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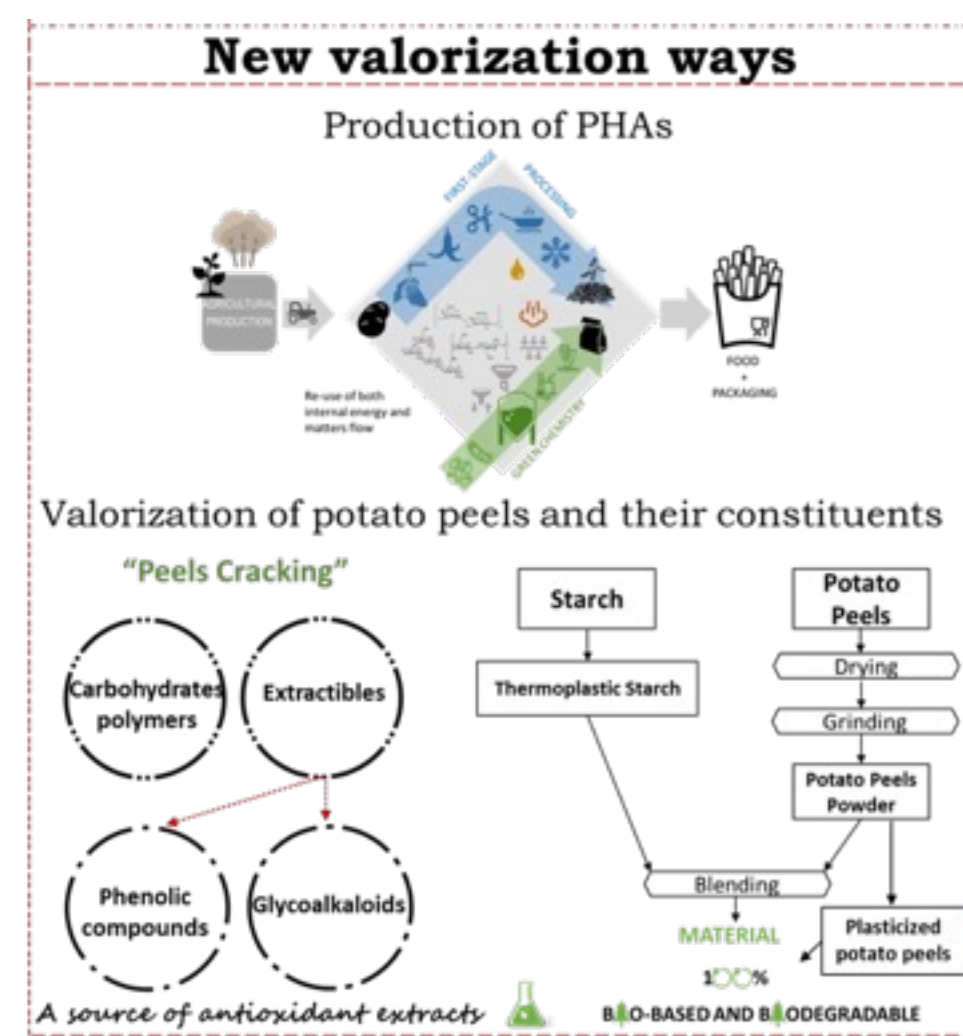
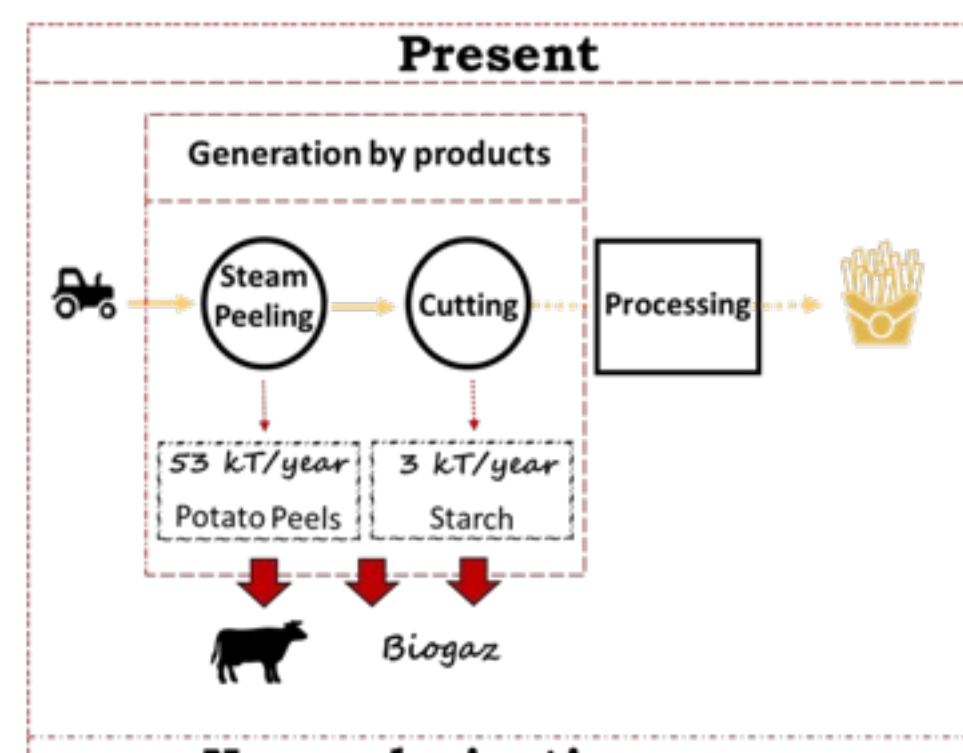


# Recovery of food co-products for the manufacture of packaging materials

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## Introduction



The food industry generates a significant amount of by-products. The upcycling of these by-products can provide new applications and be part of a circular economy approach, generating economic, environmental and social gains. To this end, the possible valorisation of a co-product of the pre-fried product production industry, in particular the production of potato chips, was investigated. This industry generates 53,000 tonnes of peels per year in France, which are currently used as animal feed or methane production.

The use of agricultural by-products for the fabrication of thermoplastic films or fibrous materials was already reported in the literature (Perotto et al. 2018, Bayer et al. 2014). The pictures below show some results using not or slightly lignified biomass. Interesting mechanical properties of films could be obtained using acid treatment of the biomass and plasticizers.

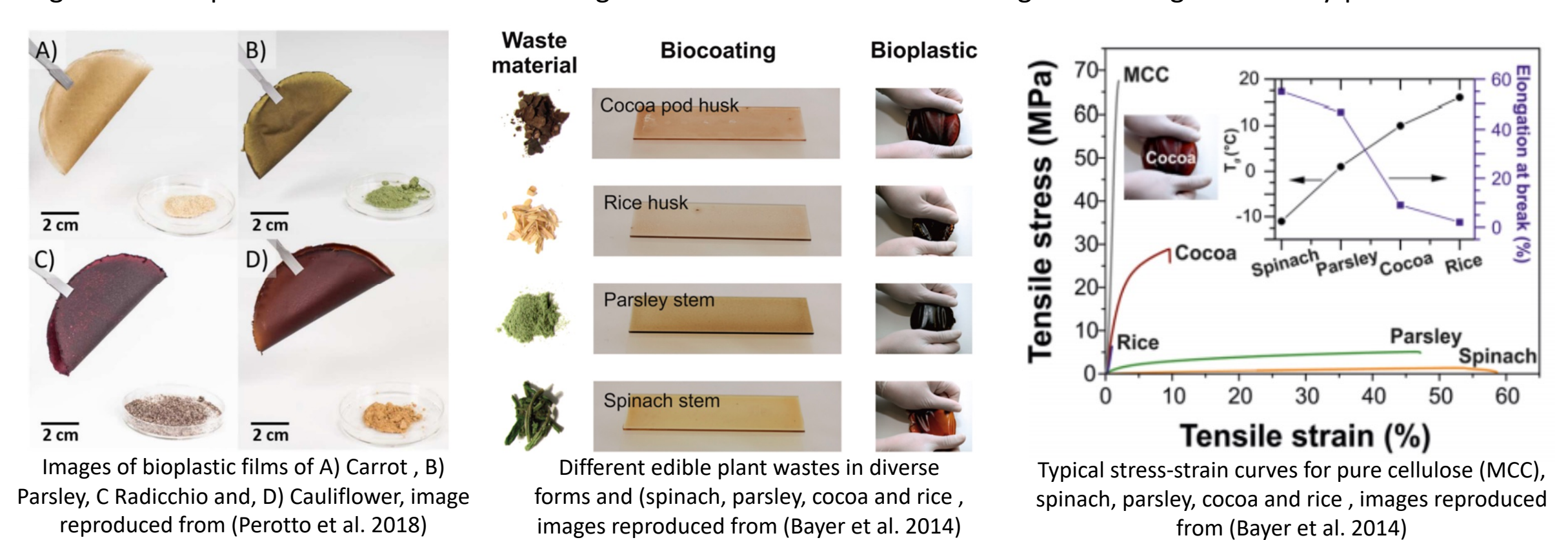
The table shows literature data on the composition of potato peels. They contain a high percentage of polysaccharides, which have film forming properties. In order to investigate the possibility to produce materials with the help of residual potato peels and starch which is unusable for food applications, samples composed of crushed peels, starch and glycerol were formulated. The thermal and mechanical properties of the resulting films were evaluated.

**Objective:** Feasibility study of the use of starch and potato peels for the fabrication of materials intended to be used as packaging

Table 1: Typical compositions of potato peels

Variety	Carbohydrates			Protein/amino acids	Ash	Reference
	Starch	Nonstarch polyaccharide	Lignin/Suberin			
Red potato		72		15.99	6.69	(Elkahoui et al. 2018)
Gold potato		70		14.17	9.12	
Organic Russet		76		11.98	7.32	
Nonorganic Russet		71		17.19	7.34	
Spunta		88		2.099	0.906	(Jeddou et al. 2016)
Nicolas variety	46.2	26.6	7	6.4	2.8	(Katarilina et al. 2015)
Russet Burbank	16.8	22.5	21.6	n.d	11	(Liang & McDonald 2014)

Figures 1: Sample literature results concerning the fabrication of materials using different agricultural by-products



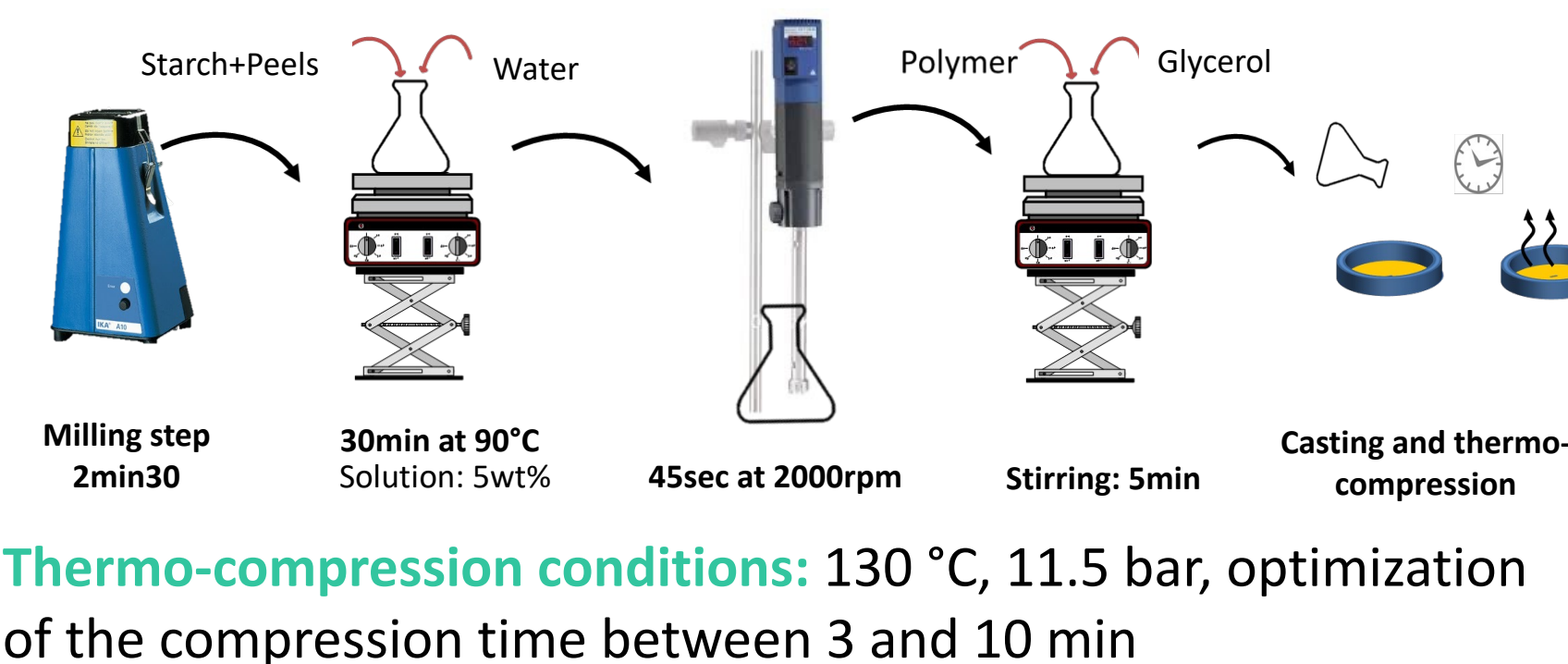
## Materials and Methods

### Composition of potato peels

Table 2: Analyzed composition of potato peels

Extraction method	Sonication (wt%)	Soxhlet Ethanol: H <sub>2</sub> O (wt%)
Extractible	33	55
Lignin	5.5	5
Hemicellulose	-	19.6
Arabinose	2.7	0.6
Galactose	2.4	2.2
Glucose	9.9	16.8
Xylose	1.1	0
Cellulose	12	7

### Film fabrication by casting



### Sample formulation

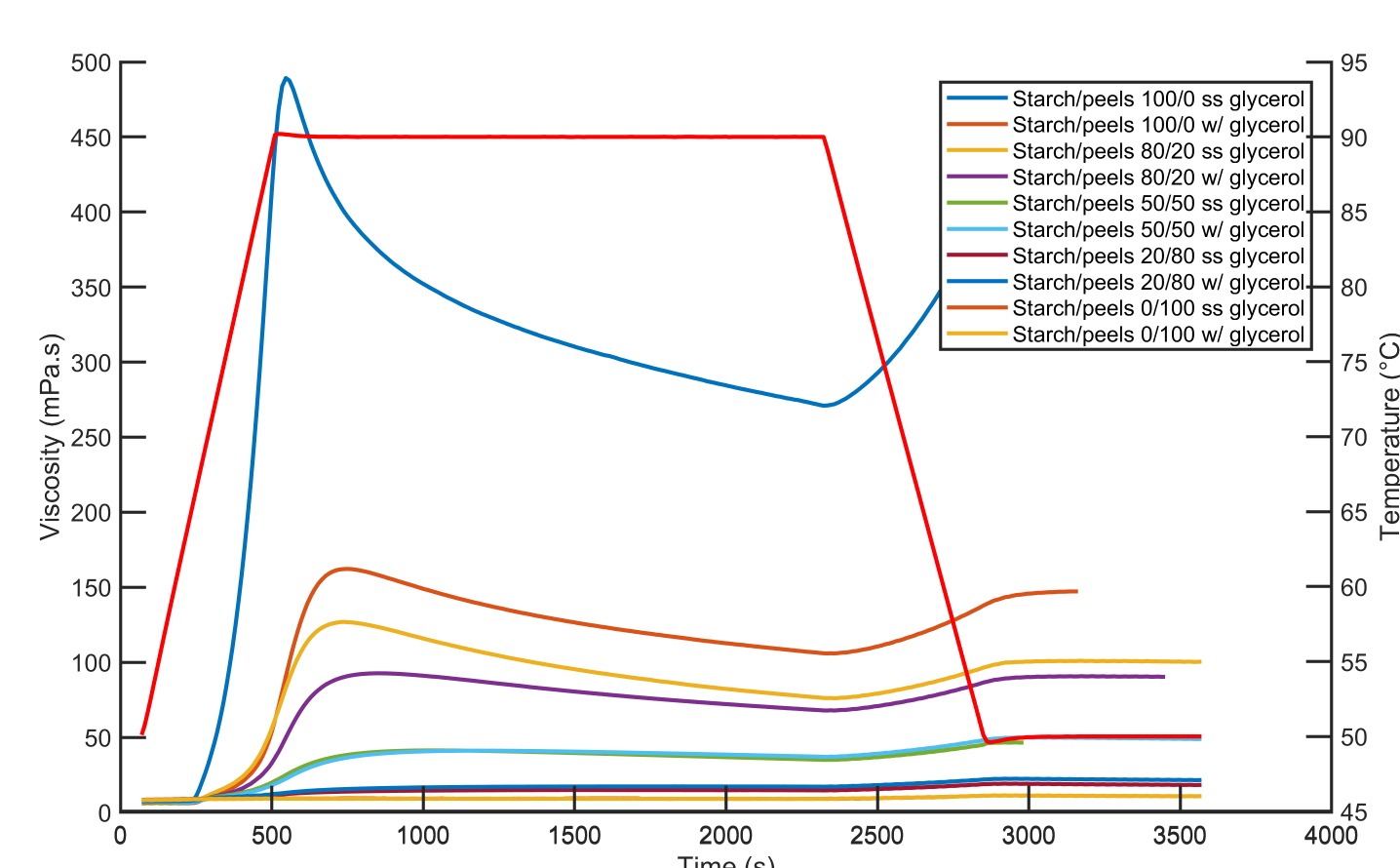
Starch: Peels	Glycerol (g)	H <sub>2</sub> O (mL)	Starch weight (g)	Peels weight (g)
100:0			3	
80:20			2,4	0,6
70:30			2,1	0,9
50:50	0,6	57	1,5	1,5
30:70			0,9	2,1
20:80			0,6	2,4
0:100				3

### Analysis

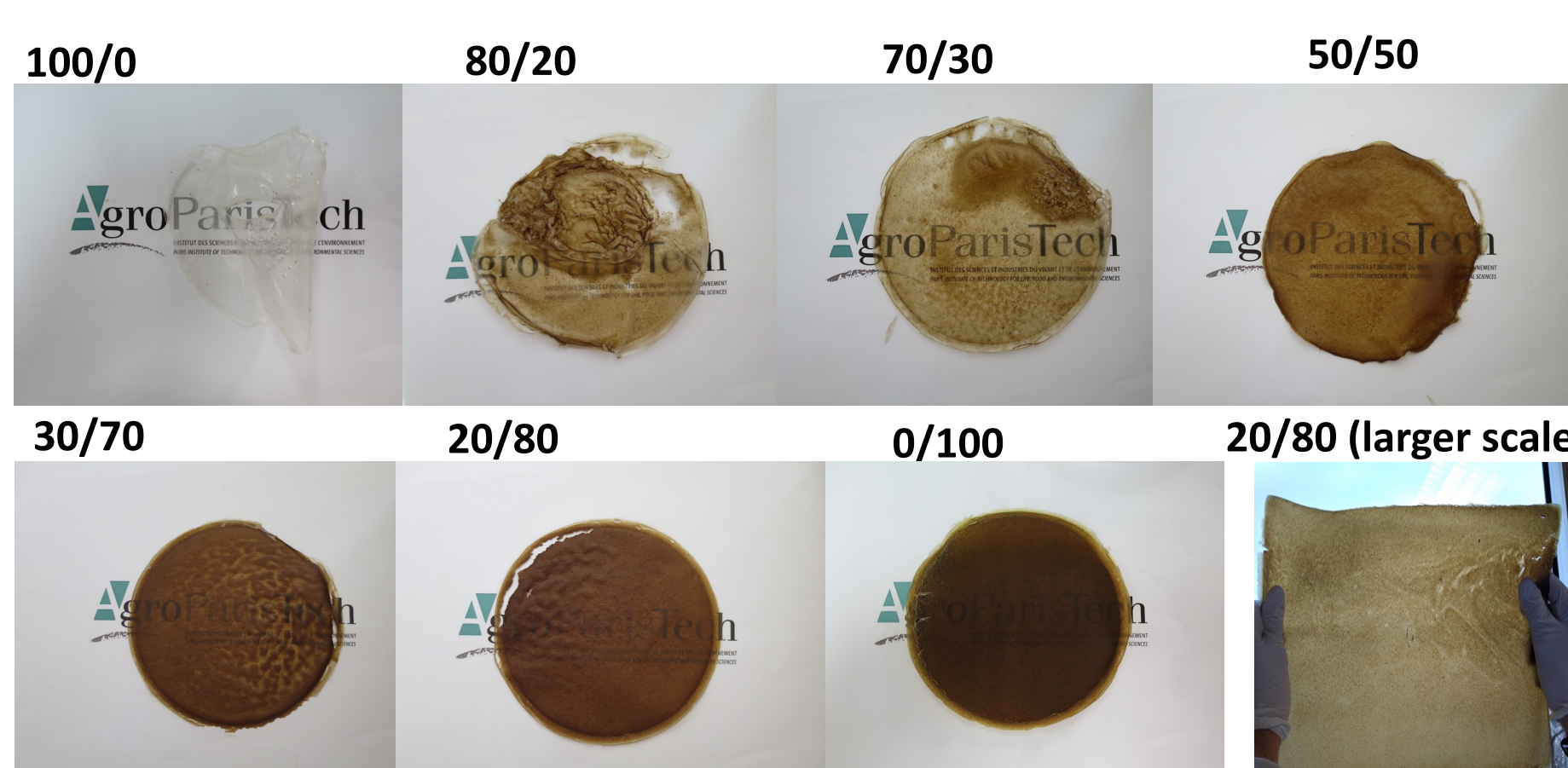
- Visual analysis
- Viscosity of casting suspensions (MCR, Anton Paar)
- Thermogravimetric analysis (TGA Q500, TA Instruments)

## Results

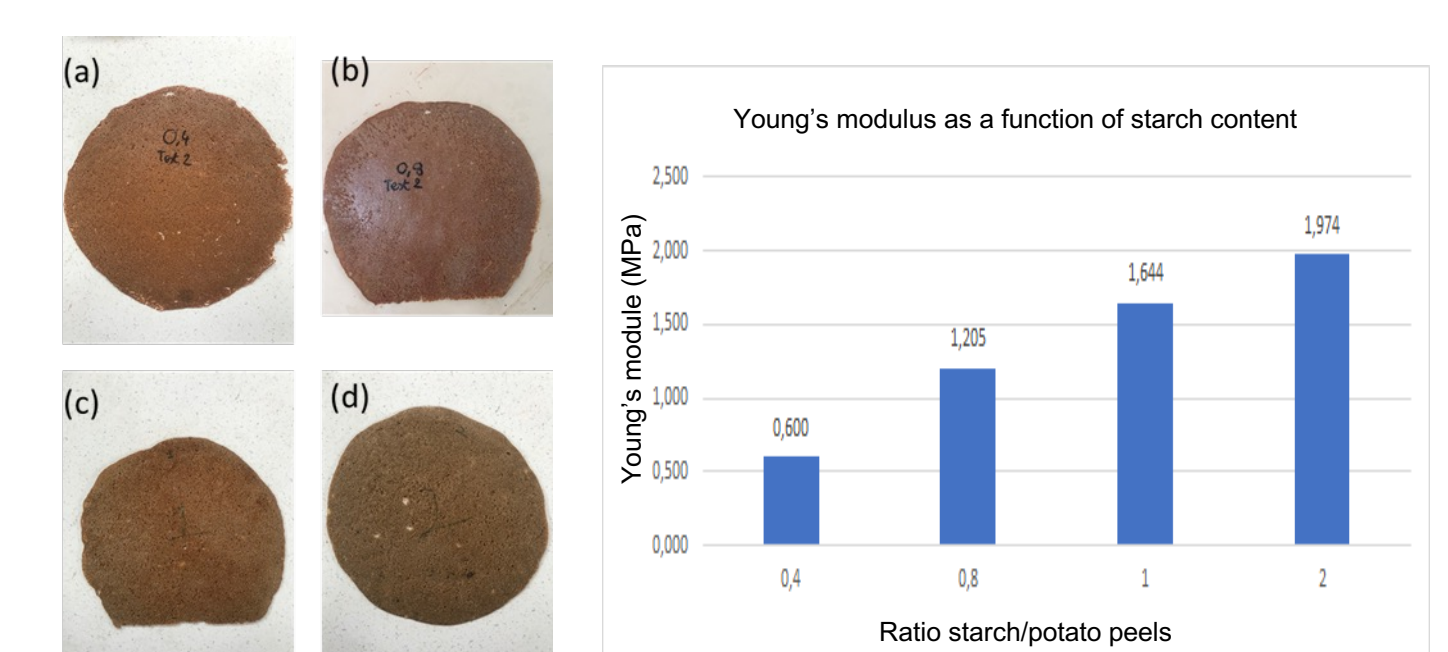
### Gelatinization of starch in the formulations



### Aspect of the cast starch/potato peels films



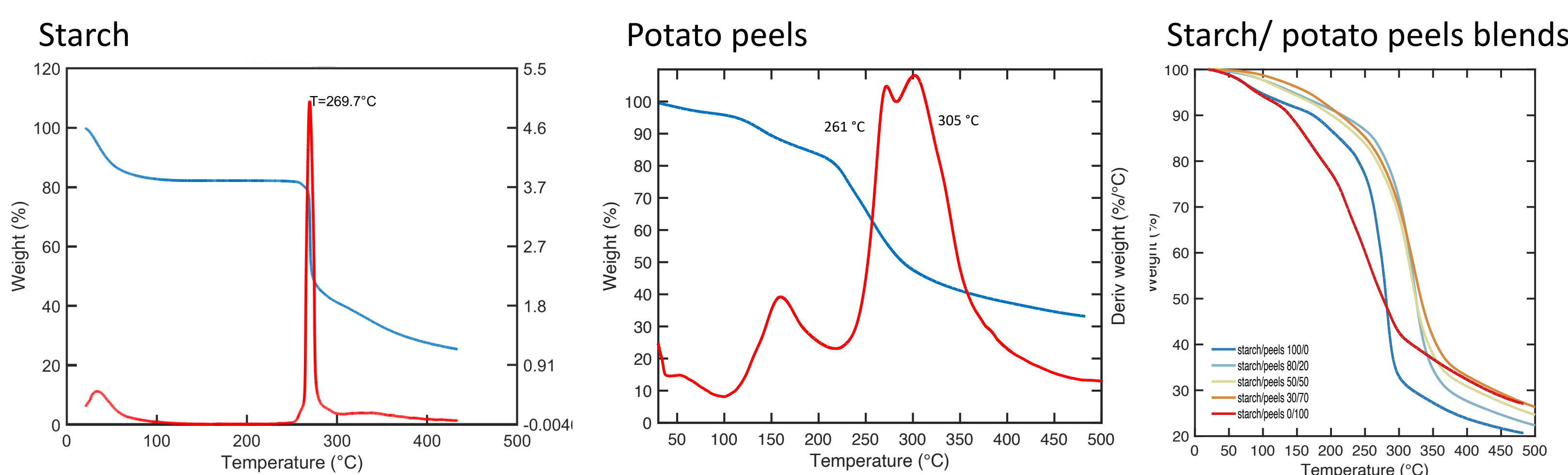
Samples after thermo-compression (130 °C, 7 min)



Thermo-compressed items of starch: potato peels with a) 29:71 w/w %, b) 44:54 w/w %, c) 50:50 w/w % and d) 66:33 w/w %

Preliminary analysis of modulus by tensile testing (5 mm/min)

### Thermal stability of starch and potato peels



- Cohesive films of starch and potato peels can be fabricated by casting and thermo-compression. Both types of films were dense, the thermo-compressed films were stiffer.
- The thermal stability of potato peels was lower than that of starch.
- Blends of potato peels and starch showed synergy to increase thermal stability of peels.

## Conclusions



<https://vimi.london/collections/biotrem>

The generation of over 53.000 T of potato peels annually for a potato processor represents a waste costly to treat. We showed in a feasibility study that this waste could be used to fabricate bio-based and biodegradable items. A first approach was the fabricate potato peels-based materials with a solution casting method, which showed the film forming ability and yielded in malleable free-standing films. More rigid, cohesive and dense materials were obtained using thermo-compression molding. They could be addressed to the production of items with very short service life, such as single use dishes. An example of items in this category is shown in the picture to the left.

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