# PROMAC Newsletter



*Dear readers,*

*I am pleased to introduce the first newsletter of 2018.*

*In the last few months, we have had several notable actions to prepare for this final year of our project.*

*In 2017, the project results have been presented in several national and international conferences and 5 peer-reviewed papers are already published and are available on our research gate PROMAC page. In October 2017, we held our general assembly and organized a workshop in order to meet with the leaders of other large projects conducting research on algae, nationally and internationally: H2020 Genialg (Station Biologique de Roscoff, France); NCR-Macrosea (SINTEF); NCR-Teknologiutvikling for taredyrking (Møre Maritime AS/SINTEF); A2F (NIBIO); Tarelaks (MFÅ); Kelpro (NIVA); 'På sporet av ny mat – innhold og biotilgjengelighet av jod, kadmium og uorganisk arsen fra tare' (NIFES) and Mar3Bio (SINTEF MC). In addition, we also conducted a workshop on the technical possibilities for industrial drying and freezing of seaweed with the consortium of the spin-off project called ISBIT (NCR 2722111). In May 2017, 750 kg of sugar kelp were processed for preparing extracts to be tested in sheep feeding trials. The last animal trials are today conducted and so are the last maturation experiment with Palmaria palmata. The final results will be ready before the summer 2018.*

*In March 2018, the PROMAC partners will also be visiting ECN in the Netherlands to investigate further the biorefineries processes. Finally, in November 2018, PROMAC will organize the final presentation of the results to all the stakeholders at a conference that will be organized during week 45 in Ålesund. Information about this final event can be found on our webpage (www.promac.no).*

*Céline Rebours*

## CHARACTERISATION OF EDIBLE SEAWEED SPECIES

One of the activities in PROMAC (work package 1) was to carry out a chemical characterization of three commercially important and edible seaweed species, the brown seaweeds *Saccharina latissima* and *Alaria esculenta*, and the red *Palmaria palmata* from the Norwegian coasts and reference locations in the North Atlantic (i.e. France and Iceland). Use of standardized harvesting protocols and post-harvest handling treatments minimized chemical composition variability due to confounding variables. The biomass' chemistry with relevance for food and feed applications, e.g. iodine, polyphenols, and heavy metals were quantified, addressing variations in (1) latitude and location, (2) season, (3) year, (4) biomass source: wild vs. cultivated, and (5) plant age.

Mean iodine concentration in bulk seaweed biomass was species-specific (Fig. 1): *Saccharina* > *Alaria* > *Palmaria* (Table 1). All three species are rich sources of iodine, and only small amounts of the seaweeds is necessary to meet the recommended daily intake for healthy adults (*Saccharina* – 32 mg dry weight, Alaria – 283 mg dry weight, *Palmaria* – 2149 mg dry weight). Iodine is an essential element required for human health and metabolism. Ingestion of high iodine may pose some health risk, e.g. nausea and thyroid dysfunction, in vulnerable people with specific risk factors. Despite high levels of iodine present in some seaweeds (e.g. the kelp *Saccharina*), ingestion of large amounts will not necessary imply a risk for excessive intake of iodine since seaweed preparation such as washing, drying, and cooking can readily re¬duce iodine content.

The amount of polyphenol that has antioxidant properties (expressed as mg phloroglucinol (or gallic acid) equivalent per g sample) is species-specific. Highest concentration was observed in *Alaria* (3.7±0.3), followed by *Saccharina* (0.8±0.06) and lowest in *Palmaria* (0.5±0.04). Moreover, accumulation of heavy metals (As, Cd, and Pb) are also species-specific. For example, total arsenic was highest in *Saccharina* (69.8±3.0 mg kg-1), followed by *Alaria* (56.9±3.1mg kg-1) and lowest in *Palmaria* (8.8±0.6 mg kg-1). Cadmium and Lead were highest in *Alaria*, and there were no significant difference in the heavy metals between *Saccharina* and *Palmaria*. No significant difference was found in the amount of Mercury between the species.

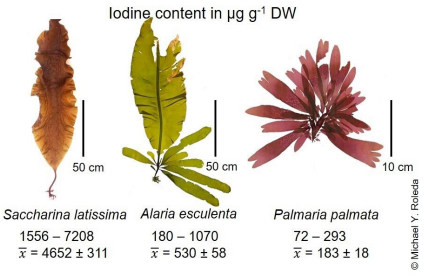



Fig.1: Species-specific differences in iodine contents. Values are ranges (minimum and maximum), means ±S.E. of all samples collected. Statistical analysis showed significant difference between species (Table 1).

Table 1: Table 1. Statistical analyses showed species-specific differences in mean iodine, polyphenol, and heavy metal (Arsenic, Cadmium, Mercury and Lead) contents in bulk biomass of three edible macroalgal species (*Saccharina, Alaria, Palmaria*) determined during two years at three different seasons from various locations and sources.

| Parameters | Test statistic | *P* value | Direct comparison** |
|---|---|---|---|
| Iodine | $\chi^2_2 = 48.709$* | **<0.001** | *Saccharina* > *Alaria* > *Palmaria* |
| Polyphenols | $\chi^2_2 = 46.053$* | **<0.001** | *Alaria* > *Saccharina* > *Palmaria* |
| As | $\chi^2_2 = 30.474$* | **<0.001** | *Saccharina* > *Alaria* > *Palmaria* |
| Cd | $\chi^2_2 = 23.673$* | **<0.001** | *Alaria* > *Palmaria* = *Saccharina* |
| Hg | $\chi^2_2 = 0.221$* | 0.895 | |
| Pb | $\chi^2_2 = 7.466$* | **0.024** | *Alaria* > *Palmaria* = *Saccharina* |

* Kruskal-Wallis *H* test, ANOVA assumptions violated (normality, variances)

** Mann-Whitney *U* tests (*P* value adjusted according to Bonferroni)

## HOW TO USE REVEALED EXCESS HEAT IN DRYING?

In WP 5 the work has been concentrating on revealing the excess heat from Tafjord Kraftvarmes waste incinerator and showing how this can be used in processing (drying) seaweed biomass.

At Tafjord there is available 10 MW at 80°C - 110°C. This can process 240 tons wet seaweed per day giving 24 tons of dried product containing 2,4 tons proteins. The price for proteins is about 16 NOK/kg. This shows the importance of focusing on high value products and proteins as rest raw material.

Due to short harvesting period and short shelf-life on fresh raw material, there is need for pre-treatment to obtain better conservation. WP 5 has focused on partly dried conservation method.

However, there are some challenges with partly drying. Seaweed is a inhomogeneous product giving an uneven drying rate. It has to be dried to 20-25% water content, and from 90% Wb to 20 % Wb 97% of the initial water is removed.

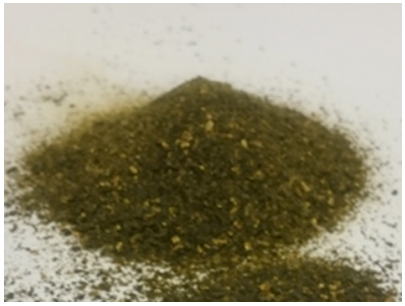
Different types of dryers have been evaluated/tested and at what temperature seaweed should be dried at. High air temperature gives increased capacity but has some quality disadvantages.

Forberg baffle dryer


Industry clip fish drier


Belt dryer (from SES)


Raw seaweed


Dryed seaweed powder


Excess heat waste

## SPIN-OFF PROJECTS FROM PROMAC

Large scale cultivation of macroalgae at sea is developing fast in Norway. From the PROMAC results, it was identified that one of the main challenges for industrial players is to maintain quality of the macroalgae after harvesting, as large amounts of biomass are harvested within a limited period of time. Effective preservation methods should minimize loss of valuable components and maintain the quality of the product and are therefore crucial for the profitability and future of the industry. Results from the PROMAC project show that drying is effective to preserve the nutrients of the macroalgae but leads to changes in the texture and conducts to a lower rehydration ability of the product. In addition, the drying process requires a lot of energy and solutions to handle large volumes need to be developed. Therefore, the challenges about preprocessing technologies need to be investigated further and two projects were proposed to Regional Research Found to investigate further the methods for stabilizing macroalgae biomass at low energy costs.

### RFF MN ISBIT (NCR 272211)

The first spin-off project from the PROMAC project was granted in June 2017. The ISBIT project is led by Møreforsking Ålesund AS and conducted in cooperation with SINTEF Ocean, FrigoCare, Tafjord Kraftvarme AS, Seaweed Energy Solutions AS, Tango Seaweed AS and Teknotherm Marine AS. The overall goal is to investigate whether refrigeration or/and freezing storage can stabilize quality and product characteristics of the sugar kelp (*Saccharina latissima*).

### RFF MN MakroTerm (NCR 282528)

The second spin-off project from the PROMAC was granted in December 2017 and will start 1st March 2018. The MakroTerm project is also led by Møreforsking Ålesund AS and conducted in cooperation with SINTEF Ocean, NTNU, Tafjord Kraftvarme AS, Seaweed Energy Solutions AS and Multivector AS. The first goal of the MacroTerm project is to map innovative drying technologies such as super-heated steam drying.

## Project facts

PROMAC is funded by the Research Council of Norway, through the Havbruk2 programme.

- 35 mill. NOK funding
- Duration: 2015 – 2018
- Project owner: Møreforsking
- Project Manager: Céline Rebours