Process and product development for tasty, healthy and safe seaweed food products in Europe

12.10.17, 7th Nordic Seaweed Conference
Maren Sæther
To enable large scale ocean farming of seaweed for food, feed, biochemicals, energy and other valuable products
Established 2009. Pioneer within seaweed farming in Europa
Development of innovative technology for large scale seaweed farming
Patented cultivation concept (“The Seaweed Carrier”) 
In-house hatchery and research lab
Pilot farm at Frøya established 2014 – as the largest seaweed farm in Norway
Cultivating *Saccharina latissima* and *Alaria esculenta* for food and other markets
Organic certification (Debio) from 2016
**Goal: become a leading European producer of high quality seaweed for food markets**
The SES team

Pål Bakken
Founder and Director

Jon Funderud, MSc
CEO

Frank Neumann, Dipl.-Ing.
Cultivation Technology

Kaia Kjølbo Rød, MSc
Cultivation Manager

Luiza Neves, MSc
Cultivation & Environment

Diogo Raposo, MSc
Hatchery & Cultivation

Maren Sæther, MSc
Processing & Biotechnology
**Location Frøya**: 5000 islands… Large habitat for seaweeds

**Clean, cold, Atlantic water**: Ideal growth conditions for brown seaweeds

**Organic certification (Debio)**
Located in Mid-Norway

**Trondheim**
- Lab and hatchery

**Frøya**
- Sea farm
- 65 ha farming concessions
- Capacity of producing 1000 t/year

**Hitra**
- Processing at Hitramat
Production cycle (6-10 months)

Deployment

Autumn

Winter

Growth phase in sea

Growth phase
Lab and hatchery

- Lab and pilot scale hatchery in Trondheim
- Development of seeding and hatchery techniques
- Supply of seeded material
- Method development for selective breeding
The Pilot farm

14/2015:
Proof of concept
100 ton *Saccharina latissima*
**23 200 meter rope**

15/2016:
Closing the value chain
25 ton *S. latissima* and *Alaria esculenta*
**16 000 meter rope**

16/2017:
Upscaling
40 ton *S. latissima* and *A. esculenta*
**26 600 meter rope**

**Future:** Upscaling and focus on processing to ensure high quality
Transport and intermediate storage on dock

Harvesting into nets

Nets are transported by boat to the processing factory

Intermediate storage and cleaning in SSW (flow-through)

Grading, packing and in-freezing
Grading  Packing  Quick in-freezing:  Boxing

- IQF
- Tunnel in-freezing
Products

• Fresh-frozen products
  • *Saccharina latissima*
  • *Alaria esculenta*
• Packed and processed on the same day of harvest
• Packing formats:
  • 250 g – 20 kg
• Organic certification (Debio)
• Packed and frozen at a certified seafood processing factory (Hitramat)
Applications of seaweed biomass

Plant health & nutrition
- Growth promoters
- Plant defense
- Macronutrients (N, P, K)
- Micronutrients (Fe, Ca, Cu)
- Trace elements

Health & nutrition (humans and animals)
- Gut health (fibers, prebiotics)
- Immune stimulation
- Anti-oxidants
- Anti-inflammatory
- Anti-biotic
- Protein
- Vitamins
- Minerals
- Fatty acids
- Skin health (cosmetics)
- Animal fur and mucus health
- Pharmaceuticals/bioactives

Human food
- Sea vegetables, snacks
- Salt replacement
- Flavor
- Texturizer

Specialty chemicals
- Alginate, carrageenan, agar
- Alginate derivatives
- Fucoidan
- Mannitol and derivates
- Fiber/textiles
- Minerals

Industrial fermentation
- Biofuels
- Biochemicals
- Single cell protein (SCP)
- Bioraffinery
Global seaweed production

- Yearly production of 30 million tons seaweed (FAO, 2016)
- Mainly aquaculture in Asia (95%)
- Production in Europe mainly in France, Ireland, UK, Spain, Iceland, The Faroe Islands and Norway
- Asian products currently dominate the European market of seaweed food products
- Increasing awareness of environmental issues as well as food safety causes an increasing demand of European seaweeds which are local, organic and traceable
Why use seaweed in food products?

- **Seaweed is healthy** – The new “superfood”
  - Excellent source of fiber, minerals and trace elements, incl. iodine
  - Contains valuable protein, omega-3 fatty acids, vitamins and antioxidants
  - Low in sodium (salt replacement) and low in calories

- **Seaweed is tasty** – The new food trend
  - Salty, “umami”, ocean flavor – highly valued in Asian cuisine and new trend among chefs in Europe
  - Bright green color (after blanching/boiling)
  - Can be used to add flavor, color and texture in food products

- **Seaweed is sustainable** – The food of the future
  - No need for feed, fertilizer, freshwater or land area
  - Seaweeds are sea vegetables
  - Vegetarian friendly
  - Organic and traceable production
• Risks by consumption of seaweed assessed by NIFES in 2016 (requested by Norwegian Food Safety Authorities)
• The most important risk factors in seaweed appear to be iodine, cadmium and inorganic arsenic, but there is a need for more knowledge regarding variation in composition, effects of processing, bioavailability and consumption patterns.
• No current regulation of upper limits of metals in seaweed for human consumption (except for seaweed as “additives”)
• EFSA has identified seaweed as an “emerging risk” and are working on a “commission recommendation” on the monitoring of metals in macroalgae and halophytes.
• Planned and on-going research in SES:
  – Investigate how various processing methods affects the content of risk components in seaweed
Variation of Iodine Content in Processed Cultivated *S. latissima*

Nicoline Korsvold (2017), Master thesis, NTNU, Norway

- Estimated daily consumption of *Saccharina latissima* in order to obtain the recommended daily intake (RDI, 150 µg/day*) and the tolerable upper limit (UL, 600 µg/day*) of iodine
- The iodine content was found by alkaline extraction of iodine from *Saccharina latissima* harvested at SES’ farm, May 2016
- **Little information about the bioavailability**

<table>
<thead>
<tr>
<th>Method</th>
<th>DW (g/day)</th>
<th>FW (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RDI</td>
<td>UL</td>
</tr>
<tr>
<td>Freeze dried</td>
<td>0.04</td>
<td>0.16</td>
</tr>
<tr>
<td>10 min boiling</td>
<td>0.16</td>
<td>0.66</td>
</tr>
<tr>
<td>20 min boiling</td>
<td>0.17</td>
<td>0.66</td>
</tr>
</tbody>
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*Defined by the World Health Organization (WHO)*

The high iodine content (especially in *S. latissima*) can also be an advantage, as the general iodine status of the European population is low.
- Important to develop food products that are tasty, healthy and safe

- SES is taken an active role in product development, together with students and food producing companies
Product development: Fish burgers with A. esculenta

Pia L. Rostad, Marit M. Amundsen, Siv Maria Nguyen (2017), Bachelor thesis, NTNU, Norway

- Air dried (35°C) and pulverized seaweed
- 0.00% - 0.56% - 1.00% - 1.44%
- Sensory analysis (elderly people 70-80 years old)
- Most of the judges (60 in total) preferred the fish burgers containing the highest amount of seaweed
R&D – Ongoing projects

FOODS OF NORWAY

BIOFEED

GENIALG

KELPPPRO

ISBIT

MACROSEA
Seaweed farming in Norway

- 26 concessions (*Saccharina latissima*)
- Norwegian Seaweed Farmers Association (2017) - Industry
- SIG-Seaweed (2014) – R&D and industry