



Sequential extraction of polysaccharides from brown seaweed

- Aiming for a biorefinery approach

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Biorefining of seaweed

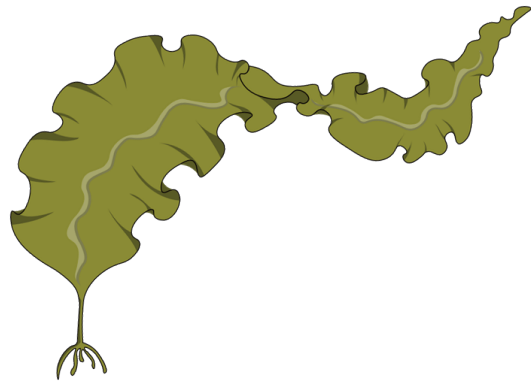
“a biorefinery should produce at least one high value chemical/material product, besides low-grade and high-volume products” – Cherubini, 2010

Today: Brown seaweed is cultivated for food and harvested for alginate products.

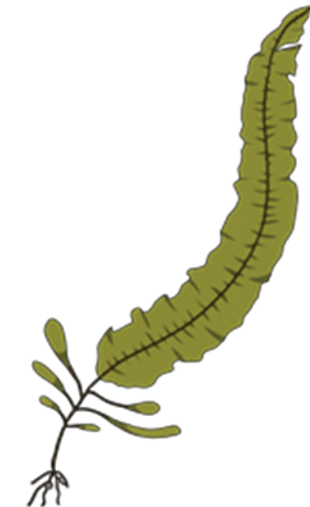




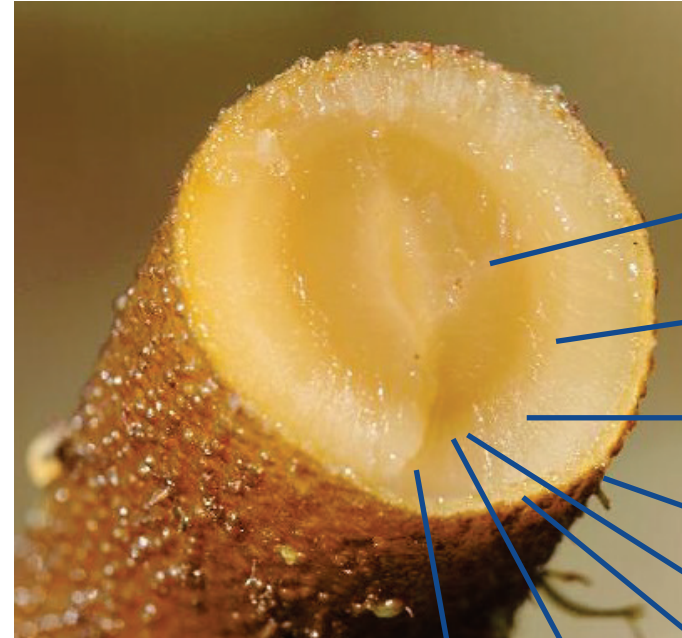
What do Seaweed Contain?



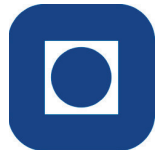
Saccharina latissima



Alaria esculenta



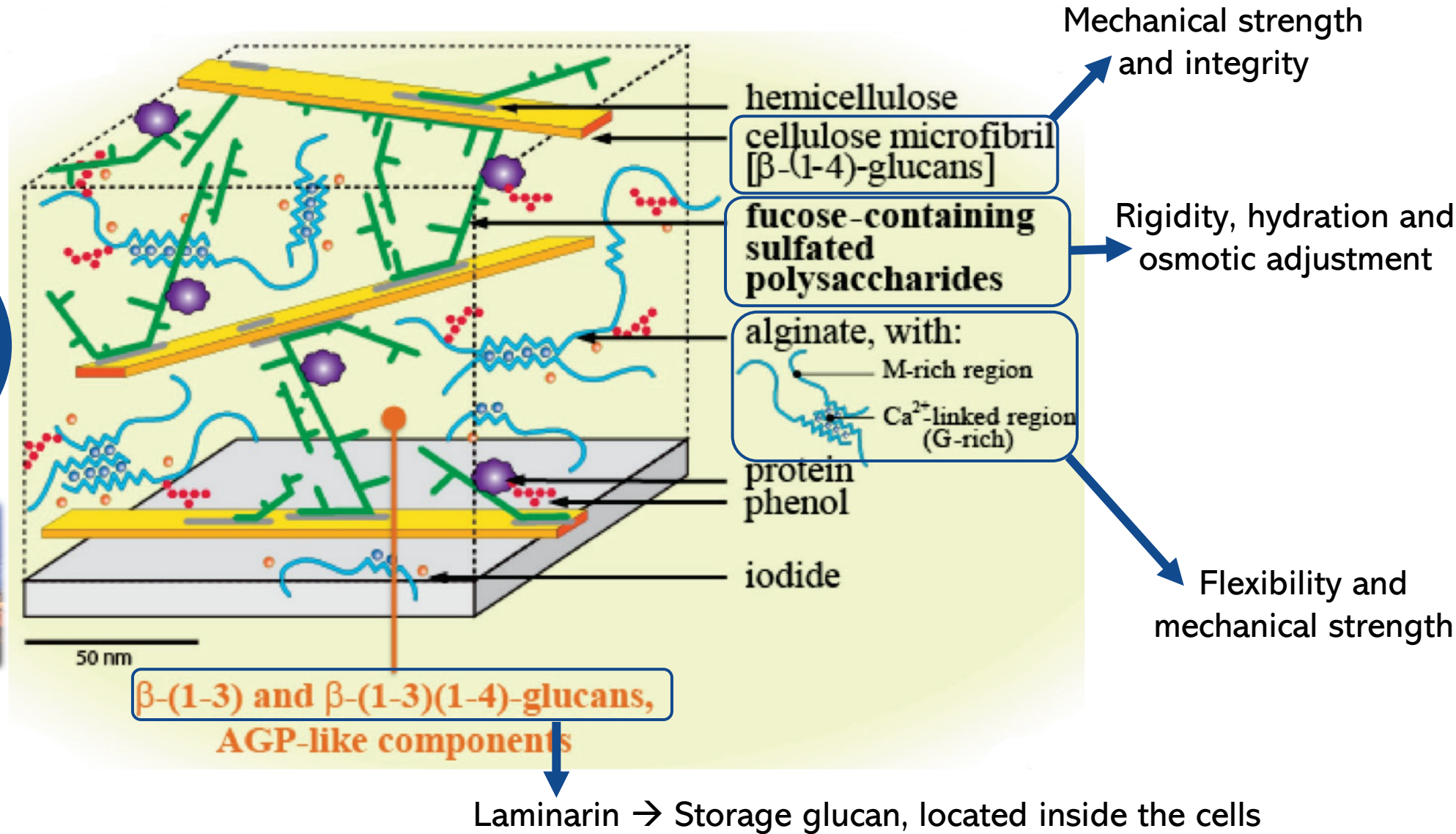
- Alginate 20-40%
- Fucoidans 5%
- Laminaran 0-25%
- Polyphenols & Pigments <3%
- Mannitol 5-15%
- Cellulose 5%
- Proteins 8-12%
- Minerals 20-45%
(divalent cations and iodine)





The Cell Wall of Brown Seaweed

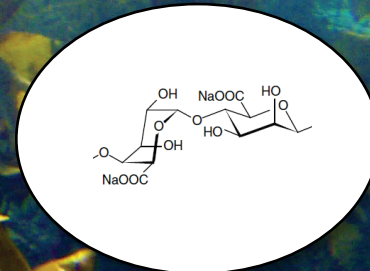
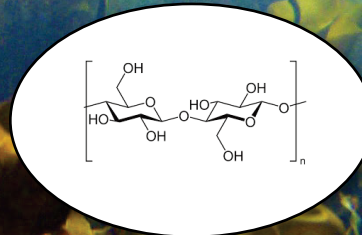
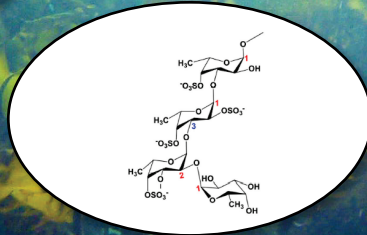
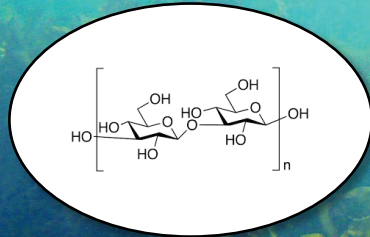
Model of Fucales
proposed by
Deniaud-Boët *et al.* 2014





Why extracting the polysaccharides?

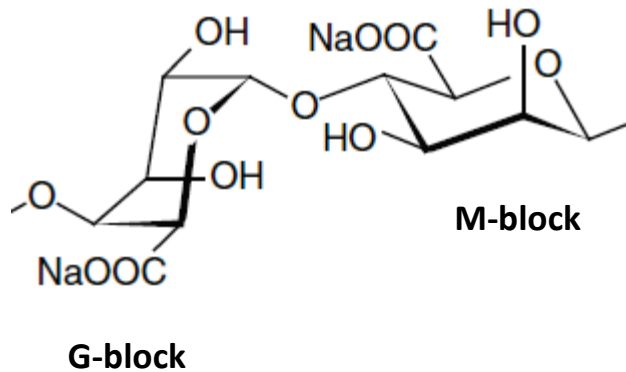
- Low-cost source
- Fast growing
- No irrigation, fertilizers
- No land area





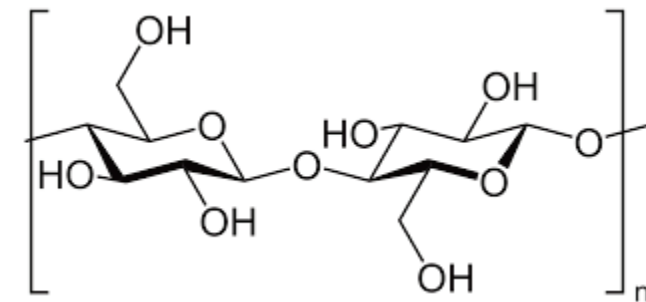
Brown seaweed polysaccharides

Alginate



1-4-linked β -D-mannuronic acid (M) and α -L-guluronic acid (G)

Cellulose



β -(1 \rightarrow 4) linked D-glucose units

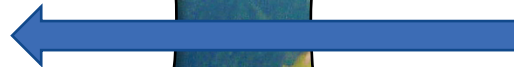
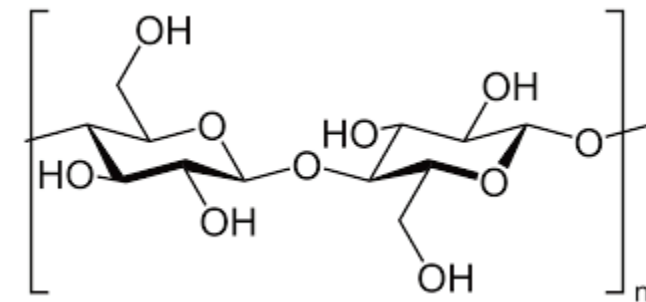


Brown seaweed polysaccharides

- Low weight, low cost, *non-toxicity*, high stiffness and strength, *biodegradable*, recyclable
- Use of cellulose based materials is increasing
- Industry relies entirely on lignocellulosic feedstock
- Seaweed cellulose: absence of lignin → purer cellulose + milder extraction conditions



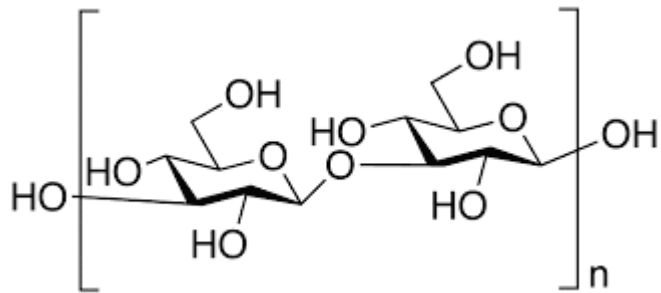
Cellulose





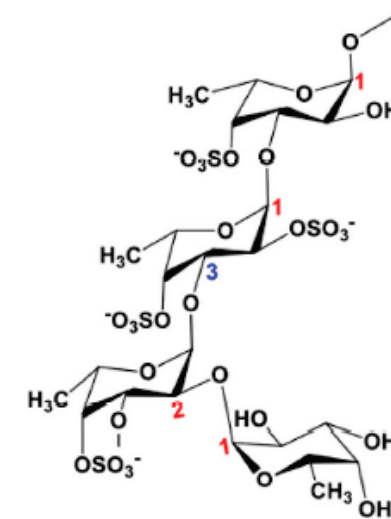
Brown seaweed polysaccharides

Laminarin



(1,3)- β -D-glucan with some 6-*O*-branching and some β -(1,6)-intrachain links

Fucoidan

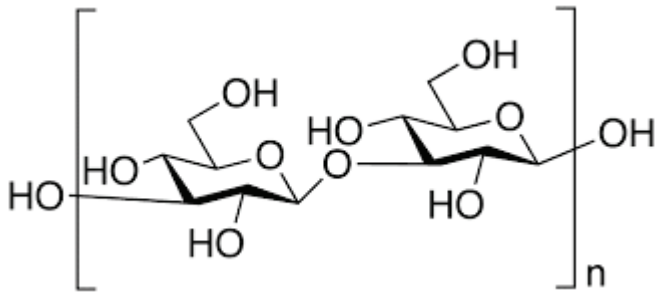


α -(1-3)- and α -(1-4)-L-fucose residues bearing one sulfate group in C2 or C4, or backbones based on a α -(1-3)-linked L-fucose residues bearing one or two sulfate groups in C2 and C4



Brown seaweed polysaccharides

Laminarin



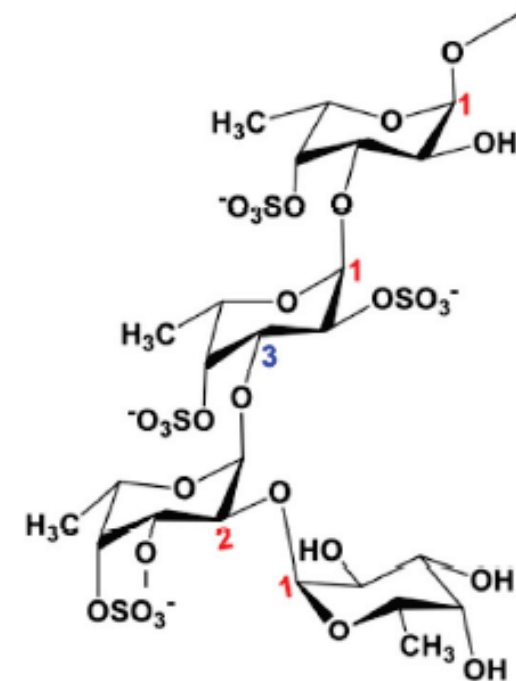
- ~ 5 kDa, 25-30 glucan units
- Anti-tumor, anti-apoptotic, anti-inflammatory and anticoagulant activity



Brown seaweed polysaccharides

- Fucose rich sulfated polysaccharide. Other monosaccharides: galactose, xylose, mannose etc.
- Bioactivities: anticoagulant, antiviral, anti-tumor and anti-inflammatory
- Heterogenous structure and diverse elemental composition → challenge for commercialization

Fucoidan



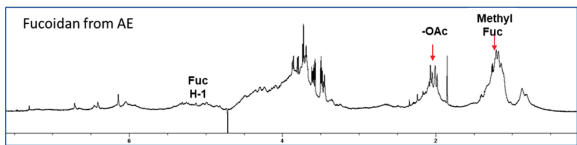
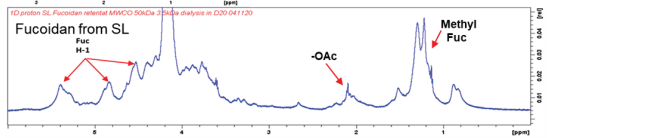
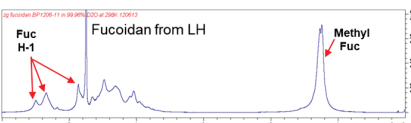
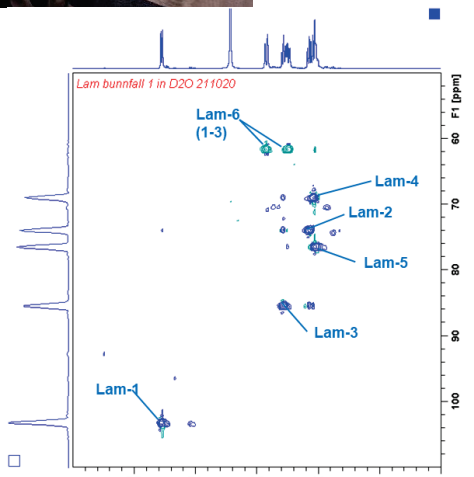
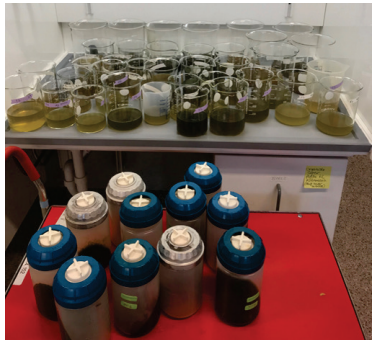


Seaweed biorefinery – current status

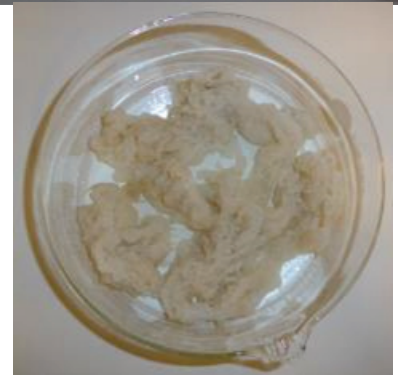


Fucoidan
Laminarin

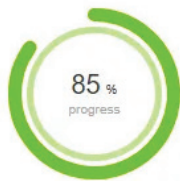
Alginate



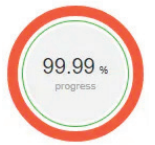
Very high molecular weight,
clear indication of fucan sugar,
sulfation and acetylation.



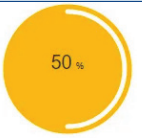
Cellulose



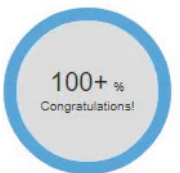
Laminarin



Fucoidan



Alginate





Experience so far ..

- We can extract all relevant sugars from seaweed
- Very mild conditions (Sustainable process)
- No negative effect on the quality of the polysaccharides
- Yields are good – but still doing some optimization





Further possibilities?

Co-extracting other valuable components?

- Amino acids, mannitol, fucoxanthin, lipids,..
- Characterisation of physio-chemical and biological activity
- Application areas e.g. biomaterials, food and feed ingredients, cosmetics, nutraceuticals etc.

Thank you for your attention!



SEAWEED INDUSTRY

**-A part of the solution for a
new bioeconomy in Norway**