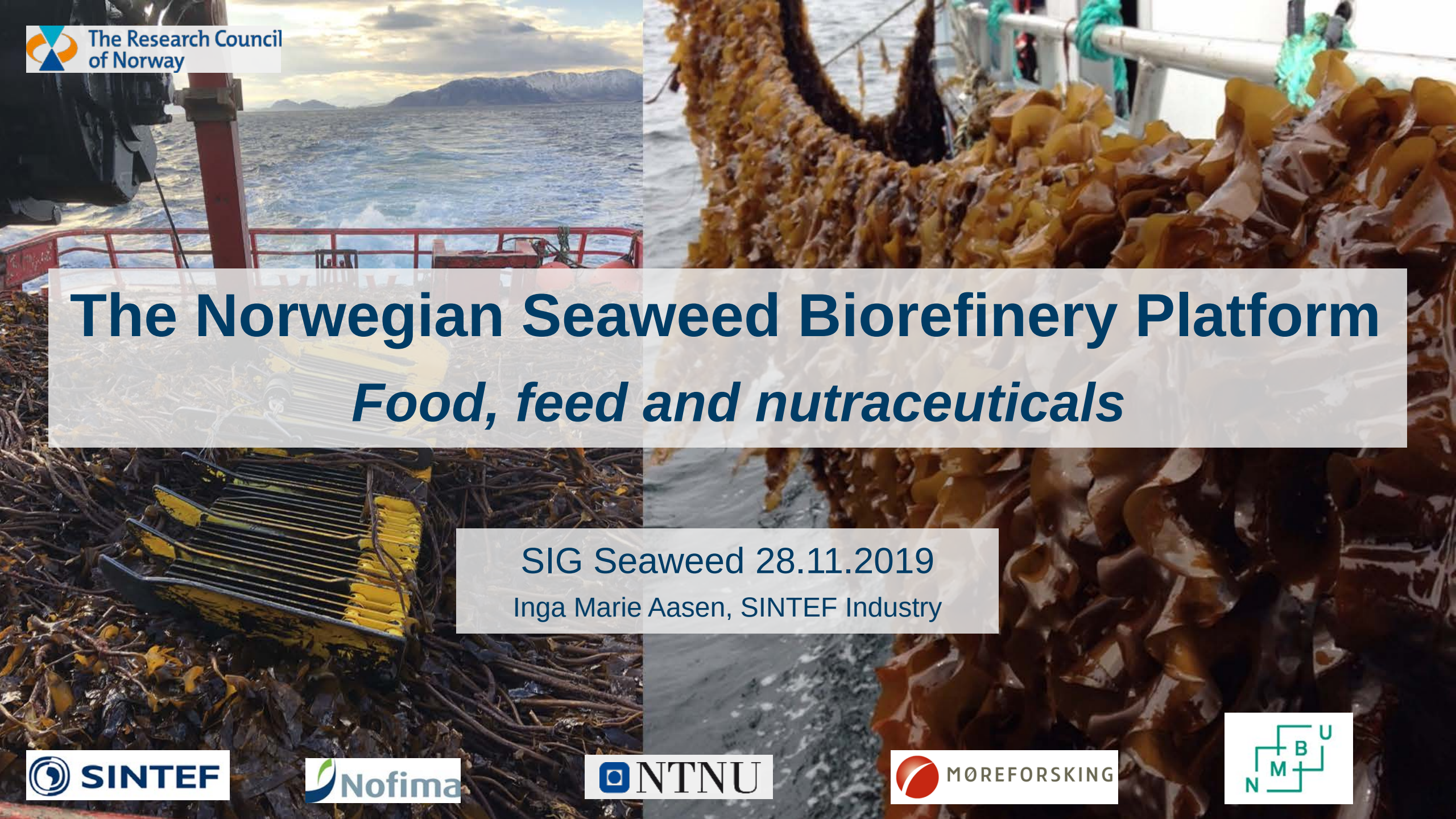


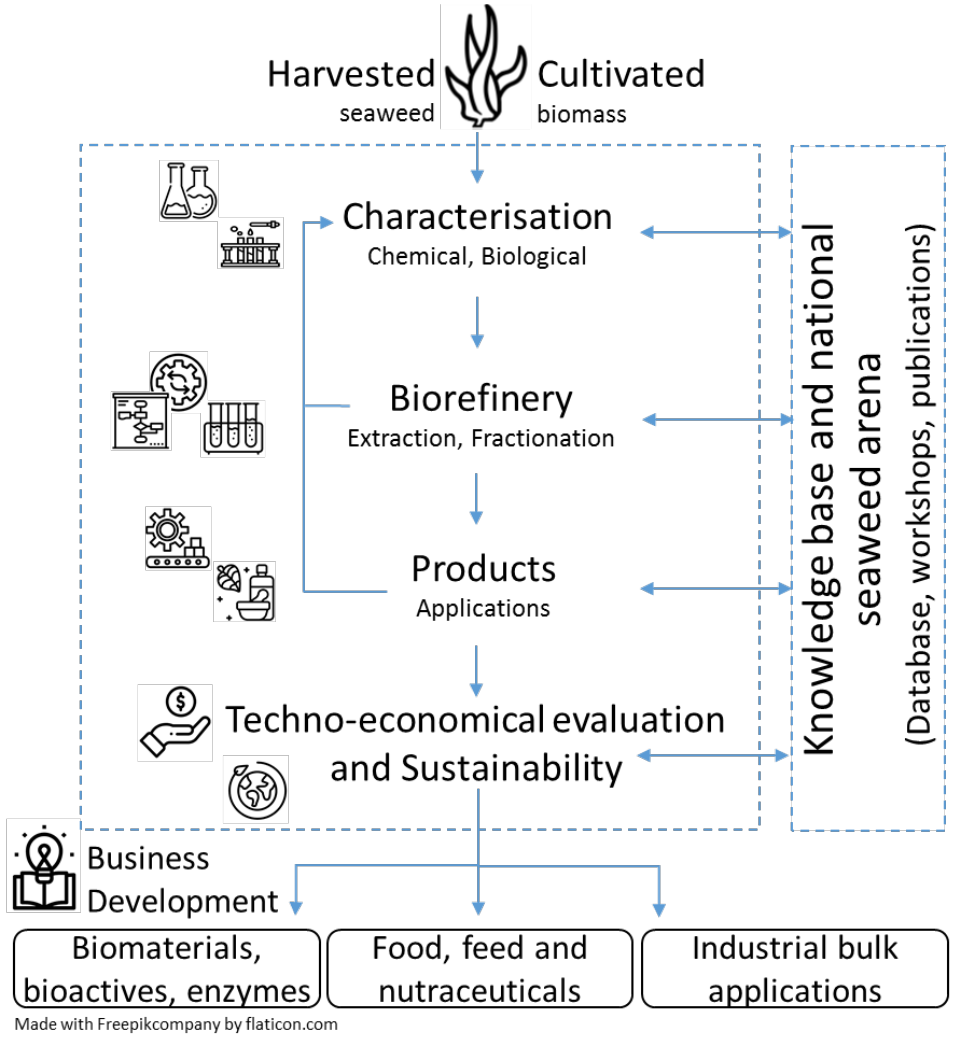
The Norwegian Seaweed Biorefinery Platform

Food, feed and nutraceuticals

SIG Seaweed 28.11.2019

Inga Marie Aasen, SINTEF Industry

SBP-N and Seaweed for food (,feed and nutraceuticals)



- SBP-N will develop a knowledge basis for the establishment and growth of a Norwegian industry based on cultivated seaweed
- Lack of a market is currently limiting the growth of the industry ➔ *Need products that may represent significant volumes, with a short path to the market*
- Food is currently the main application of seaweed on a global basis

Seaweed for food – bottlenecks and research needs

How to make seaweed to a significant component of everyday meals (eg consumed on a weekly basis)?

- Food safety
- Tasty, nutritional and healthy

➔ Product development (by the industry)

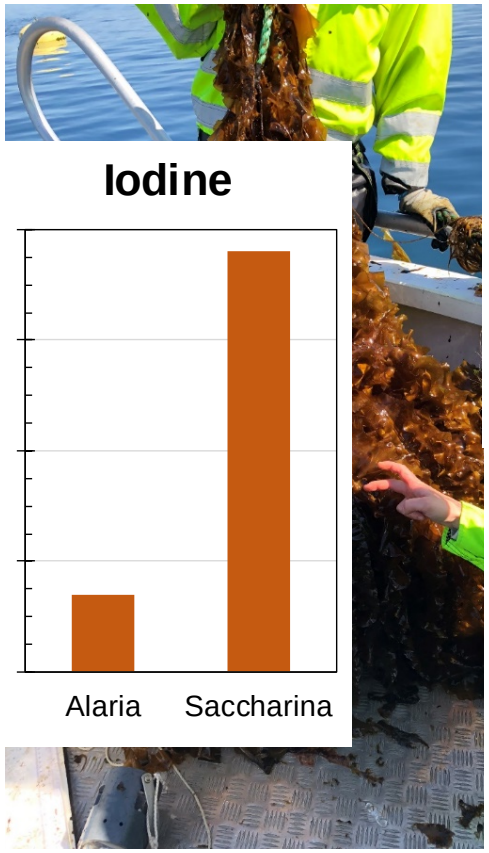
Our contributions:

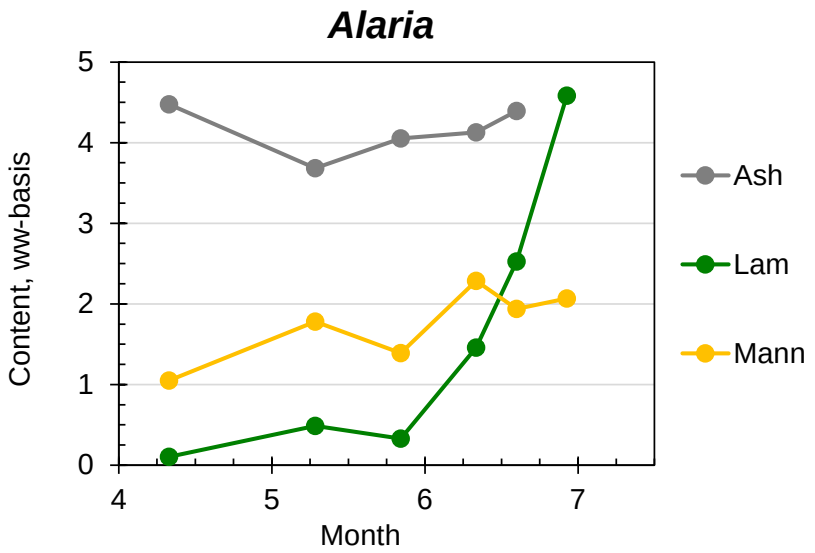
- Dialogue with the industry on the requirements that needs to be fulfilled (safety, quality-related properties)
- Generate generic knowledge needed for the product development and the corresponding processing

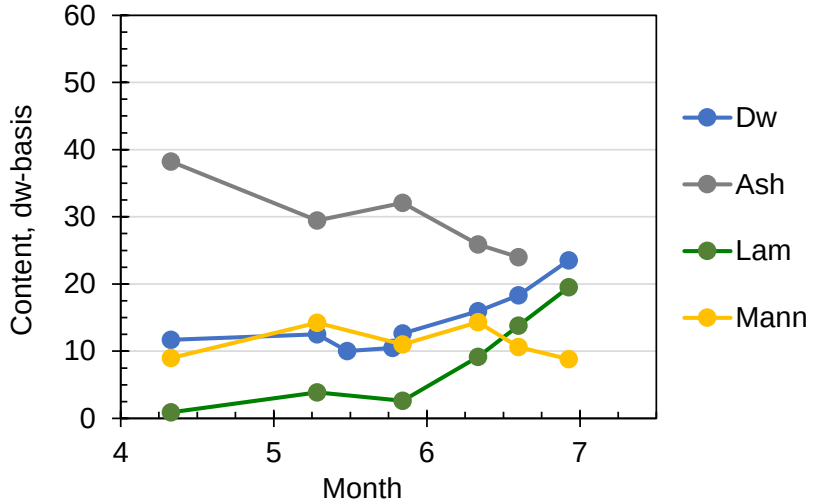
Examples – Feedstock knowledge

Saccharina and *Alaria* are different:

- The iodine content is 5-10 fold higher in *Saccharina* than in *Alaria*
- Laminaran starts to accumulate earlier in *Alaria* than in *Saccharina*
  - ➔ Flavour will be different in April and June
  - ➔ Different markets and applications?

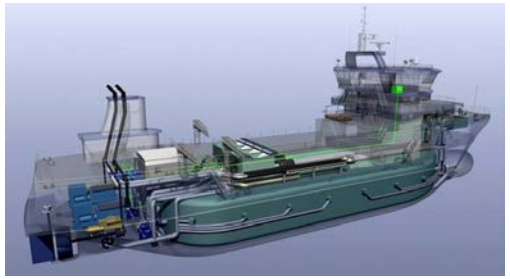






Examples – Extended shelf-life and preservation of fresh biomass

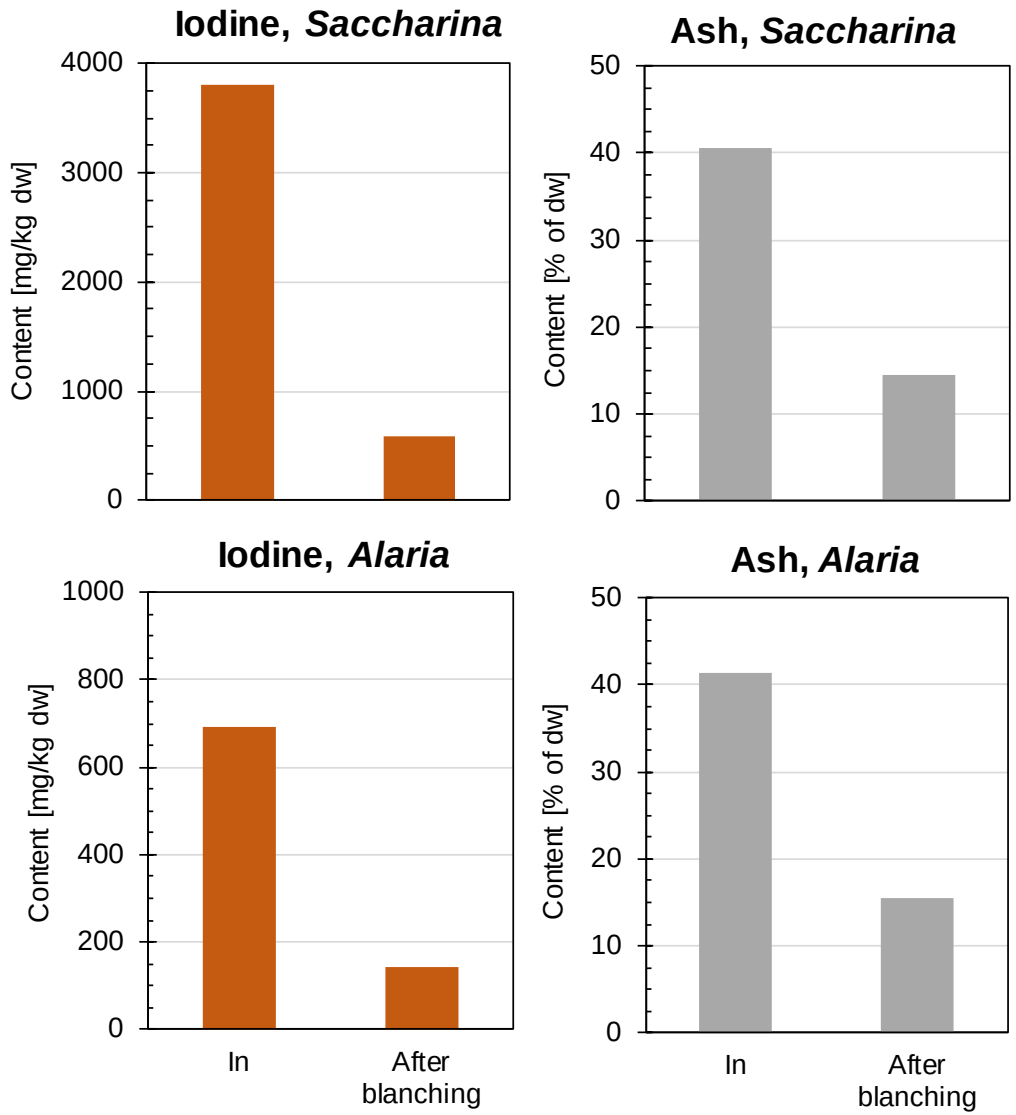
- Prolonged shelf-life by *lowering temperature* – important for storage between harvest and drying/processing
  - RSW (refrigerated seawater) at -1.0 °C, double the shelf-life compared to +7 °C
- Freezing on- or off-shore, ensure all year supply of biomass
  - Optimal freezing and thawing solutions
  - Prevent quality- and drip-loss (incl. soluble proteins)
  - On the other hand: The thawing liquid may be an easily available source of valuable components



Examples – Iodine (and salt) reduction

- Blanching for iodine reduction
  - Iodine reduced to ~20 % of original levels
  - Salt reduced to ~35 % of original levels
- Iodine intake
  - Recommended 150 µg; maximum 600 µg iodine per day

➔ *Can eat maximum 6.5-8 g ww un-processed Saccharina per week, but 450 g blanched Alaria!*



The way further ….

For food: Focus on *Alaria*, leave *Saccharina* for other applications

- Examples on gaps & research needs in initial processing and preservation:
  - Is it possible to reduce iodine without loss of flavour compo-nents (free amino acids, small peptides etc)?
  - Optimization of energy use and quality aspects during freezing and drying

PhD-work on Drying in collaboration with DTU: Cecilie Wirenfeldt-Nielsen, Main supervisors Susan Holdt, DTU and Turid Rustad, NTNU

0) Hydrothermal processing of sugar kelp and the loss of iodine and valuable compounds
I) Understanding drying of two brown algae; methods and conditions
II) Survival of microorganisms during thermal processing
III) Kinetic modelling of colour, texture and chemical changes during thermal treatment
IV) Correlations between sensory and quality components in processed seaweed products
V) Safety and quality aspects of storing processed seaweed products

The next step: Products – Some calculation examples

- Vegetable mix (frozen or fresh), consumed once a month for every Norwegian household:

  29 million 'portions' á 500 g; 20 % seaweed -> *2900 tonnes wet weight*

  Cost of seaweed (100 g per portion), assuming 50 kr/kg ww: *~10 kr (current price 25-40 kr per portion)*

- Frozen Pizza, new variant with 10 % of the market:

  26 000 tonnes (2018); 10 % of the market with 10 % seaweed: *260 tonnes wet weight*

  Cost of seaweed (52 g per portion), assuming 50 kr/kg ww: *~2.30 kr (current price 40 kr per pizza)*

(10 000 t ww per year -> 2 kg / person = 38 grams/person/week)

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Processing – Options to be prioritised

- Food safety *and palatability*
- Processing will depend on the application:

  To be used as a vegetable (wet and visible) or as an ingredient in cereal products or products based on minced meat/fish/ vegetables (dried and milled)?

  - Ingredient in formulation for plant protein extrusion
  - Incorporation in cereal products; dough stability/product taste
  - Fractionation (soluble extracts)
  - Enzymatic hydrolysis of polysaccharides and/or protein to change rheology, taste and/or generate monomers to facilitate fermentation
  - Fermentation with lactic acid bacteria

Feed and nutraceuticals

Polysaccharides (fibres) and oligomers of these, related to gut-health (microbiota and immunology)

- Studies on structure-activity relationships will be coordinated with on-going, and new, parallel projects
  - Fucoidan: Most interesting
  - Laminaran – a β-1,3-glucan: Potential prebiotic, but competes on prices and effects with plant (grains/cereals)- and yeast-based products
- Characterisation of oligomers formed during enzymatic hydrolysis of polysaccharides to modify texture
- Documentation of health effects (animal models): Some studies possible, but need spin-off projects

Summary

Three prioritised areas:

- Initial biomass processing and pre-servation, coordinated with parallel projects
- Selected model products and related process development
- Integration of the processed seaweed biomass in food products

Communication with the Norwegian Food Safety Authority


Photo: Seaweed Energy Solutions