



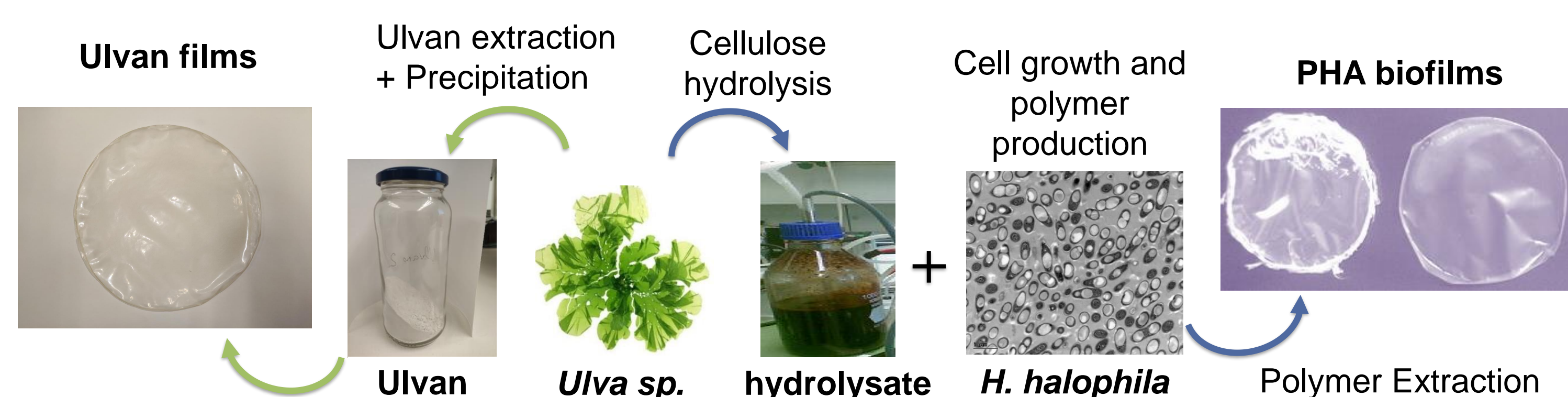
Turning *Ulva* sp. to biodegradable plastics

Biotechnology and Biosciences

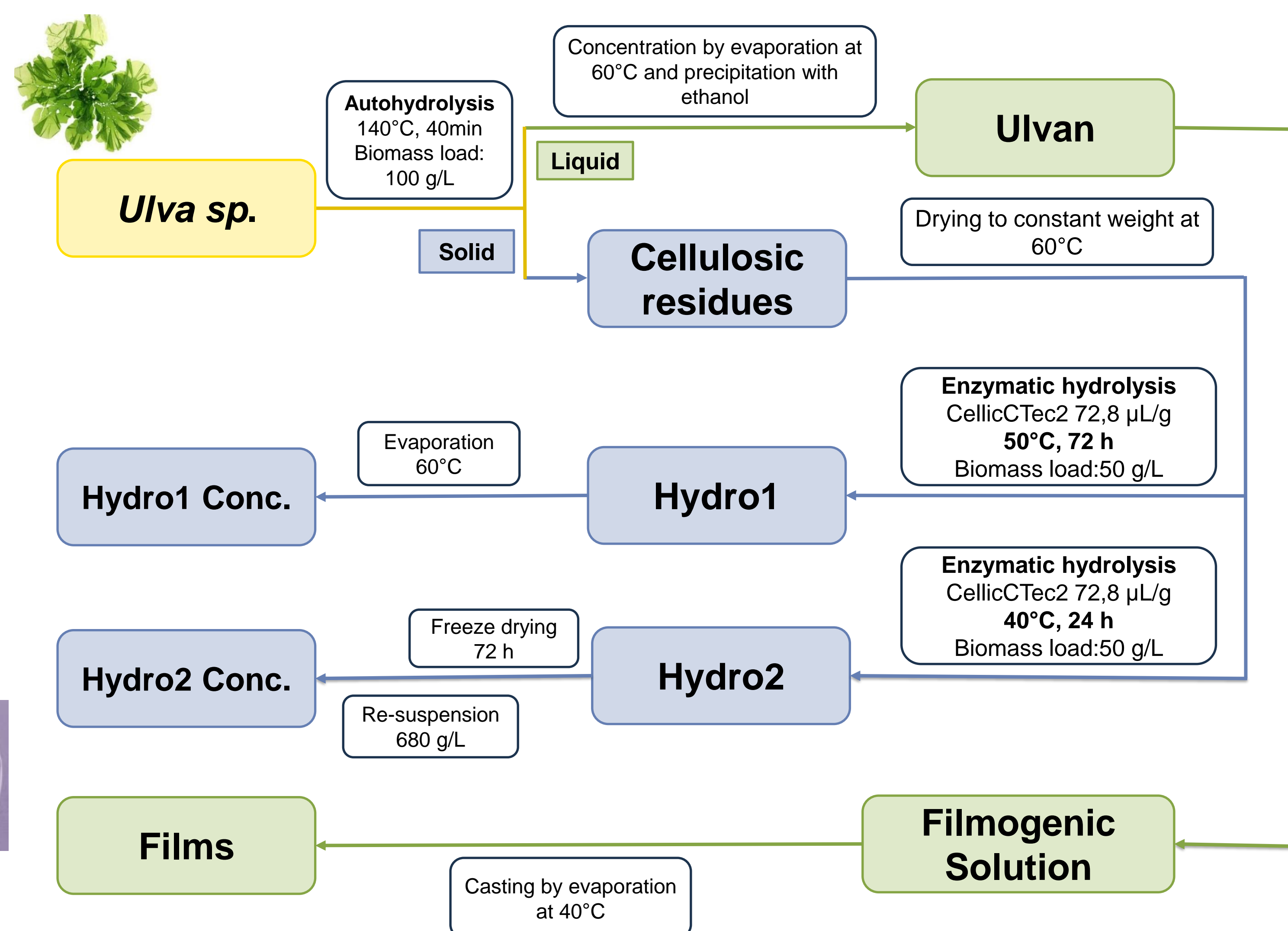
Marco Teles (marco.teles@tecnico.ulisboa.pt)

Background and Motivation

- This work results from the need to develop materials that are biodegradable and sustainable substitutes of petrochemical plastics.
- Polyhydroxyalkanoates (PHA) are polyesters produced by bacteria such as *Halomonas halophila*. They are excellent candidates for synthetic plastic replacement, have similar mechanical properties but are biodegradable.
- These bioplastics can be produced from cellulosic residues of seaweed, after extraction of the phycocolloid fraction.
- Ulva* sp. contains ulvan a sulphated polysaccharide. This phycocolloid can be extracted and used to produce biodegradable bioplastic films. Formulations must be developed by adding agents for its processability.



Methods



Results and Discussion

Hydrolysis of cellulose in *Ulva* sp.

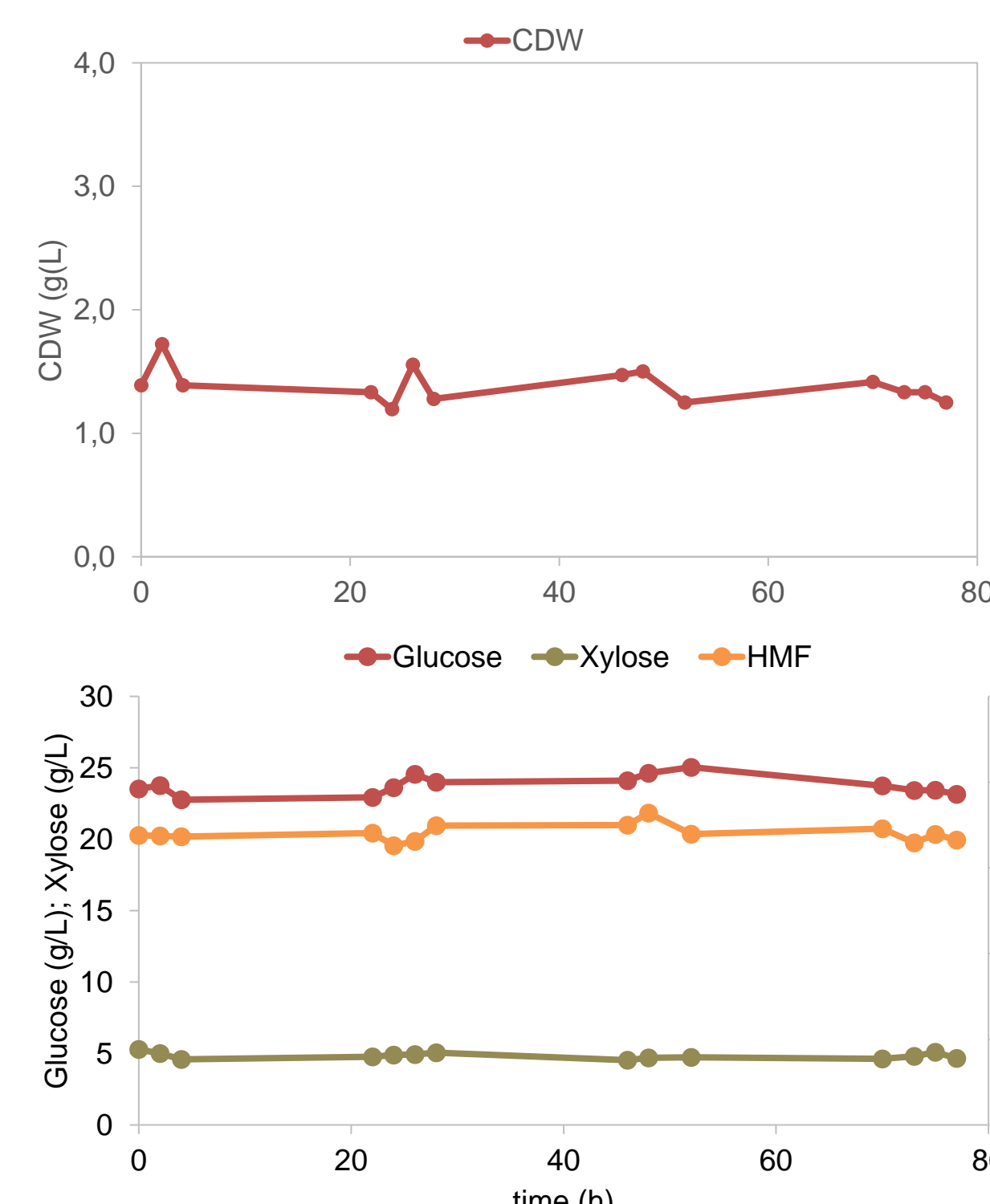
Table 1: Composition of *Ulva* sp. hydrolysates

	Hydro 1	Hydro 1 Conc.	Hydro 2	Hydro 2 Conc.
Glucose (g/L)	19.4	242.5	16.3	268.6
Xylose (g/L)	4.4	54.5	3.9	42.1
HMF (g/L)	0.2	7.0	0.08	0.6

*"Determination of total carbohydrates in algal biomass." NREL/TP-5100-60956. National Renewable Energy Laboratory. 2015. HMF: Hydroxymethylfurfural : inhibitor of cell growth.

Hydrolysates 1 and 2 were tested as substrates for growth and PHB production by the bacterium *Halomonas halophila*

H. halophila in Hydro1



H. halophila in Hydro2

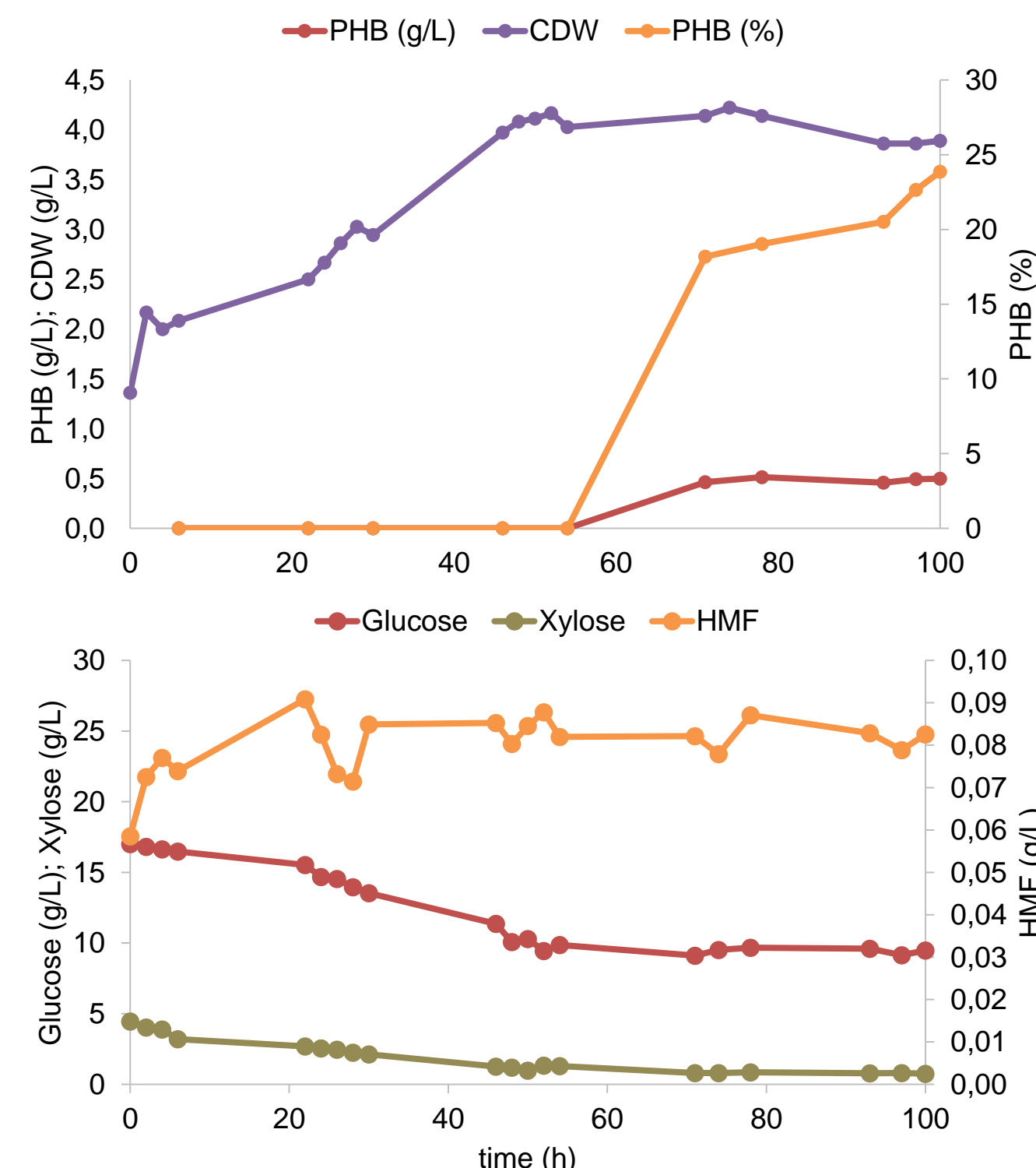


Figure 1: Shake flask assays using two *Ulva* hydrolysates (Hydro 1 and Hydro 2) as substrates for PHB production by *Halomonas halophila*.

Hydro 1: *H. halophila* was not able to grow or produce PHB in a medium with 0.7 g/L HMF.

Hydro 2: *H. halophila* grew and produced 0.5 g/L of PHB, equivalent to 23.8% of its dry weight when HMF was 0.08 g/L.

Ulvan films

Table 2: Composition of the filmogenic solutions tested
CMC-carboxymethyl cellulose. Glycerol Unit µL/mL

	1%	2%	1%	2%	1%	1%	2%	1%	1%	1%	2%	1%	
Ulvan													
Pectina					1%	1%	1%	2%					
CMC									1%	1%	1%	2%	
Glycerol			1,2	1,2		1,2	1,2	1,2		1,2	1,2	1,2	
Qualitative assessment	---	--	--	-	-	-	-	+	+	+	++	++	+



Figure 2: Films composed of ulvan 1% + Carboxymethylcellulose 1% + 1,2 µL/mL glycerol 86% (v/v)

Ulvan alone cannot form films with the intended properties.

Some of the films tested have the desired physical and mechanical properties (similar to plastics), especially those with carboxymethylcellulose (CMC) and adhesives with glycerol.

Mechanical and thermal analyses will be carried out soon.

Conclusions

Ulva sp. hydrolysates generate liquors rich in glucose and xylose, however these liquors also contain HMF, an inhibitor of cell growth.

H. halophila can grow and produce Poly-3-hydroxybuturate (PHB) with these hydrolysates as the only carbon source, however, its growth and production are directly limited by the presence of HMF. Producing hydrolysates with as little HMF as possible or finding ways to remove it is necessary.

Ulvan can be extracted, recovered and purified from algae of the genus *Ulva* using thermal treatments and solvent precipitation.

The recovered ulvan can form films with characteristics similar to plastic, however, it requires other matrix agents and additives to acquire adequate physical and mechanical properties.