The HYFFI Project

Hydrocolloid derivatives as functional food ingredients

The overall aim of the HYFFI project was to provide the SME partners with information, knowledge and capacity to produce alginate and agar LMWP (low molecular weight polysaccharide) fractions from *Ascophyllum nodosum* and *Gelidium* spp. seaweeds and also from commercially available alginates and agar powders, with valuable prebiotic activity, and to exploit the commercial possibilities of these extracts.

The consortium was made up of three SMEs from the European seaweed industry, all with a commercial interest in health & nutrition, and three RTD centres of excellence for health & nutrition research and biopolymer & polysaccharide chemistry.

CyberColloids' role in the project

CyberColloids were responsible for the development of two novel processes for the depolymerisation of the agar and alginates, either from powders or *in situ* within the seaweed matrix. Methods utilising mild hydrolysis with food grade acids or depolymerisation with hydrogen peroxide were applied. 19 novel LMWPs were produced.

CyberColloids were also responsible for the scaled up production of two candidate LMWPs and formulation of a drink for delivery of these to the intervention volunteers.

Industrias Roko SA, Spain

The largest agar manufacture in Europe, producing agar for food, technical & microbiological applications.

www.rokoagar.com

Hebridean Seaweed Co., Scotland.

The largest seaweed processor in UK, manufacturing seaweed products for animal feed, soil enhancement and nutraceutical sectors.

www.hebrideanseaweed.co.uk

Marigot Ltd., Ireland.

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

www.aquamin.com

Key project findings

The methods developed to depolymerise the agar and alginate were successful for both powdered extracts and for whole seaweed. The MW of agar and alginate was reduced sufficiently to enable a meaningful dose (8g) to be delivered in formulation for the intervention study without any issues with viscosity. Some LMWPs however, were highly coloured and had off tastes.

***Ascophyllum* seaweed being processed**

The 19 LMWPs were screened *in vitro* in batch culture for prebiotic potential. Fermentation properties in particular and changes in microbiota indicated that several of the LMWPs had prebiotic potential. As far as we are aware this is the first study where batch culture fermentation has been used to study the effects of seaweed extracts on modulation of gut microbiota.

Two LMWPs, one agar- and one alginate derived, were selected for further investigation in an *in vitro* gut model system (three-stage continuous culture system) and in a human intervention study. This selection was based on over riding technological and organoleptic criteria.

Further investigation (Ramnani *et al* 2011) revealed that other LMWPs showed greater prebiotic potential but these could not be tested within the framework of the project.

A LMWP derived from *Gelidium* seaweed in particular exhibited potential to be used as a prebiotic with significant increases in bifidobacterial populations and concomitant increase in acetate and propionate.

In the gut model and human studies, only small changes in gut microflora profile were seen with both LMWP products. In some cases changes were observed in bacterial groups with potentially beneficial effects, e.g. the increase in *Faecalibacterium prausnitzii* associated with agar intake in the human volunteer study. Unlike in the batch culture studies, only small changes in short chain fatty acid (SCFA) profile were seen which probably reflect the minor changes in gut bacterial numbers.

Although statistically significant, these results are unlikely to be of biological importance due to the small magnitude of the changes and therefore the conclusion is that the two agar and alginate LMWPs had no prebiotic effects in human volunteers. However, this is the first study of its kind and more detailed studies on the fermentability of the LMWPs need to be carried out using the three-stage continuous culture system to simulate conditions that prevail in the large intestine.

Gelidium sequipidale

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

There did not seem to be a correlation between molecular weight and prebiotic properties of seaweed extracts that were investigated. However, relatively little is still known about the fermentation characteristics of seaweed derived polysaccharides and any oligosaccharides that may have been generated during depolymerisation, or indeed of the potential interplay between different bacterial groups in the colonic ecosystem. This area warrants further investigation.

The intervention study did however show that there were potentially beneficial changes in gut function characteristic of dietary fibre in the volunteers consuming the agar or alginate LMWP derivatives. During consumption of the LMWPs there were significant increases in stool weight by comparison with the placebo group and the agar LMWP reduced faecal pH.

Furthermore, post prandial glucose absorption was decreased in subjects consuming modest amounts (8g/day) of alginate LMWP. Such effects indicate that despite the considerable reduction in molecular weight of the polysaccharides and the associated decrease in viscosity, fibre-related properties in the gut were maintained.

Ascophyllum nodosum

Potential for future research

This study represents one of very few that have addressed the fermentation characteristics of seaweed derived polysaccharides and even fewer that have evaluated the potential health benefits of seaweed derived ingredients in an intervention study using human volunteers. There is much scope to further and expand the work started here in the area of prebiotic potential and gut function and also in the area of glycemic modulation.

For more detail see:

Ramnani, P., Chitarrari, R., Tuohy, K., Grant, J., Hotchkiss, S., Philp, K., Campbell, R., Gill, C., Rowland, I. (2012). "In vitro fermentation and prebiotic potential of novel low molecular weight polysaccharides derived from agar and alginate seaweeds", Anaerobe, Feb;18(1):1-6.

CyberColloids Ltd., Ireland.
Private R&D company, experts in polysaccharide and hydrocolloid chemistry and developing novel processing methodology for seaweed and other polysaccharide rich biomasses.

www.cybercolloids.net

NICHE, University of Ulster, N. Ireland.
N.I. Centre for Food & Health, pre-eminent university department in the UK and Ireland in the area of nutrition and health, specific expertise in conducting human intervention studies.

www.ulster.ac.uk

University of Reading, UK
Department for Food & Nutritional Science. Internationally recognised centre of excellence specialising in research on role of dietary components on human health and risk of chronic disease.

www.reading.ac.uk/food