Norwegian Seaweed Biorefinery Platform (SBP-N)

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SIG Seaweed
INDUSTRIAL BIOTECH NETWORK NORWAY

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A reflection I will like to share

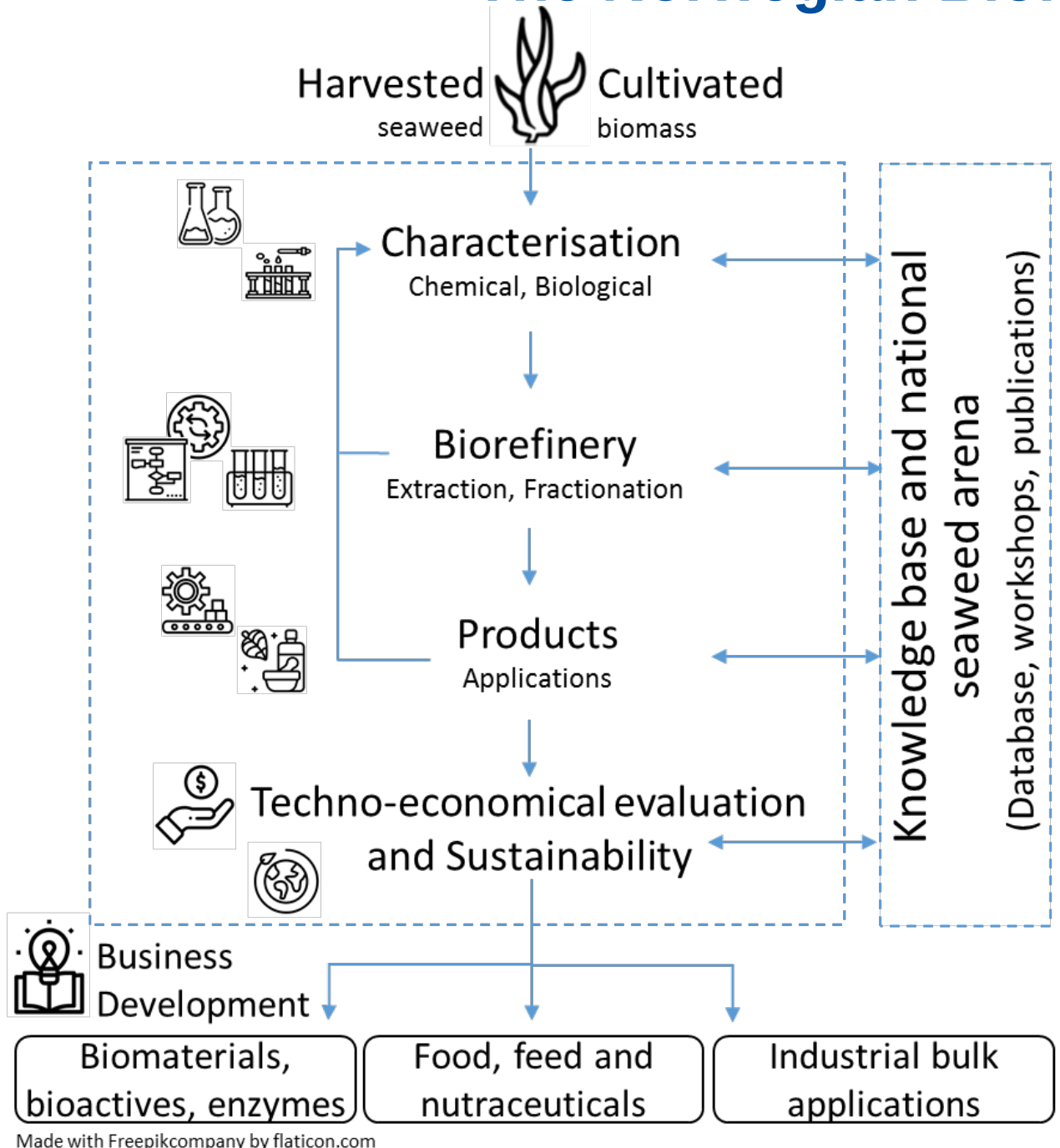
“Den tong då stå å lire mæ ka’ nøtt kan en gyr?”

Karen Marie Aachmann (70 år) 2019

“The seaweed you’re playing with – can it be made into something useful?”

This is the ***challenge*** we have!

The Norwegian Biorefinery Platform



Nofima

Norges miljø- og biovitenskapelige universitet

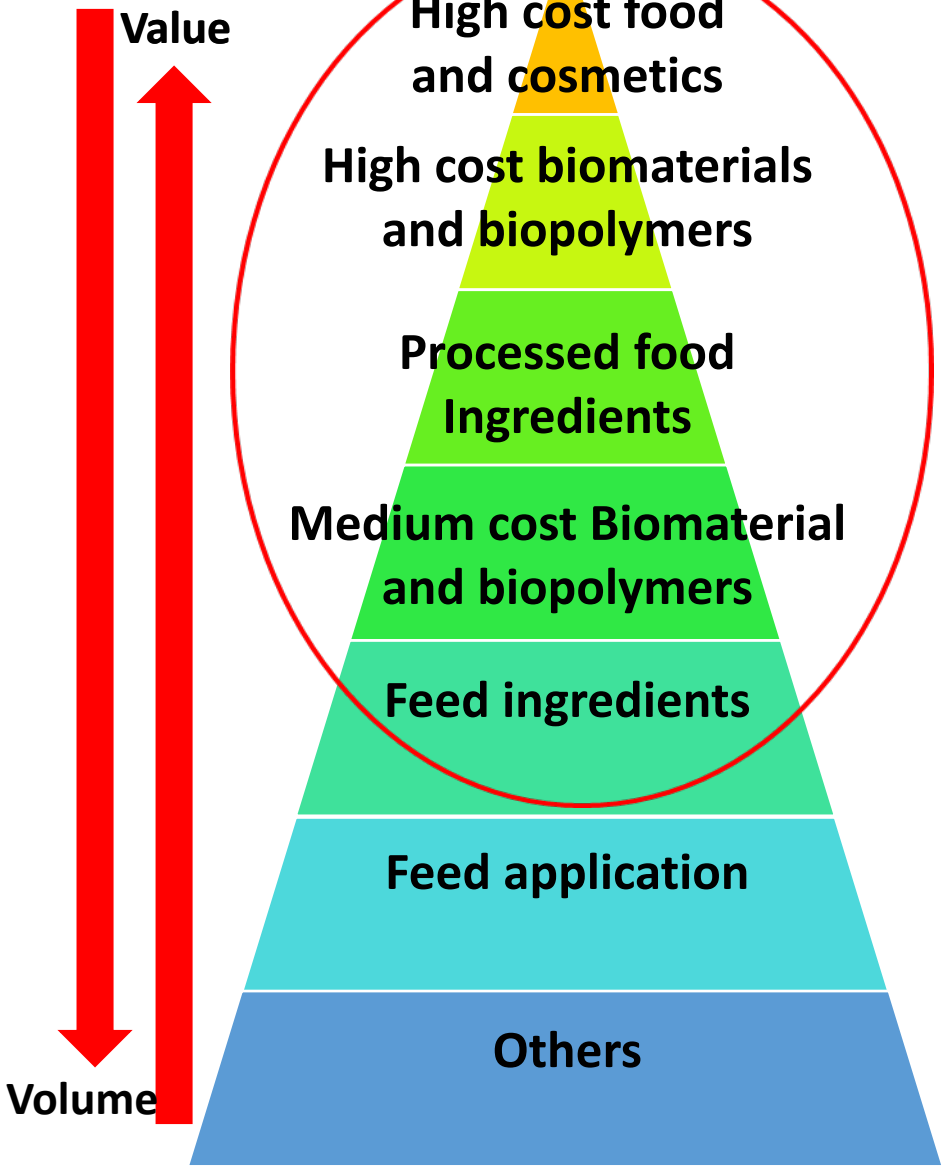
MØREFORSKING

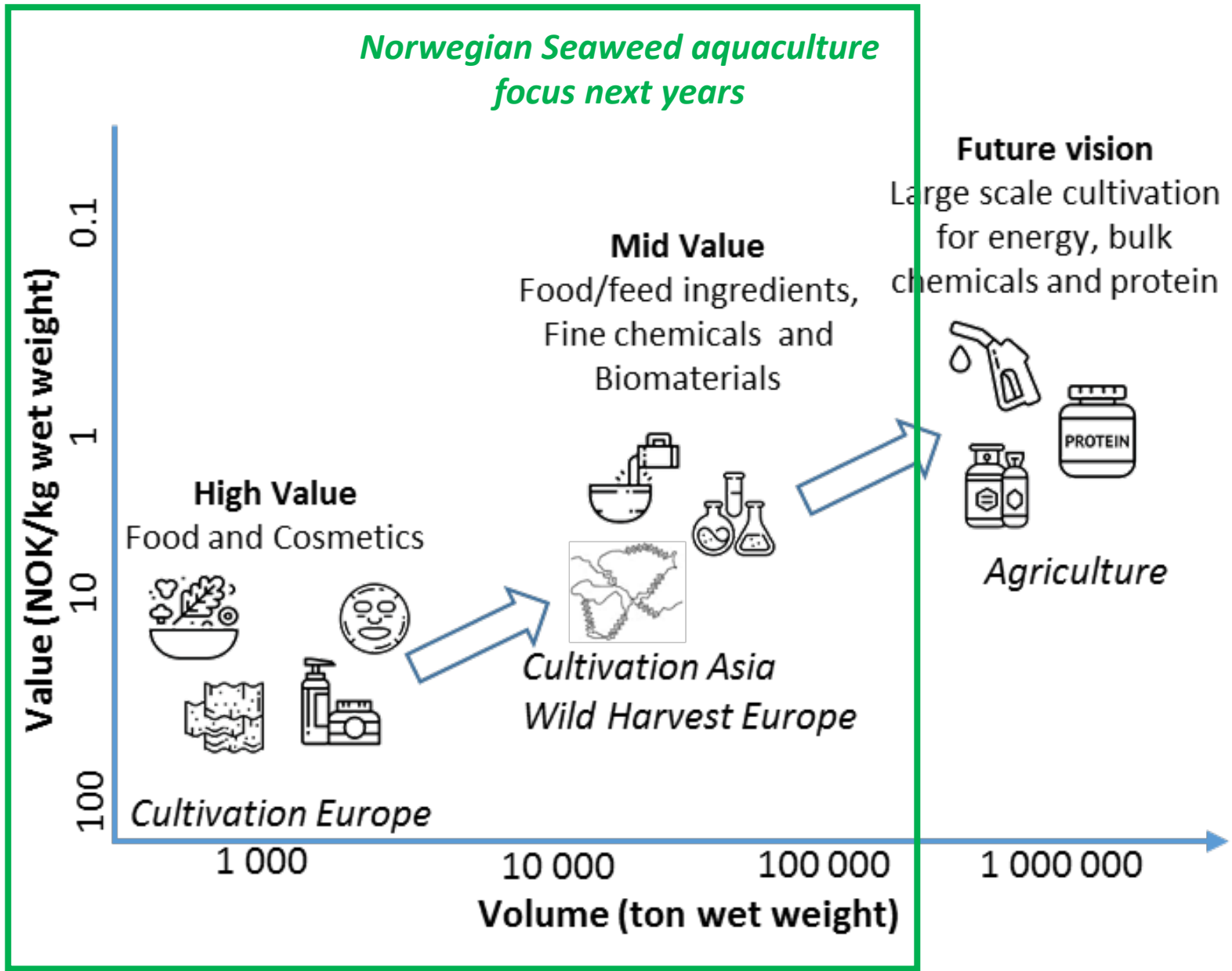
NTNU
Norwegian University of Science and Technology

SINTEF

The Research Council of Norway

«Market roadmap»
From high value Food to industrial commodities





Alginate

Fucoidan

Laminaran

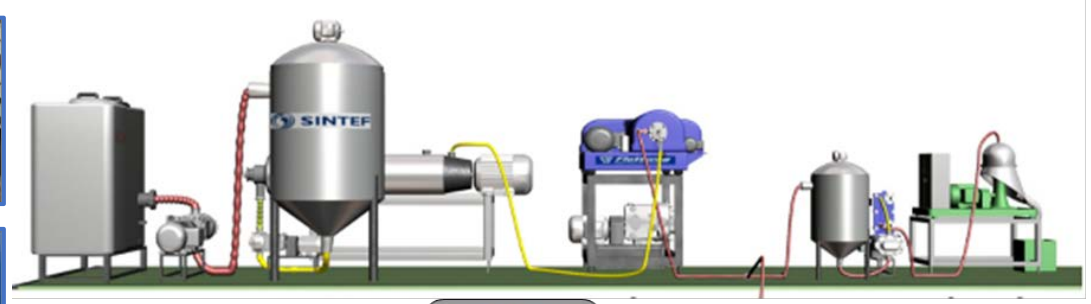
Polyphenols & Pigments

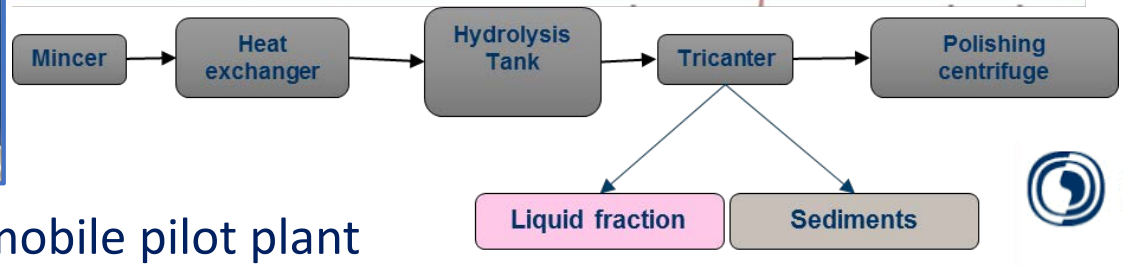
Mannitol

Recent results and ongoing activities

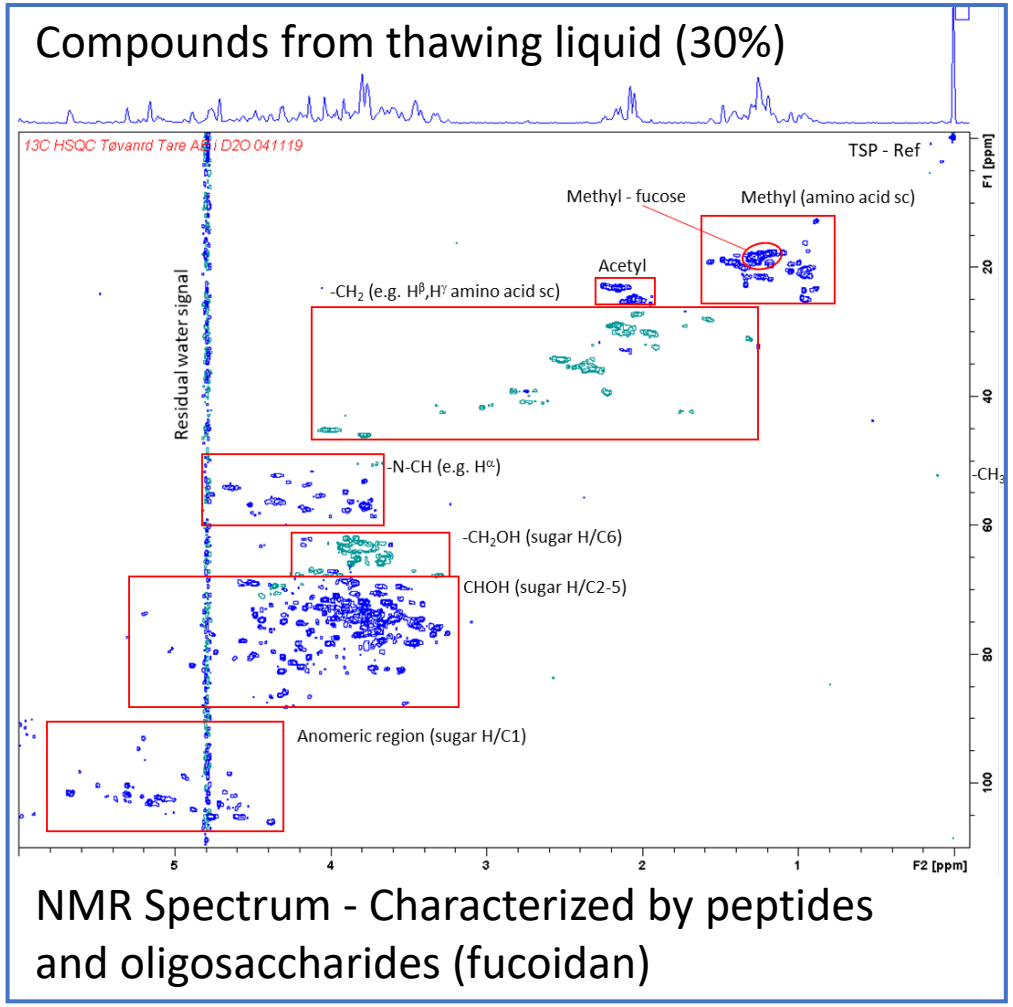
From Harvest to Pretreatment and Characterisation

- Short harvest time (4-6 weeks), perishable product.
- Must be preserved to ensure good quality and longer shelf life.
- SINTEF Ocean has knowledge and experience with various preservation methods (drying, cooling, freezing, acid treatment).





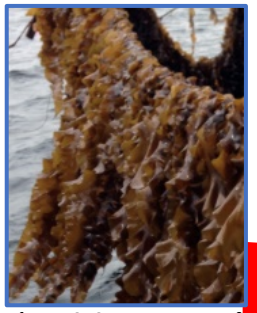
SINTEF Ocean's mobile pilot plant



SINTEF OCEAN

NTNU

Initial Biorefinery of Alginate from Cultivated Seaweed

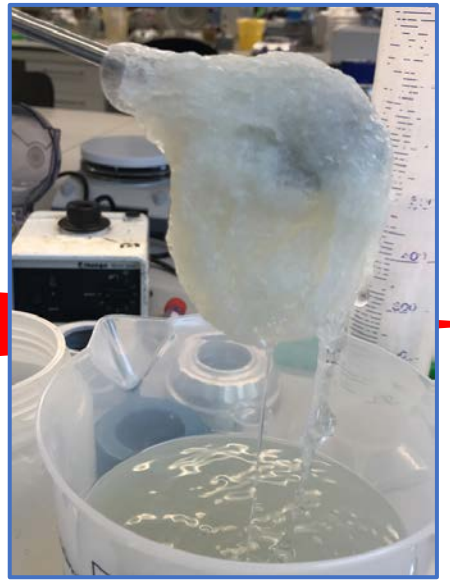


'Sukkertare'

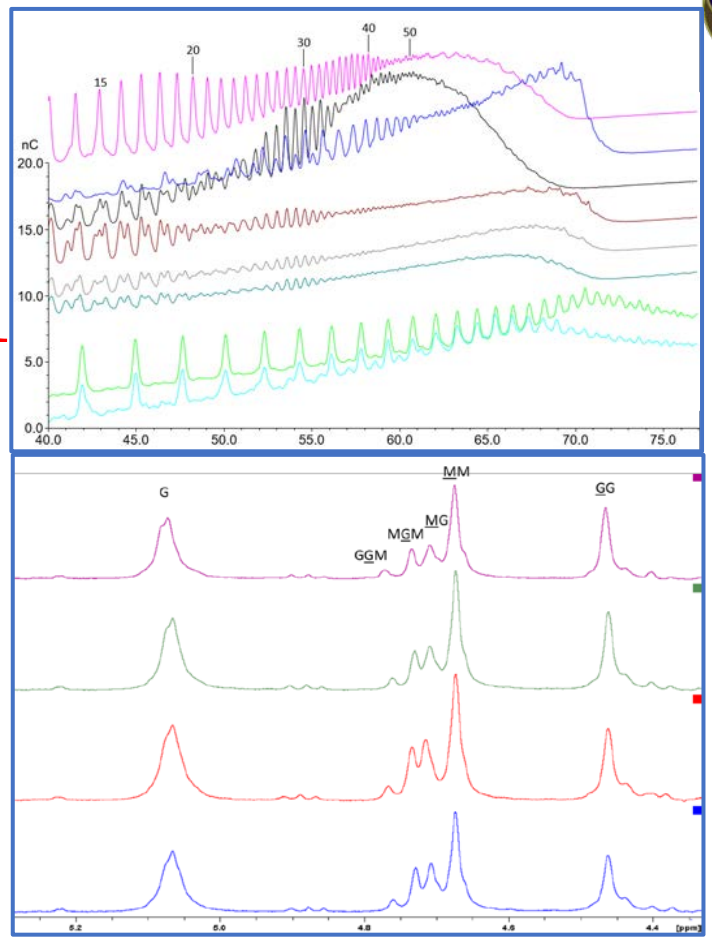
'Butare'

Thaw water - solid

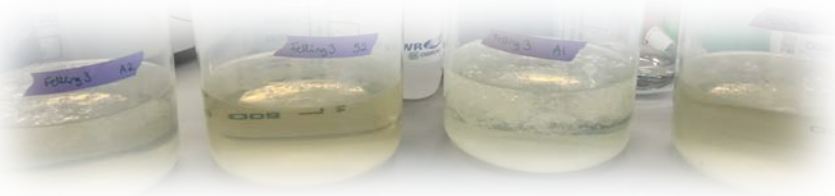
Chopping



Precipitation

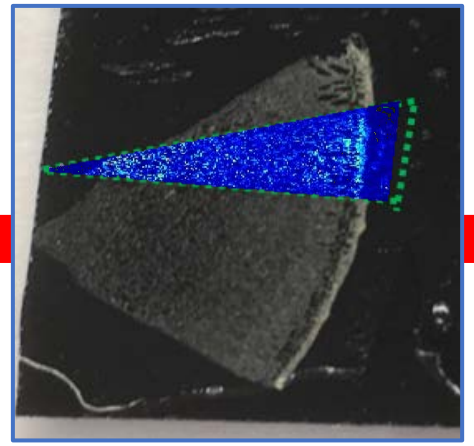


- F_G in 'Sukkertare' and 'Butare' are similar to alginate from 'Stortare' leaf
- High Mw (~500 kDa) for alginate in in 'Sukkertare' and 'Butare'
- Similar profiles of the long G-blocks in in 'Sukkertare' and 'Butare' as in 'Stortare'

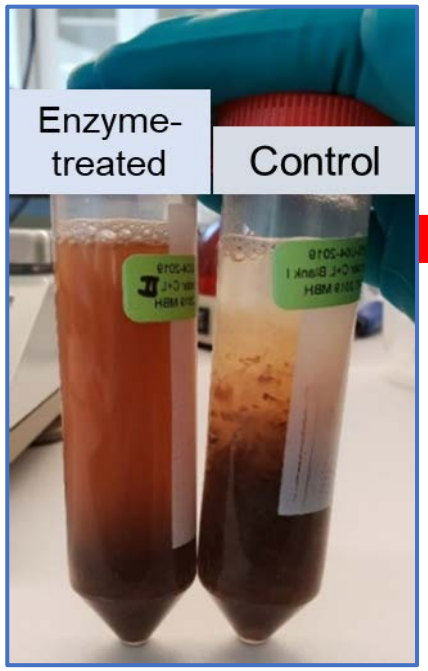


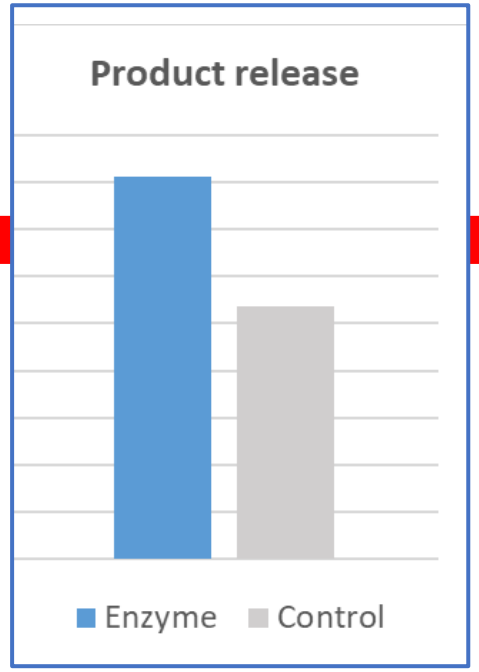
NTNU Norwegian University of Science and Technology SINTEF Nofima

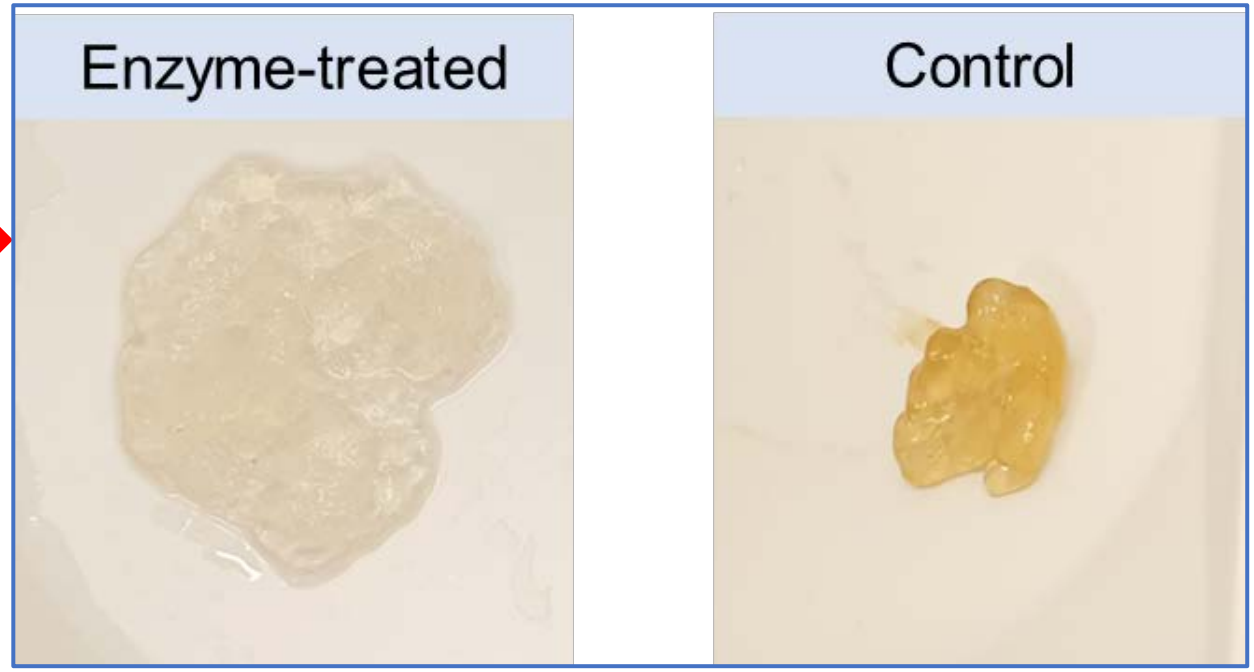
Initial Biorefinery with Enzymatic Processing of Macroalgae



- Compositional characterization of algal biomass, including distinct structures (stipe bark, core etc.)
- Spatial organization of polysaccharides and other products





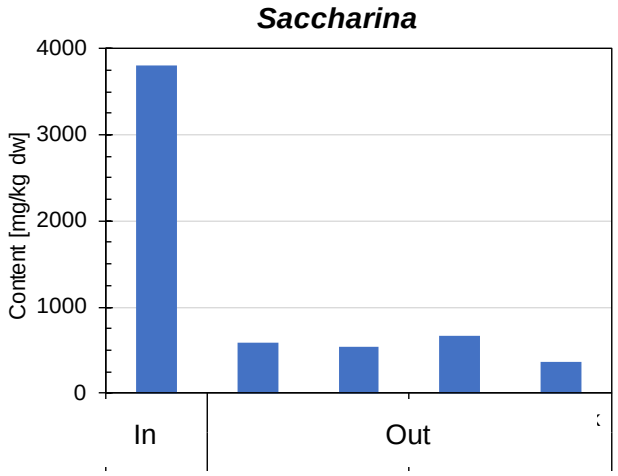


- Improved yield of alginate

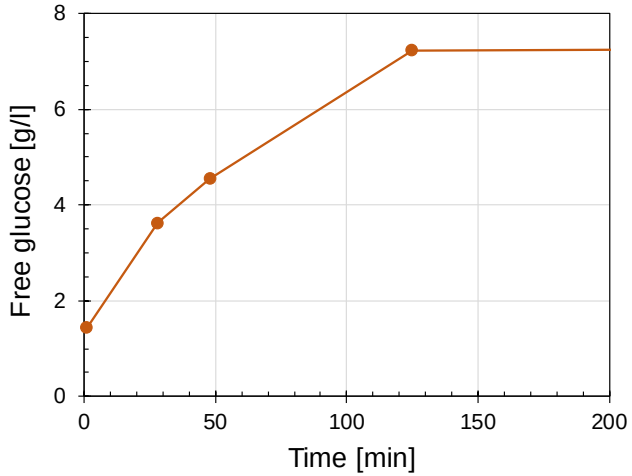
Products from Seaweed as Food Ingredients

- Pretreatment for iodine and salt-reduction
- Enzyme treatment for modification of rheology and taste, and as pretreatment for fermentation
- Fermentation for new tastes
- Standard EU protocol for iodine analysis is setup at SINTEF I and NTNU

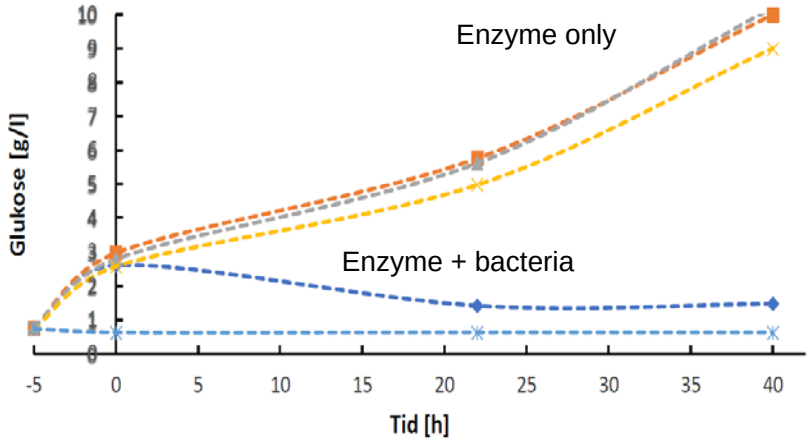
Iodine reduction



Hydrolysis of laminaran in milled Alaria
(harvested in June, 20 % laminaran of dw)

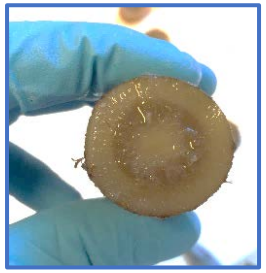


Fermentation with lactic acid bacteria, w/wo hydrolysis of laminaran



➔ ***Sweet taste, substrate for fermentation***

Additional Products and their function: Fucoidan and Laminarins



ACS APPLIED BIO MATERIALS Article
Cite This: ACS Appl. Bio Mater. 2018, 1, 1880−1892
www.acsabm.org

Structural Characterization of Fucoidan from *Laminaria hyperborea*: Assessment of Coagulation and Inflammatory Properties and Their Structure−Function Relationship

Georg Kopplin,[†] Anne Mari Rokstad,[‡] Hugo Mélida,[§] Vincent Bulone,[§] Gudmund Skjåk-Bræk,[†] and Finn Lillelund Aachmann*[,†]

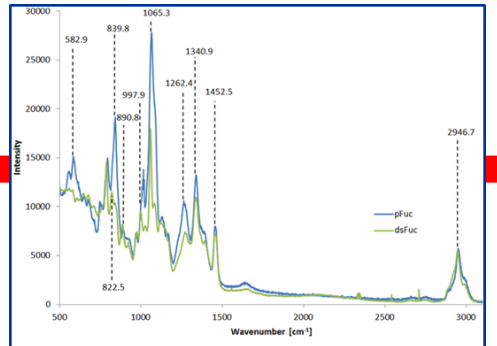
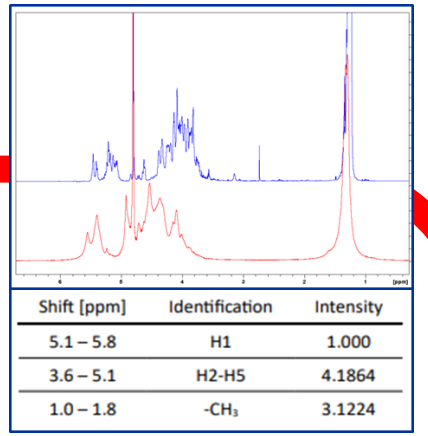
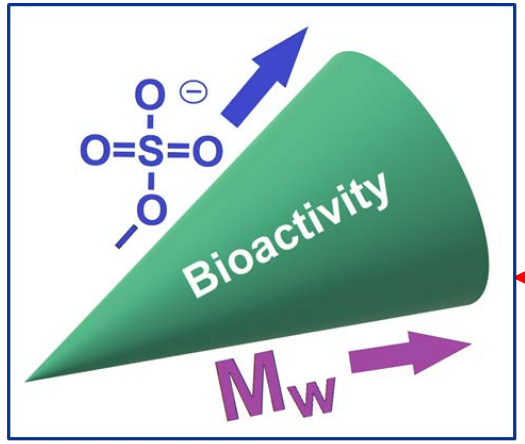


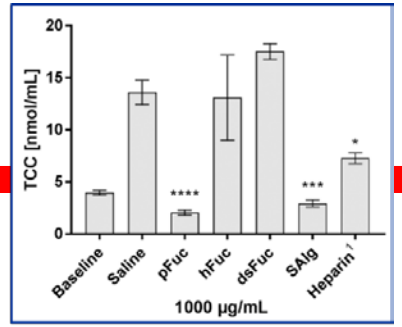
Figure 1. Raman spectra of purified fucoidan (blue) and desulfated fucoidan (green) from 500 to 3100 cm^{-1}.



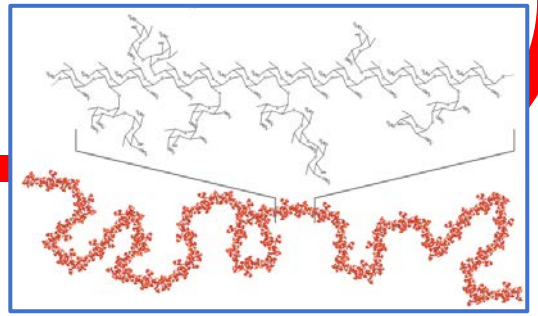
Shift [ppm]	Identification	Intensity
5.1 – 5.8	H1	1.000
3.6 – 5.1	H2-H5	4.1864
1.0 – 1.8	-CH_3	3.1224

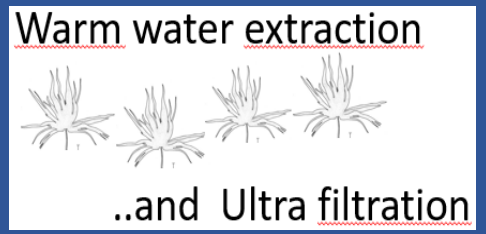


Structure-functional relationships

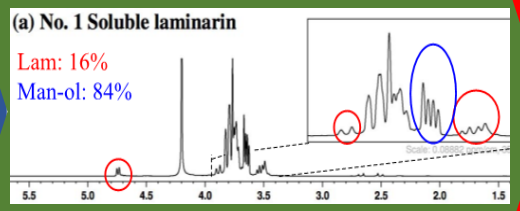


Complement activation

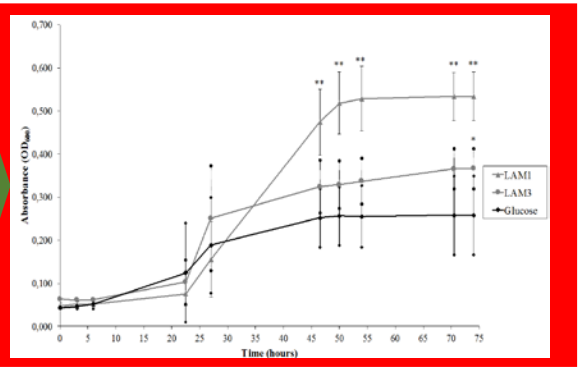




Extraction



Characterisation



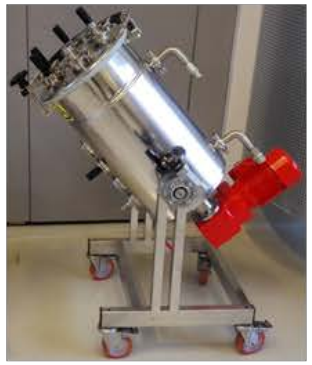
Prebiotic activity on gut bacteria in fish

Mar3Bio

MARPOL

Seaweed for feed product based on microbial protein

Wood



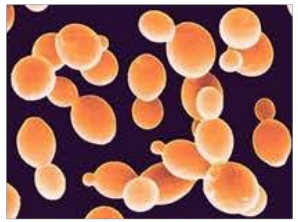
Enzymatic hydrolysis

Fermentation

Spray drying

Hydrolysates

Yeast broth
(Single cell protein)



Dried yeast

Brown seaweed

N, P, minerals
glucose
mannitol

Enzymes
Cellulases
Alginate lyases

Yeast

Fish feed trials

Feed ingredient (substitute soy)

Norges miljø- og biovitenskapelige universitet

Microbial Protein Produced from Brown Seaweed and Spruce Wood as a Feed Ingredient
Sharma et al, J. Agric. Food Chem. 2018, 66, 31, 8328

FOODS OF NORWAY

Knowledge Generation and Education

SBP-N project:

- ✓ Structure-functional characterisation of polysaccharides from seaweed and their application
- ✓ Enzymatic toolbox for seaweed

1 Post Doc. and 3 PhD - To be defined based **on stakeholders input (Possible with 'Nærings PhD' associated SBP-N)**

Associated PhD project

Thermal processing of seaweeds and the effects on quality and safety in regards to human consumption (DTU/NTNU)

Potential User cases:

- ✓ Characterization and isolation of compounds from thawing liquid and leakage from fresh seaweed
- □ Silage/acid preservation of seaweed
- ✓ Extraction and characterization of alginate from sugar kelp and winged kelp, both from raw material and from processed (rest-)fractions
- □ Extraction of fucoidan from sugar and winged kelp for structural characterization and bioactivity testing.
- ✓ Iodide reduction in sugar and winged kelp raw material and processed (rest-)fractions aimed for food and feed use

Other student project starting autumn 2019:

1. Enzyme assisted protein extraction from sugar kelp
2. Extraction of protein from sugar kelp and winged kelp – use of Ultrasound
3. Extraction of polyphenols and characterization
4. Studies of thaw water
5. Enzyme engineering of alginate modifying enzyme
6. *Alaria Esculenta* as bioactive ingredients in food packaging
7. *Alaria Esculenta* as bioactive ingredients to enhance shelf life of minced salmon
8. Functionalization and application of alginate oligomers

Exchange students from Peru: Extraction of Alginate from Peruvian Seaweeds

Thank you for your attention!

Steinshamn Taremottak

Foto: Olav Øiehaug