

Introduction to CyberColloids' seaweed focused research

January 2019



- We have worked with seaweed derived ingredients for many years.
- As experts in the hydrocolloids world – routinely working with agar, carrageenan and alginate.
- Combined experience spans the entire value chain from raw material to end use.
- Hydrocolloids industry traditionally wasteful - based on mass extraction of one component.
- We realise that seaweeds have far more to offer than just the hydrocolloid components.
- In 2005 started to look at seaweeds differently.



- Through Irish national funding and EU funded FP7 projects we have built a knowledge platform on:
 - nutritional benefits of edible seaweeds;
 - bioactives from edible seaweeds;
 - different processing approaches;
 - market for seaweed derived functional foods;
 - application in food and drink products.
- Overall aims to:
 - maximise the use of the whole biomass;
 - multi-stream processing;
 - improved palatability/inclusion for ingredient development.



- Early projects focussed on developing a better understanding of the potential use of seaweed ingredients for health & nutrition.
- In particular issues re. use of edible seaweeds & seaweed derived ingredients :
 - industry & consumer perception;
 - fundamental requirement of palatability (taste);
 - how processing can affect/modify palatability;
 - commercially sustainable sources;
 - regulatory restrictions re. processing – use of kitchen science and approved food use processes.



Our research

- See <http://cybercolloids.net/services/research-innovation> for details.
- InterTrade Ireland funded project (2005/7): investigating the nutritional potential of edible seaweeds for the development of ingredients for functional foods.
- Irish Marine Institute Industry Led Award (2008/9): investigating the flavouring and taste components of Irish seaweeds for use in reduced salt products.
- InterTrade Ireland funded project (2010/11): developing extraction and characterisation techniques for the production of seaweed extracts with anti-cancer potential.



Collaborative European research

The SWAFAX Project



Hebridean Seaweed Co., Scotland.
The largest seaweed processor in UK, manufacturing products for animal feed, soil enhancement and nutraceuticals.
www.hebrideanseafood.co.uk



Marigot Ltd., Ireland.

Specialists in the development and manufacture of human supplements and animal feed based on calcareous marine algae.



Mesosystems S.A., Portugal.

Market leaders in the manufacture of high quality products and equipments for medical cosmetics, beauty and health & wellness.

www.mesosystems.com

The HYFFI Project



Colloid derivatives as functional food ingredients

The HYFFI project was to provide the SME partners with knowledge and capacity to produce alginate and agar LMWP (low molecular weight polysaccharide) fractions from *Ascophyllum nodosum* seaweeds and also from commercially available alginates and agar. The project also aimed to exploit the valuable prebiotic activity, and to exploit the

commercial interest in health & nutrition, and three RTD (Research Technological Development) projects in health & nutrition research and biopolymer & food packaging.

The project was led by Mesosystems S.A. and involved the development of two novel processes for the manufacture of high quality products and equipments for medical cosmetics, beauty and health & wellness. The project was also responsible for the development of two novel processes for the manufacture of high quality products and equipments for medical cosmetics, beauty and health & wellness. The project was also responsible for the development of two novel processes for the manufacture of high quality products and equipments for medical cosmetics, beauty and health & wellness.

SEAREFINERY

The Seaweed Biorefinery - for high value added products
www.searefinery.eu



The overall aim of Searefinery is to develop and test an innovative biorefinery approach for seaweed exploitation in Northern Europe, led by industrial key players and specifically aimed at producing alginate, bioactive molecules for nutraceuticals, functional foods, cosmetics, pharmaceuticals and biobased materials.

Searefinery will develop eco-friendly chemical and enzymatic processing technologies to extract and purify high value-added components such as antioxidants, antimicrobial components and hydrocolloids from cultivated seaweed species (including e.g. *Saccharina latissima* and *Alaria esculenta*).

Bioactive compounds such as, e.g. phlorotannins, fucoidan, and laminarin, will be selectively tested for bioactivity. In addition, laminarin and marine proteins will be assessed in nutraceutical and selected food model systems. Alginate will be evaluated as an additive for textile applications via coating and extrusion technologies.

In order to maximise the value of the biorefinery feedstock (input) and derived products (output), monocultures will be grown on innovative textile cultivation substrates with high yield biomass production. Seasonal variation, replicated over two years, of selected biomolecules will be a measuring tool for harvesting the seaweeds with maximum contents of bioactive compounds.

Searefinery is funded under the Marine Biotechnology Era Net by co-funding agencies:



The TASTE Project



Application of edible seaweeds for flavour enhancement and salt reduction

The TASTE project was to develop new and healthy products from edible seaweeds (*Ascophyllum nodosum*, *Saccharina vesiculosa*) using innovative processing solutions and to develop ingredients in a range of salt reduced foods. Thus, offering seaweed salt reduction targets for a group of SMEs in the food industry.

Flavour enhancement and salt reduction are key drivers in the food industry. Seaweed derived flavour is still, widely used in Asian products but its building rapidly. Edible seaweeds components with potential for use in the interest from the TASTE project



CyberColloids have been working with seaweeds and seaweed derived ingredients for many years. The CyberColloids team has expertise that spans the entire seaweed value chain. The company recognises the real potential to develop new and innovative ingredients from edible European seaweeds.

This project received funding from the European Union's Seventh Framework Programme managed by REA - Research Executive Agency FP7/2007-2013



Functional fibres for digestive health



HYFFI Project (2008-2011):

- To produce a range of LMW alginates and agars through controlled depolymerisation.
- To assess and compare the prebiotic potential of these substrates with Inulin – the standard industry prebiotic.

Key findings*:

- No evidence for prebiotic potential *in vivo*.
- Prebiotic potential of LMW *Gelidium* – *in vitro*.
- Increases in SCFA production *in vitro* & *in vivo* – evidence that seaweed derived fibres being fermented.
- LMW alginate had significant effect on post-prandial glucose response.



MARIGOT
IRELAND LTD



This project received funding from the European Seventh Framework Program managed by REA – Research Executive Agency FP/2007-2013

* Ramnani et al 2012

SWAFAX Project (2010-2013):

- Investigated the antioxidant and anti-inflammatory potential of phlorotannin rich extracts from *Ascophyllum nodosum*.

Key objectives:

- to develop methodologies for phlorotannin rich extracts from *Ascophyllum nodosum*;
- to screen these *in vitro* for potential antioxidant and anti-inflammatory benefits;
- to evaluate the bioavailability of the phlorotannins *in vivo*;
- to evaluate antioxidant & anti-inflammatory biological activity *in vivo*.



Key findings *in vivo* bioavailability study*

- A variety of metabolites were detected in the urine and plasma of 15/24 human volunteers after the ingestion of a seaweed.
- First evidence that seaweed derived polyphenols actually metabolised.
- Some metabolism at 0-8hr after ingestion but most at 8-24hr.

Key findings *in vivo* intervention study**

- No significant changes in any of the parameters for the study population as a whole – not really surprising.
- Subset of subjects who were obese (n=36/80) a number of significant differences in antioxidant status after an 8 week intervention.
 - differences in peroxide levels; reduction in basal DNA damage
 - 28% reduction in the acute inflammatory marker CRP – n.s.



The TASTE project (2012-2014):

- Aim to develop new healthy flavour ingredients from edible seaweeds with the potential to replace sodium in food products that traditionally contain high levels of NaCl.
- Focussing on 3 commercial viable species:
 - *Ascophyllum nodosum*;
 - *Fucus vesiculosus*;
 - *Saccharina latissima*.
- Using a combination of physical & enzymatic processing to “unlock” the important flavour components.
 - physical pre-processing to open up seaweed structure;
 - enzymatic hydrolysis using commercially available enzymes and seaweed specific enzymes from partner Prokazyme.



aleor



- Wanted to explore use of whole seaweed;
 - issues with colour, odour and taste;
 - non-specificity of commercial enzymes limited the release of taste enhancing compounds;
 - protein rich extracts – better results but not cost attractive - NaCl extremely cheap ingredient.
- Novel enzyme combination successful.
 - for use on whole seaweed;
 - no odour issues, umami like taste with mouthfeel;
 - limited sensory evaluation;
 - definitely a longer-term commercial opportunity.



- The **SEAREFINERY** project (2015-2018)
- Aim was to develop eco-friendly chemical and enzymatic processing technologies to extract and valorise high value-added components such as antioxidants, antimicrobial components and hydrocolloids from cultivated seaweed species in an integrated biorefinery.
- Utilising cultivated brown seaweed species - *Saccharina latissima* and *Alaria esculenta*.
- CyberColloids mainly responsible for:
 - developing and optimising extraction protocols for antioxidants and alginate;
 - evaluation in different food & cosmetic end products;
 - process scale up.



Key project outcomes:

- Successful cultivation of seaweeds on different growing substrates – ropes, ribbons and nets.
- New techniques and storage bags for ensilage of harvested seaweed.
- New alginate based textiles for industrial use.
- A multi-stream biorefinery concept for the extraction of valuable phlorotannins, laminarin, fucoidan and alginates.
- Successful demonstration of scaled-up biorefinery processes (600 kg).



CyberColloids' key achievements.

- New laboratory scale processes for the extraction of alginate from whole seaweed biomass and from biorefinery residues.
- Demonstration of technology transfer to pilot scale.
- New processes to promote gelling functionality of alginate *in situ* – *i.e.* without need for extraction.
- New seaweed fibres for use as texture ingredients (Na alginate replacers) in food and cosmetic applications.



- The hydrocolloids world in which we operate is changing – moving away from the purposeful extraction of ingredients.
- We are changing too – focus on developing new processes that promote the textural functionality of alginate, carrageenan & agar *in situ* – no need for extraction.
- Opportunities to maximise the use of the whole seaweed biomass – less waste, more sustainable.
- Opportunities for new applications in food and cosmetics.
- Opportunities to apply our thinking to different seaweeds.



- As hydrocolloids experts we have a long history of process development and scaled up verification.
- We also work with a team of associates for the design, build and commissioning of new manufacturing units.
- We are now applying this practical thinking to the scaled up production of bioactive extracts from a range of biomasses including seaweed.
- Opportunities to optimise and scale up processes with new partners.
- Opportunities to expand thinking with new biomass streams.



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The SWAFAX Project



Seaweed derived anti-inflammatory agents and antioxidants

Seaweed contains a wide range of bioactive compounds, including polyphenols, with potential antioxidant and anti-inflammatory activity. Although polyphenols from land plants are widely used as functional food ingredients and food supplements, seaweed sources have been little studied and exploited. The current project was therefore designed to address this commercial opportunity to obtain bioactive polyphenols from seaweeds for application in food and health & wellness products. The consortium comprised 5 SME partners from the seaweed and health & wellbeing sectors and 3 centres of excellence for health & nutrition research and biopolymer & polysaccharide chemistry.

Brief overview of the project

During the initial stages of the project seaweed polyphenol extracts (SPEs) were prepared from a range of European seaweeds including the brown seaweed *Acroplythum nodosum*. The antioxidant and anti-inflammatory activities of these extracts were then investigated in vitro in humans in (i) a short-term dietary intervention that addressed bioavailability and metabolism and (ii) a 24-week dietary intervention study. The end points of which included prevention of oxidative DNA damage in lymphocytes and modulation of anti-inflammatory and pro-inflammatory cytokines in plasma.

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Role in the project

Market leaders in the development of two novel processes for the production of high and low molecular weight alginate and agar LMWV products were identified. The processes were then investigated in vitro in humans in (i) a short-term dietary intervention that addressed bioavailability and metabolism and (ii) a 24-week dietary intervention study. The end points of which included prevention of oxidative DNA damage in lymphocytes and modulation of anti-inflammatory and pro-inflammatory cytokines in plasma.

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For more information about our research activities see www.cybercolloids.net or contact Ross, Angie or Sarah@cybercolloids.net