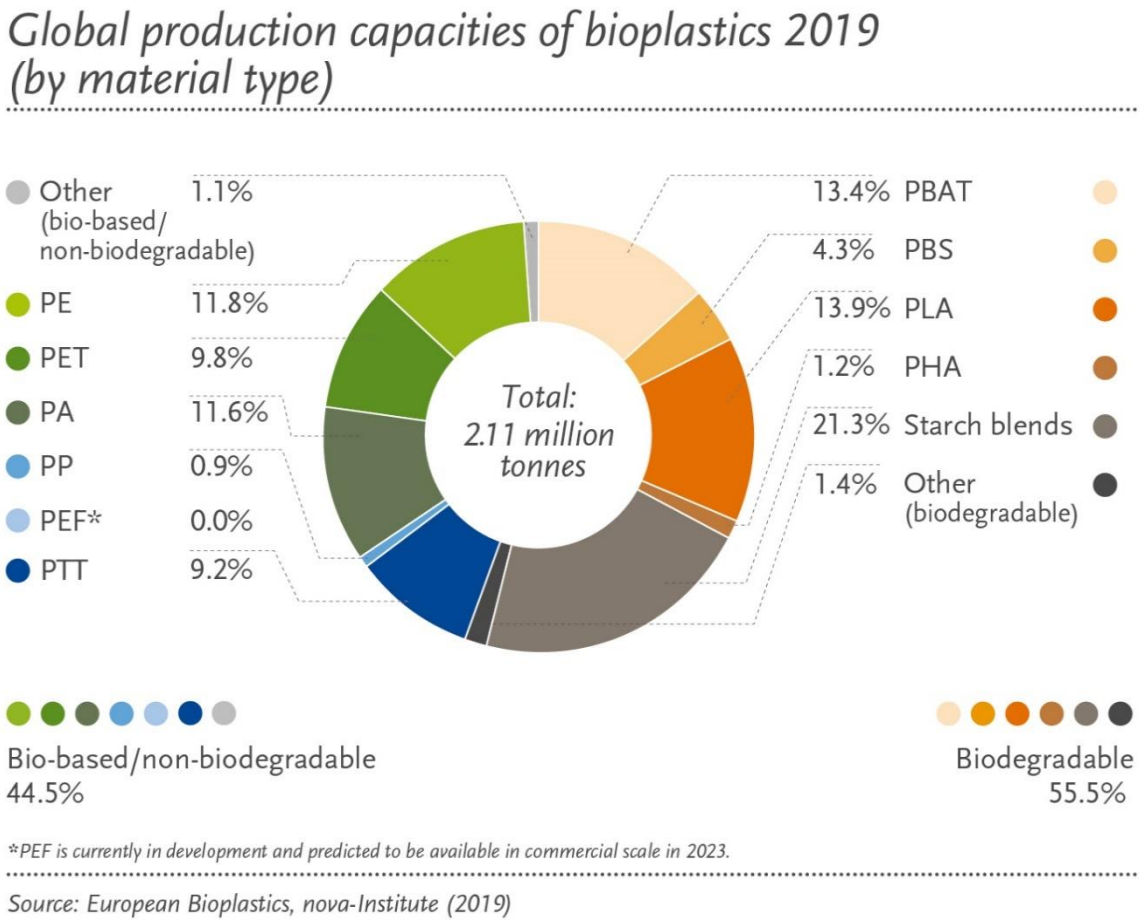
PROPERTIES	TYPICAL VALUES	UNITS	TEST METHODS
POLYMER PROPERTIES			
Melt Flow Rate			
at 230 °C and 2.16 kg	2.0	dg/min	ISO 1133
Density	905	kg/m³	ASTM D1505
Molecular Weight Distribution	Broad	-	-
Isotacticity	Medium	-	-
FORMULATION			
Anti static agent	☐	-	-
Nucleating agent	☐	-	-
Gas fading stabilized	☐	-	SABIC method
MECHANICAL PROPERTIES			
Tensile test			
strain at yield [1]	10	%	ISO 527-2 1A
stress at yield	37	MPa	ISO 527-2 1A
tensile modulus [2]	1500	MPa	ISO 527-2 1A
Izod impact notched			
at 23 °C	3.5	kJ/m²	ISO 180/1A
Charpy Impact Strength Notched			
at 23 °C	4.5	kJ/m²	ISO 179/1eA
THERMAL PROPERTIES			
Heat deflection temperature [3]			
at 0.45 MPa (HDT/B)	85	°C	ISO 75
at 1.80 MPa (HDT/A)	55	°C	ISO 75
Vicat Softening Temperature [4]			
at 10 N (VST/A)	152	°C	ISO 306
at 50 N (VST/B)	88	°C	ISO 306

Benchmarking of existing bio-based packaging solutions

General overview of the market of bioplastics

Biodegradable plastics altogether, including PLA, PHA, starch blends and others, account for over 55.5 percent (over 1 million ton) of the global bioplastics production capacities. Table 1 synthesis the production capacities of bio polymers with distinction of biodegradable and non-biodegradable polymers.

Table 1 :



Packaging remains the largest field of application for bioplastics with more than 53 percent (1.14 million tons) of the total bioplastics market in 2019.

Gaps to be filled by bio materials for packaging application

Despite extremely dynamic researches and developments on biobased and biodegradable materials (>1,4k scientific publications/year on the last 10 years), commercially available bio-packaging (see **Erreur ! Source du renvoi introuvable.**) does not yet properly meet the huge market and society demands.

Table 2 : Synthesis of existing bio based material solutions

Bio based Materials	Bio based content	Compostability	Origin	Benefit	Drawback
Cellulosic	>90%	Home compost	Cellulosic pulp	Origin + end of life	Tear resistance at low temperature, lack of barriers (oxygen, fat…)
PLA based	100%	Industrial EN 13432 or NFT 51-800	Corn, cane sugar, cassava, beets	Biodegradable in industrial conditions	Potato extract (Feedstock competition) Low and high temperature behaviour to be improved
Starch based	30-100%	Industrial EN 13432 or NFT 51-800	Maize, wheat, potato	Biodegradable in industrial conditions	Potato extract (Feedstock competition) Sensibility to temperature variations Hydrophobicity
Bio PE	Up to 95%	No	Cane sugar	Recyclable, same characteritics as PE	Not biodegradable
PHA	100%	Home compost	Various co-products	Origin + end of life + adjustable features	To be adjusted for specific needs

Source : EuraMaterials

Currently marketed bio-polymers are either stemming from food resources (e.g. PLA, PBS, starch-based blends or PHB), or not fully biodegradable in natural conditions (case of PLA), or not water resistant (case of starch-based blends), see table 2.
Among the cons for the use of biodegradable plastics are usually quoted the following items :

- Costly
- Partially use of genetically modified organisms (for PLA production for example)
- Use of lands, fertilizers and pesticides for crops, potential food competition
- Narrow processing window (lower melting temperature)
- Brittleness
- Thermal degradation
- Specific procedure for disposal
- No recyclable or polluting recyclable chain

So next generation of bio materials will have to consider and respond to some of these issues.

Nonetheless products are already on the market and offer continues to grow.

Overview of main packaging products /raw materials on the market – specific properties

Table 3 gathers available information about the main materials already on the market with packaging applications.

Table 3 : Overview of main packaging products /raw materials on the market – specific properties

MATERIALS AVAILABLE FOR FOOD PACKAGING - MAIN MANUFACTURERS	MAIN APPLICATIONS	SHAPING	PRICE	VOLUMES	YOUNG'S MODULUS (MPPA)	ELONGATION AT BREAK %	GLASS TRANSITION T°
CELLULOSIC FUTURAMA	• Fresh products • Bakery products	Casting	_	_	2000 MD 1000 TD	18-22 MD 32 – 70 TD	
PLA BASED TAGHLEEF - NATIVIA – RODENBURG - INGÉO	• Fresh products • Bakery products snacking, paper bags • Roast chicken	Extrusion / thermoforming	0.8/1.5€/kg (+ transformation price)		454	38	55-60
FKUR - BIOFLEX	• Fruits and vegetables bags • Thermoformable trays	Thermoforming Injection /Extrusion	2.85-3.70 €/ kg	No restriction	730	No break	65

BASF – ECOVIO/ECOFLEX **NATUREPLAST - NPSOFT**	• Fruits and vegetables bags • Thermoformable • Trays	Thermoforming Injection /Extrusion Extrusion/injection			1200	420	
STARCH BASED NOVAMONT – MATER BI BARBIER- MATER-BIO **SPHERE** **VÉGÉPLAST - VEGEMAT**	• Food trays • Cup • Disposable dishes • Yogurt pots • Disposable bags • Fruits and vegetables bags • Thermoformabel trays	Blow molding / extrusion / injection molding Extrusion/injection	3-5 € / kg	120.000 t	90-700 2000	250-600 0.79	
BIOBASED PE ALFAPAC – SPHERE (BRASKEM)	• Rigid packaging • Films • Same properties as PE	Extrusion/injection Blow molding			445.2 +/- 20.3	531.3 +/- 26.6	

Source : EuraMaterials

Conclusion

This deliverable provides key data as a starting point for the design of future packaging developed in the project.

Compostability appears clearly as a common improvement need for new food packaging even though it must not challenge properties linked with food protection and processability.

The project may reveal technical limitations and impossibility to reach all the target properties. Alternative high added value markets like luxury or medical packaging with sometimes less restricting constraints can then be considered.

This project has received funding from the Agence Nationale de la Recherche under grant agreement N#ANR-19-CE43-0006