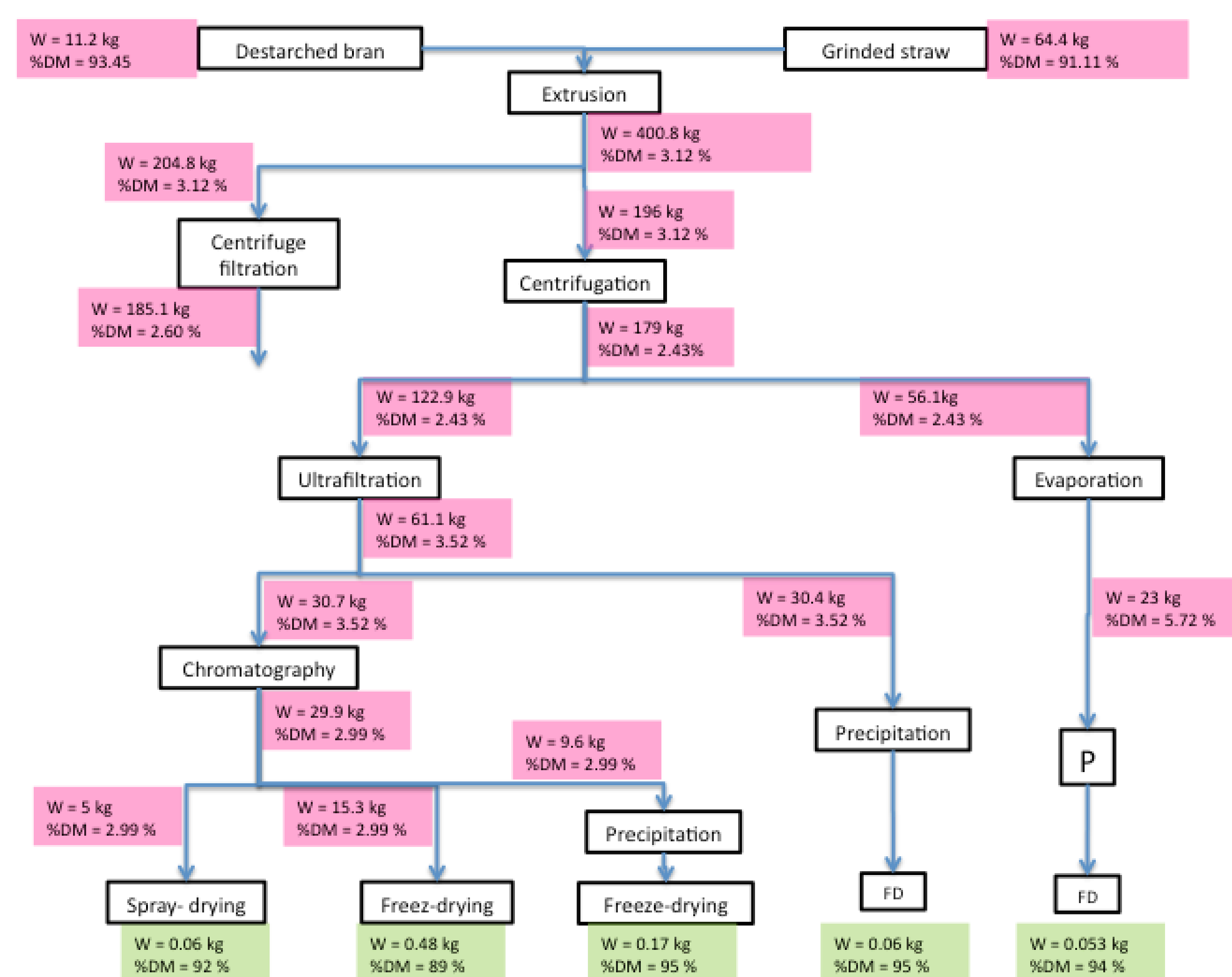


Pierre-Yves PONTALIER is associate professor at the Laboratory of Industrial agro-industry (UCAI). The extraction/purification studies were performed by Leslie Jacquemin during her PhD, co-managed by Caroline Sablayrolles for life cycle analysis

Extraction et Purification

Extraction was done by twin screw extrusion at large scale in order to produce large amount of hemicelluloses for film production and to compare different pathways for extract purification.



Centrifugation is more efficient than filtration for liquid/solid separation while ultrafiltration allows for both concentration and partial purification of the extract.

Hemicelluloses characterization and properties

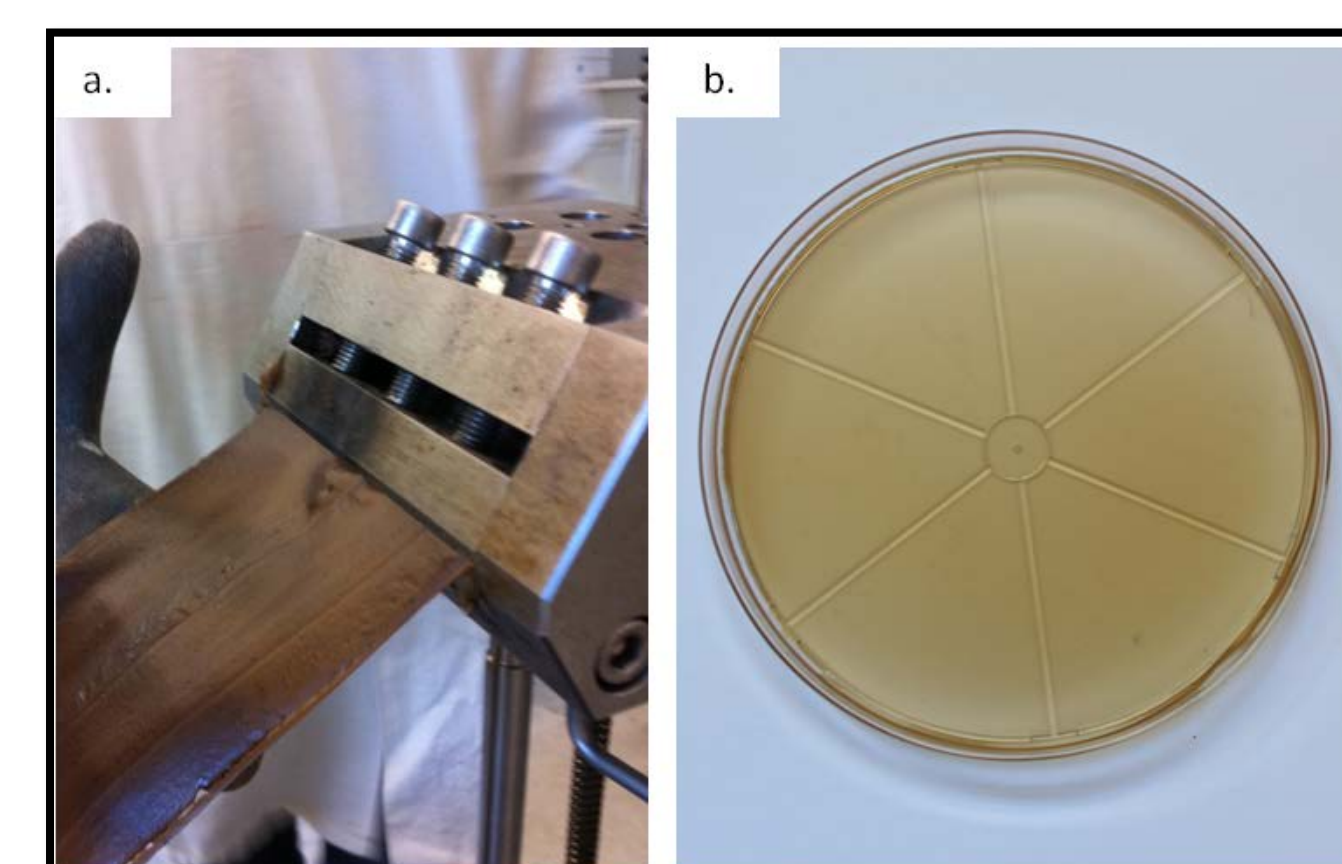
Specific characterization of the extract has been performed at INRA of Nantes, partner BIA (Pr. Saulnier) and at the Helsinki university, partner UH (Pr. Tenkanen)

Composition of the powder obtained after each of the evaluated process.

Composition	Direct precipitation	UF+ Precipitation	UF+CH + Precipitation	UF+CH + Freeze drying
Mass (kg)	0.53	0.60	0.17	0.48
Dry matter (%)	94	95	95	89
Organic matter	91	94	95	85
Protein (% dw)	12.9	15.5	11.7	8.2
Lignin (% dw)				
Rhamnose (% dw)	0.21	0.2	0.16	0.09
Fucose (% dw)	0.07	0.06	0.08	0.05
Arabinose (% dw)	6.38	6.61	7.05	3.87
Xylose (% dw)	17.76	17.64	18.82	10.01
Mannose (% dw)	0.35	0.33	0.34	0.36
Galactose (% dw)	1.12	1.16	1.18	0.72
Glucose (% dw)	22.47	20.68	22.95	12.75
Sum (% dw)	48.36	46.68	50.57	27.85
X/A	2.78	2.66	2.66	2.58
X/G	0.79	0.85	0.82	0.78
Molar mass (Da)	316 000	438 000	88 000	NPD
Recovery (%)	29	34	81	

NPD: no peaks defined

Results indicates that alcoholic precipitation produce the purest powder. The combination of ultrafiltration and anionic chromatography do not allows for the production of a pure hemicellulosic powder.



Large amount of glucose comes from the remaining starch, In all cases. Properties of the films produced by mono-screw extrusion are compared to those of films obtained by casting. Films properties were determined at UH and UCAI.

Comparison of the properties of the films obtained by casting or by extrusion after addition of glycerol as plasticizer

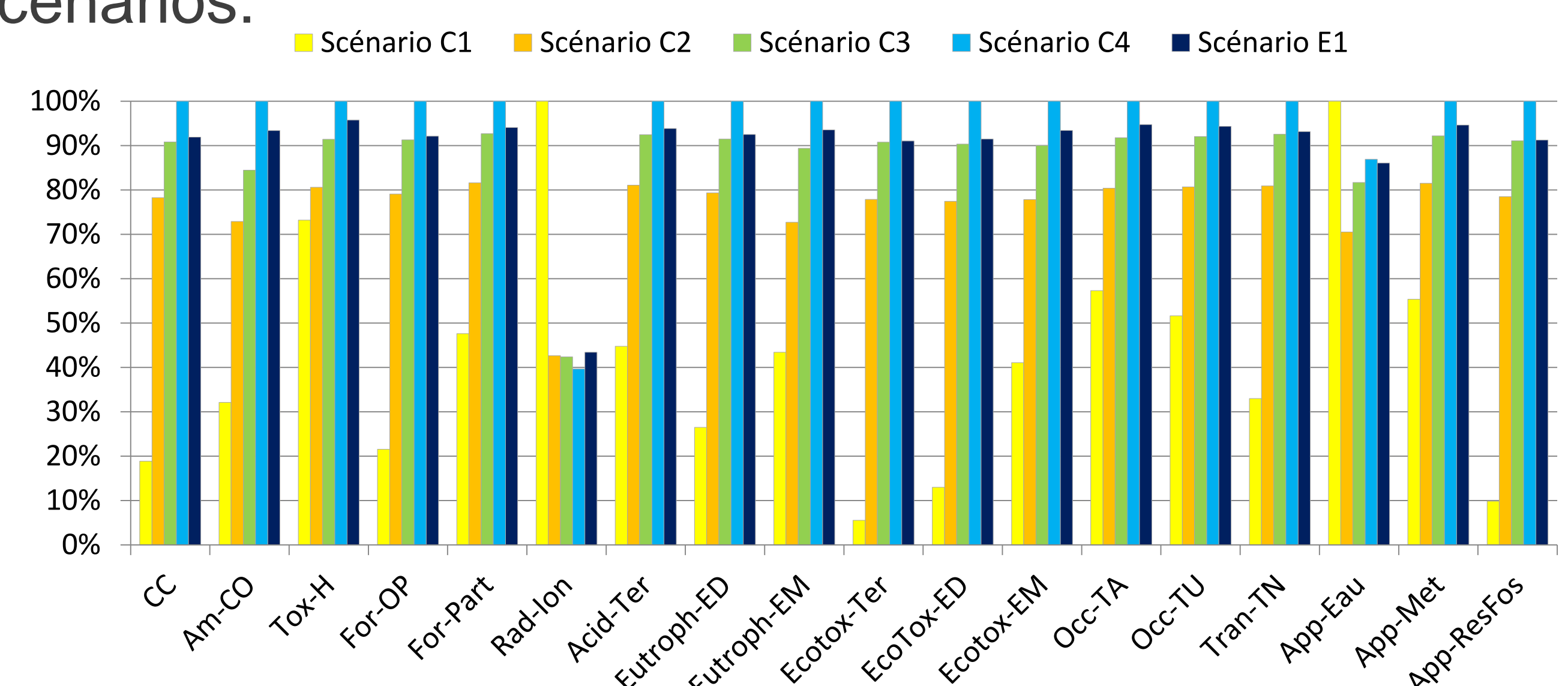
		Die Thickness	N ^a	Cut direction ^b	Film Thickness	E ^a	UTS ^a	EL ^a	VWP
		(μm)	(rpm)		(μm)	(Mpa)	(MPa)	(%)	(g.mm.m ⁻² .j ⁻¹ .KPa)
1	Extrusion	100	100	v	226.9 ± 12.5	191.1 ± 49.5	7.2 ± 0.7	7.3 ± 2.1	n.d.
2	Extrusion	100	125	v	228.0 ± 21.9	201.8 ± 15.3	7.2 ± 0.8	6.9 ± 1.3	n.d.
3	Extrusion	250	100	p	297.8 ± 15.5	182.9 ± 16.5	6.3 ± 0.4	6.6 ± 1.1	28.8 ± 0.4
4	Extrusion	250	100	v	335.7 ± 30.7	221.9 ± 24.9	7.3 ± 0.5	7.4 ± 2.8	
5	Extrusion	400	100	v	385.9 ± 49.6	254.6 ± 56.9	8.2 ± 1.2	3.7 ± 0.4	n.d.
6	Extrusion	400	75	v	411.1 ± 25.2	240.0 ± 42.0	7.8 ± 0.6	4.4 ± 0.9	n.d.
7	Casting				44.0 ± 7.0	33.2 ± 5.8	5.9 ± 0.6	34.7 ± 6.3	8.7 ± 0.6

^a N = Screw rotation speed, E = Young modulus, UTS = Ultimate tensile strength, EL = Elongation, VWP = Water vapor permeability; ^b extruded films contain 30 parts of glycerol or sorbitol regarding the initial dry matter in powder; cast films contain 30 % of glycerol regarding the initial dry matter content of casted solution; ^c The dumbbell shaped specimen used for determination of tensile properties were cut in the same direction as the film formation (v) or perpendicularly (p) (parallel to the die)

Extrusion produces film with a higher mechanical resistance than casting but with elongation rate 6 time smaller.

Life Cycle Assesment

A life cycle Assessment has been lead on the different scenarios:



Result have shown that precipitation have the high impacts, respectively because of the ethanol fabrication and the energetic consumption. The scenario C1, which is the one without precipitation appeared to be the best in the majority of impact categories.

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