

STIMULATING A BIOBASED ECONOMY BY OPTIMISING THE SEAWEED PROCESSING TRAIN



Seaweed is one of the most promising aquaculture crops of the future. Seaweed components are used in many different industries such as food, animal feed, cosmetics, pharmaceuticals, bioplastics and fuels. Needing only seawater, nutrients present and CO₂, it is on its way to become a significant sustainable crop in the transition to a biobased economy. Seaweed contains many valuable components such as proteins, bio stimulants and carbohydrates. These components have an important role as sustainable raw materials in the biobased, circular economy of the future.

Over the past few years research into the use of seaweed has intensified, as well as the demand for specialized research and processing facilities.

OUR SEAWEED SCALE-UP LABORATORY

ECN part of TNO has upgraded its seaweed processing laboratory from bench to pilot scale to meet this growing demand. The ECN part of TNO laboratory is fully equipped for research and development of seaweed applications. In addition to this, ECN part of TNO brings extensive experience to the table from a decade of experimental seaweed research and participation in (inter)national research projects. Our multidisciplinary team has years of experience in translating customer needs into the design of processes, systems and installations for R&D and beyond.

The Seaweed Processing Laboratory offers:

- the entire processing chain for the conversion of (fresh) seaweed into products such as carbohydrates, platform chemicals, plant stimulants or proteins;
- characterisation and screening of seaweed composition;
- realistic processing conditions for producing samples so users can carry out relevant product tests;
- the flexibility to perform processing steps separately as well as in sequence;
- a unique combination of extensive seaweed refinery experience and lab infrastructure.

We look forward to helping optimize your seaweed biorefinery process!

OPTIMIZATION OF THE VALUE CHAIN FOR SUSTAINABLE SOLUTIONS



ADVANCED BIOFUELS

Seaweeds are a renewable source of carbohydrates that, unlike their terrestrial biomass counterparts, do not compete for arable land with edible crops. Also, they do not contain large fractions of recalcitrant non-sugar components. These features makes seaweed particularly suitable as feedstocks for the biorefining industry in the production of conventional biofuels, such as ethanol and butanol, and advanced fuel boosters, such as furan-based molecules. We have a proven track record in producing sugar rich fractions for further processing towards fuel alcohols and furanics as advanced fuel additives. Together with our partners we will continue the research in order to take these technologies to the next level.

RENEWABLE MATERIALS

Fine chemicals, synthesised from seaweed, as well as seaweed fibres, derived after extraction of active components, can be used in the production of renewable chemicals including furanics, lactic and succinic acids, that can replace fossil components in plastics and polymer products, for example tableware.

AGRICULTURE

In our lab we develop, test and validate extraction methods for (in)organic bio active seaweed substances. The bio-activity of seaweed can be associated to its content of macro- and micro-nutrients, plant-growth regulators, phytohormones, and saccharides. These improve soil quality, stimulate root and plant growth, and activate defence mechanisms which help to drastically improve plant productivity in the agricultural sector.

FOOD AND FEED

Seaweed's popularity as an alternative and sustainable source of proteins for both food and feed applications is increasing. We are able to develop tailor made processes for the extraction and purification of protein or carbohydrate extracts for food and feed applications.

EMERGING NON-FOSSIL, NON-ANIMAL ALTERNATIVES

The chelating properties of several seaweed polysaccharides offer non-fossil, non-animal alternatives for the production of stable gels/gelatines e.g. for creams, desserts, plant-based milks, and many other food products. Agar and carrageenan from red seaweeds, and alginates from brown seaweeds are already commercially available and their global markets sum up to over 100,000 tons per year.

REDUCTION OF GREENHOUSE GASES

Several studies have shown that the use of seaweed in the diet of ruminant livestock has nutritional benefits and significantly reduces the release of greenhouse gases.

IMPROVING HEALTH AND BEAUTY

The beneficial effects of seaweed substances have been discovered by the beauty- and pharmaceutical industries and are used in various medical applications e.g. in the prevention of diabetes, hypertension, cardiovascular diseases and mental degenerative disorders as well as in various cosmetic applications like anti-aging.

We provide all the steps needed for the production of food, cosmetic and pharmaceutical components. The implementation of these methods in a lab has to be realised by our clients.

OUR SEAWEED PROCESSING FACILITIES



SOLIDS PROCESSING

- **Wet cutter/wet biomass processor:** designed for size reduction and homogenization of large seaweed leaves and stems before further processing. Suited for fresh and ensiled seaweed.
- **Freeze dryer:** reduces the moisture content from more than 80% to less than 10% at room temperature or lower, preserving the cellular structure and purity of seaweed.



SEAWEED FRACTIONATION AND CONVERSION: 100L AUTOCLAVE REACTOR

- Designed to manage acids and bases, temperature up to 150°C and pressures up to 3 bar.
- Ideally suited for cold and hot water extraction e.g. for production of mannitol or bio stimulants, acid or enzymatic hydrolysis e.g. for sugar production, sugar fermentation, etc.



100,000 TONS

Agar and carrageenan from red seaweeds and alginates from brown seaweeds are already commercially available and their global markets sum up to over 100,000 tons per year.



SEPARATION AND PURIFICATION

- **Centrifuge:** separates solids and/or fibers after extraction, as well as carbohydrate fractions.
- **Spray dryer:** purifies seaweed components e.g. sugars, mannitol, proteins and/or bioactive components.



- **Membrane unit:** suited for the selective separation of different components e.g. carbohydrates, minerals; and for the increase of concentration of active components in extracts.
- **Rotary evaporator:** concentrates active components and platform chemicals e.g. furanics or bio alcohols in solution.



ALL STEPS ARE FULLY SUPPORTED BY OUR CHARACTERIZATION AND SCREENING KNOW-HOW

- These include the analysis of CHNS, ash, moisture, nutrients, biochemical composition, process synthesis and scale-up.



MACROFUELS

(H2020, Grant No. 654010, 2016–2019)

MacroFuels aims to produce advanced biofuels, including ethanol, butanol, furanics and biogas, from seaweed or macro-algae. MacroFuels will develop technology for the production of fuels which are suitable as liquid fuels or precursor thereof for the heavy transport and aviation sectors. The seaweed lab will be used for producing sugar syrups from seaweed to be converted into biofuels.



MACROCASCADE

(BIC JU Grant No. 720755, 2016–2020)

MACRO CASCADE will prove the concept of the cascading marine macroalgal biorefinery i.e. a production platform that covers the whole technological chain for processing sustainable cultivated macro-algae biomass to highly processed value added products. Algae based products for food, feed, cosmetics, pharmaceutical will be tested and documented for their bio-activities and health properties. The lab will be used to provide essential feedback for developing realistic process schemes.



PORT4INNOVATION: MAXIMALISEREN ECONOMISCHE OPBRENGST ZEEWIER

This project brings together the several Dutch institutions and SMEs to develop new and sustainable biorefining concepts for the production of seaweed and high-value seaweed-derived products in the region of North Holland. The lab will be used to produce samples to perform realistic product tests by our collaborators.

PARTNERS

We have strong collaborations with institutes and companies in academic, research and industrial sectors of the Netherlands and Europe, including Stichting Noordzeeboerderij, Wageningen University & Research, Deltares, the Maritime Research Institute of the Netherlands (MARIN), the Royal Netherlands Institute for Sea Research (NIOZ), SIOEN Industries, and Avantium.

DEDICATED TO YOUR SUCCESS

We dedicate our expertise and experience to the improvement and optimization of our client's seaweed process development. Please contact us to discuss your scale-up and sample needs.

TAKING SEAWEED APPLICATION TO THE NEXT LEVEL

Research lies at the heart of our organization. We dedicate a vast amount of time and resources to extending our knowledge, understanding and development of seaweed applications on an international level. We can collaborate with you in tailor made development arrangements.

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