Sequential extraction of four polysaccharides from cultivated *Saccharina latissima (SL)* and *Alaria esculenta (AE)*

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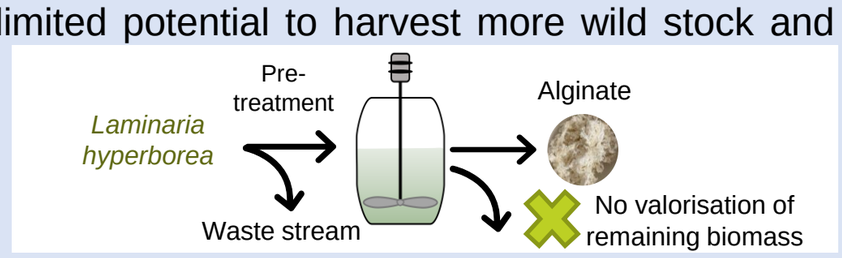
INTRODUCTION

Norway has a well established algae industry where the main product is alginates from wild-harvested *Laminaria hyperborea* (*LH*). However, there is a limited potential to harvest more wild stock and expand the sector.



A transition to include more cultivated biomass is needed to avoid over exploitation of wild seaweed resources. Cultivated seaweeds can contribute to meeting increasing demands.

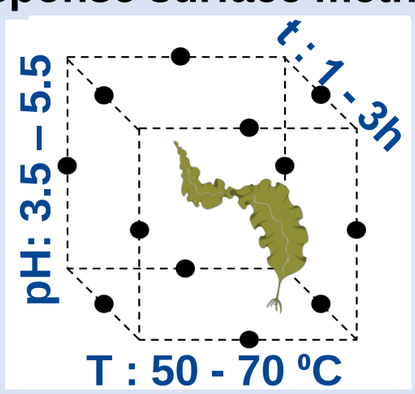
Goal: Expand traditional alginate extraction using cultivated *SL* and *AE* to further include:

- Fucoidan & Laminarin
- Cellulose

without compromising the quality of the alginates nor the co-extracted polysaccharides for greater valorisation of the biomass using an environmental and economical sustainable process.

METHODOLOGY

1. Response surface methodology on Fuc/Lam extraction



Find models to optimize:
Yield of Fuc/Lam → max

Describe: how alginate MW is affected by Fuc/Lam extraction

$$y = const. + \sum_{1}^{k} \beta_i x_i + \sum_{1}^{k} \beta_{ii} x_i^2 + \sum_{i>j} \sum \beta_{ij} x_i x_j$$

2. Compositional analysis of biomass

- Dry matter and Ash, CNS, monosaccharide, ICP-MS (minerals)

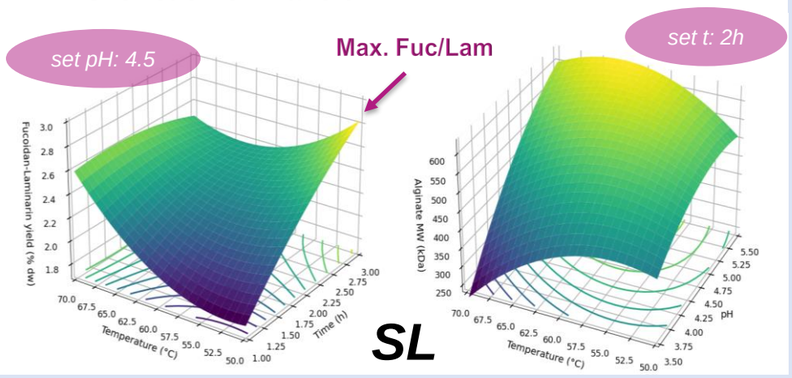
3. Pilot-scale extraction to recover all four polysaccharides

- Sequential extraction, yield polysaccharides, and physicochemical properties alginates and hydrogel characterisation

Responce surface models describing:

Yield of Fuc/Lam
As function of T and t

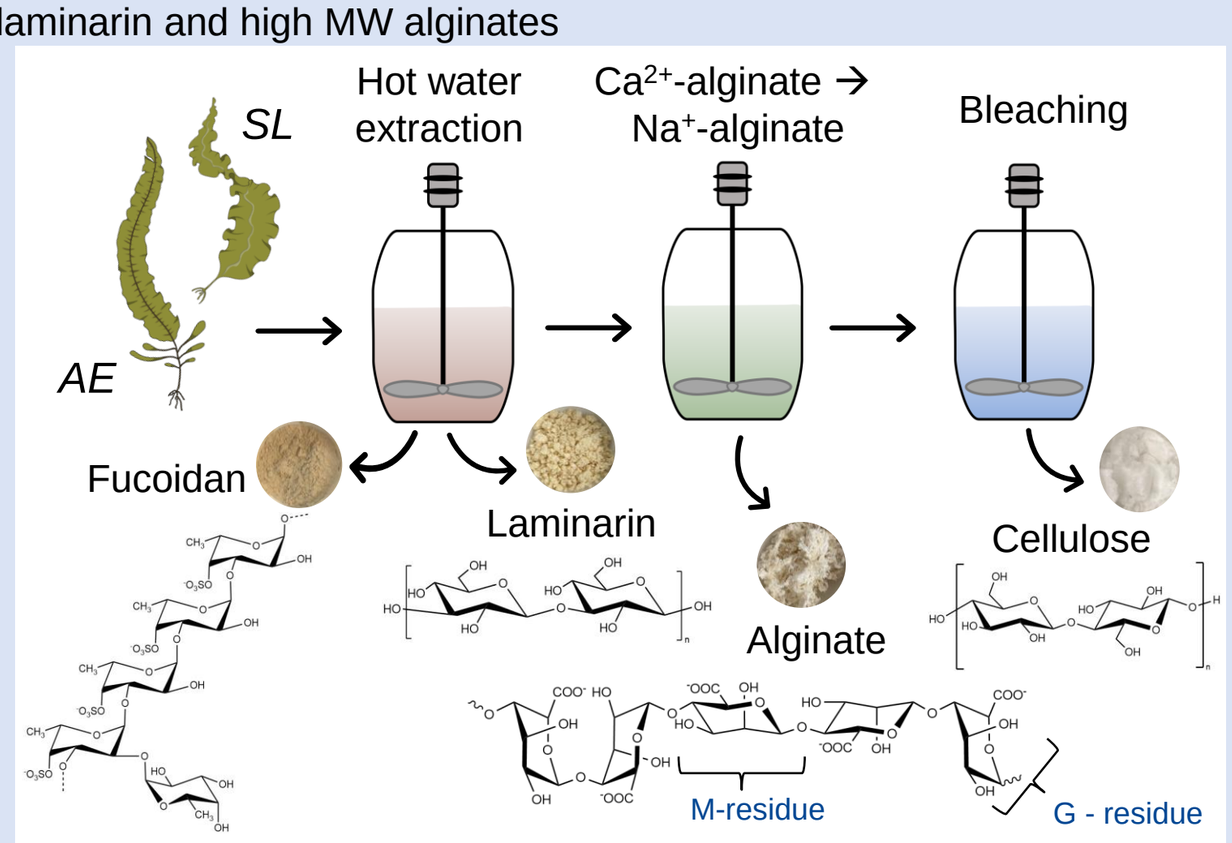
Alginate MW
As function of T and pH



Temperature (T) & time (t) are important variables for extraction of fucoidan and laminarin
While pH and temperature mainly affects the MW of alginates

Pilot-scale extraction of fucoidan, laminarin, alginate and cellulose from *SL* and *AE.*

Applying optimized conditions to gain max yield of fucoidan and laminarin and high MW alginates



Polysaccharide yields from 17 kg of *SL* and 19 kg *AE*

	Fucoidan/Laminarin		Alginate		Cellulose		Total	
	(g)	(% dw)	(g)	(% dw)	(g)	(% dw)	(g)	(% dw)
SL	80	5.0	172.6	10.76*	111.2	6.9	375.2	23.4
AE	223.5	9.5	166.5	7.085*	228.9	9.7	618.9	26.3

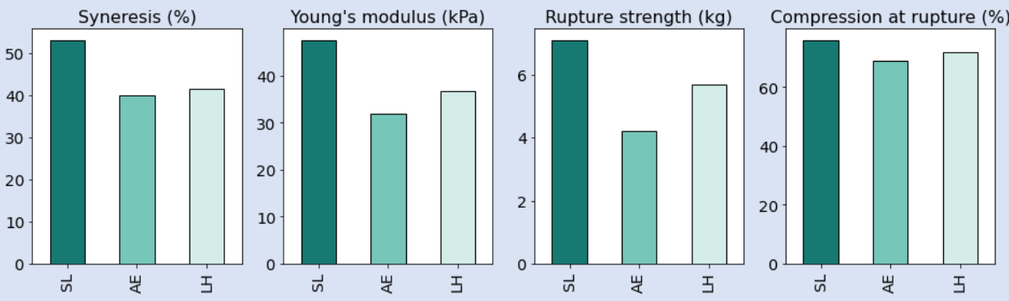
Total yield in (g) and (% dw) of entering dry biomass

* Alginate yield *not optimal*, < 20 % dw could have been extracted from the applied biomass

Alginates from cultivated *SL* and *AE* can be used to produce gels having similar qualities as alginates extracted from the fronds from *LH*

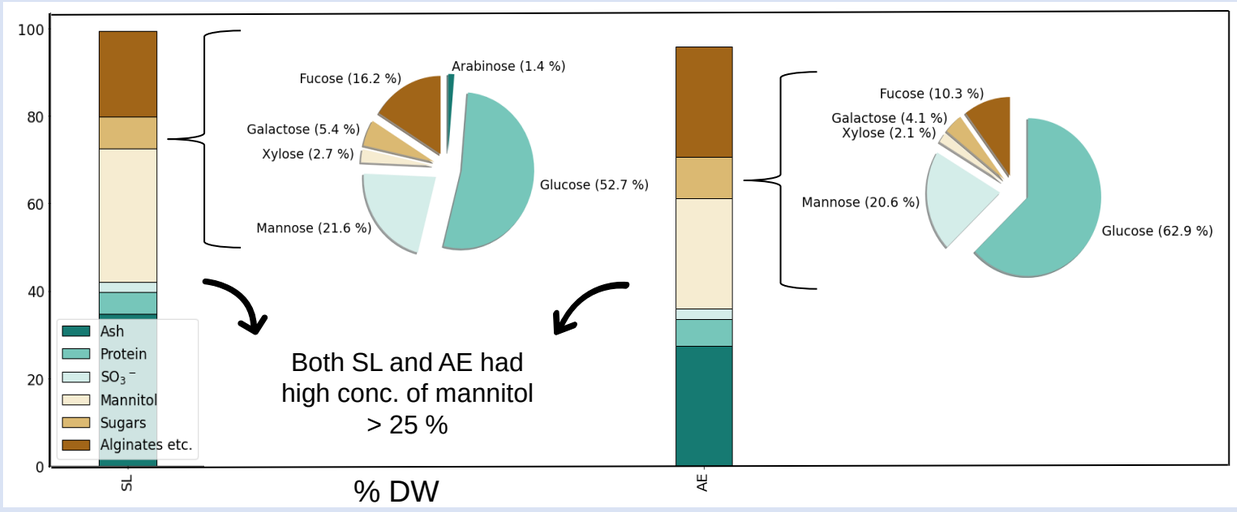
	M_w (kDa)	F_G	F_M	F_{GG}	$F_{GM,MG}$	F_{MM}	$F_{GGM,MGG}$	F_{MGM}	F_{GGG}	$N_{G>1}$
SL	396	0.48	0.52	0.31	0.17	0.35	0.040	0.13	0.27	9
AE	230	0.49	0.51	0.33	0.16	0.35	0.043	0.12	0.29	9
LH	272	0.46	0.54	0.29	0.17	0.38	0.041	0.15	0.25	7

MW of alginates from *SL*, *AE* and *LH* fronds and chemical composition: fraction (**F**) of **G** and **M** residues and average length of G-blocks: $\mathbf{N_{G>1}}$



Physical properties of gels produced from alginates extracted from *SL*, *AE* and *LH* fronds

SL had higher concentrations of fucose (fucoidan) while *AE* had the highest content of glucose (cellulose and laminarin).



CONCLUSION

1. Conventional extraction of **alginates** from cultivated brown algae can be expanded, combining ***mild chemical methods*** to include retrieval of:
   - **Fucoidan & Laminarin**
   - **Cellulose**
2. Applying response surface methodology, the yield of fucoidan and laminarin was optimized & high MW alginates ensured.
3. *SL* had higher concentration of water soluble fucoidan and *AE* more laminarin.
4. The biomass was rich in mannitol and the process can easily be modified to collect mannitol too.

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