Medicinal uses of seaweeds

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Introduction

The medicinal use of seaweeds has a long tradition in Asia. But also in Europe seaweeds have been used already by the ancient Romans to treat wounds and burns. Seaweeds represent a promising source of novel bioactive compounds with health-promoting properties which cannot be found in terrestrial plants. Some seaweed compounds, such as alginate, are already used regularly in the medicinal field as binding agents, carrier material of medical tablets or wound dressings. Besides this, there is strong evidence that seaweed compounds can also have direct health promoting effects. But although these effects have been addressed in numerous in vitro and in vivo animal studies, studies on humans are still scarce.
This factsheet gives a selective overview on the proposed applications of seaweeds and seaweed compounds for medicinal purposes with a focus on species from the North Sea, but should not be taken as a medical advice.

Prevention of cardiovascular and metabolic diseases

- Cardiovascular diseases (CVD)

Cardiovascular diseases are disorders of the heart and blood vessels. According to the World Health Organization, they are the leading cause of mortality and contribute to 30% of all deaths worldwide. Due to their high content of dietary fiber, seaweeds have been suggested as a food source that could aid the prevention of CVD. In animal studies it was shown that the uptake of *Ulva*, *Porphyra tenera* and *Laminaria digitata* had a positive impact on cholesterol levels and the lipid composition of rats. The carotenoid fucoxanthin, which is found in brown seaweeds, also contributed to the reduction of blood pressure and stroke risk factors. In human patients, the intake of a daily dose of alginate - a polysaccharide found in brown algae such as *Saccharina latissima* or *Undaria pinnatifida* - has limited the uptake of glucose and cholesterol by the test persons and could consequently be of use in the prevention of CVD.
Seaweeds also provide a vegan alternative to fish consumption as they are rich in omega 3 polyunsaturated fatty acids that have a positive effect on blood pressure and triglyceride levels.

- Type 2 diabetes

Type 2 diabetes is a chronic metabolic disease resulting from an inefficient use of insulin. Studies on diabetic patients have demonstrated beneficial effects of seaweed fiber, such as alginate (brown seaweeds), agar or carrageenan (red seaweeds), on several markers of diabetes (blood glucose, lipids and the body mass index). Furthermore, insulin levels after carbohydrate-rich meals were more balanced when accompanied by an ingestion of extracts from the brown seaweeds *Fucus* sp. and *Ascophyllum nodosum*.

- Obesity

Obesity has become one of the world's most serious public health problems. Consumption of dietary fiber can facilitate weight loss by enhancing the feeling of satiety. Seaweed fiber is well-suited for this purpose and its weight loss support has been proven in several clinical studies. For instance, consumption of *A. nodosum* enriched bread reduced the total energy uptake of the study objects significantly. Furthermore, in a 12 week trial period, the intake of alginate led not only to a significant weight loss in overweight and obese test persons but also to long-term changes in their fat mass.

Antimicrobial properties of seaweeds

Microorganisms are the causative agents for various types of infectious diseases. The invention of antibiotics in the early 20th century has improved human health conditions significantly, but an overuse of antibiotics has resulted in the development of drug resistant strains. Therefore, novel bioactive compounds are needed. Since seaweeds contain a high number of potential novel therapeutic agents which show antimicrobial effects on a range of bacteria, they could play a crucial role in the treatment of bacterial diseases in the future. However, clinical studies are necessary. So far, the majority of reports on the antimicrobial properties of seaweed is based on in vitro experiments where a large number of seaweed compounds have been identified as highly effective against microbial growth, including compounds from *Ulva*, *Saccharina* and *C. crispus*.

Active compound	Source	Application
Alginate	Brown seaweeds, e.g. *L. digitata*, *S. latissima, U. pinnatifida*	Prevention of CVD, obesity and diabetes
Carrageenan	Red seaweeds, e.g. *Chondrus crispus*	Prevention of CVD, obesity and diabetes, treatment of viral infections
Fucoidan	Brown seaweeds, e.g. *L. digitata*, *S. latissima, U. pinnatifida*	Cancer prevention, treatment of viral infections
Fucoxanthin	Brown seaweeds, e.g. *L. digitata*, *S. latissima, U. pinnatifida*	Cancer prevention
Kainic acid	Red seaweeds, e.g. *P. palmata*	Treatment of worm infections
Sesquiterpenes, phlorotannins, lectins, halogenated compounds	Various seaweed species	Treatment of bacterial infections

Seaweeds may not only be effective against bacteria, but also against viruses. In vitro and animal studies have demonstrated antiviral activity of seaweed compounds against enveloped viruses, such as herpes simplex virus type 1 and 2 and HIV. Furthermore, carrageenan has a longstanding role in traditional medicine as a cure for coughs and the common cold. Its antiviral activity against human rhinovirus has also been proven experimentally.

Cancer prevention

It has long been postulated that seaweed consumption has cancer-preventive effects. This theory is mainly based on epidemiological observations which show lower cancer incidence in populations who consume seaweed rich diets than in populations with Western diets. Additionally, anticancer properties of seaweed and seaweed components have also been demonstrated by in vitro and in vivo studies. The brown seaweed *U. pinnatifida* showed antitumor activity in breast cancer cells. Furthermore, consumption of the red seaweed *Porphyra* has been linked to preventive effects against breast cancer in postmenopausal women. Although the bioactive compounds were not identified in a majority of the studies, several compounds were suggested as potential antitumor agents (see table).

Seaweeds for bone health

Osteoporosis is a degenerative disease defined by reduced bone mass and micro-architectural deterioration of the bones. Dietary modifications, in particular an increased uptake of calcium-rich food, can help to promote the maintenance of bone health. Since the calcium content of *A. nodosum*, *L. digitata* and *Ulva* is at least twice as high as in milk, they could play a role in the prevention of bone diseases.

Prevention of neurological disorders

A potential role of seaweeds has also been proposed regarding the treatment of Alzheimer's disease (AD), a chronic neurodegenerative disease. The plaque accumulation of amyloid beta (A_β) protein on the neurons is considered to play a crucial role in the pathogenesis of AD. Therefore, decreasing A_β production at an early stage of AD could be a promising strategy to slow down the progression of the disease. In vitro studies have documented a potential role for seaweeds in impairing amyloid beta plaque formation, including species of the genera *Saccharina*, *Alaria* and *Chondrus*.

Animal in vivo studies also suggest potential effects of seaweeds against other neurological disorders, such as Parkinson's disease, epilepsy and depression.

Seaweeds as vermifuges

Another medical application of seaweeds is the treatment of worm infections. Several red seaweeds, for instance *Palmaria palmata*, contain kainic acid, a substance that causes a muscular block in the parasitic nematode *Ascaris*. The worm cannot maintain its position against the peristaltic movements in the intestine and is removed from the patient with defecation.

Conclusion

Although the research on bioactive, health promoting compounds of seaweeds is emerging, clinical studies are still lacking in terms of quantity and quality. Furthermore, in many cases where positive effects of seaweeds or seaweed extracts have been demonstrated, the active compounds could not be identified reliably. Thus, more research on this topic is needed. However, the vast number of in vitro and in vivo animal studies indicates a high potential for pharmaceutical applications of seaweed compounds. It also needs to be considered that seaweeds can accumulate pollutants or unhealthy compounds from the environment. The origin and quality of seaweed biomass for medical applications is therefore of crucial importance and the consumption should follow recommended guidelines. As the Dutch seaweed industry is increasing, health-promoting compounds could provide a high-value market for seaweed biomass.

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Main sources:
Deleris et al. (*2016*). Seaweeds in human health in: Seaweed in Health and Disease Prevention. doi: 10.1016/B978-0-12-802772-1.00010-5
Brown et al. (*2014*). Seaweed and human health. Nutrition reviews 72(3): 205-216.