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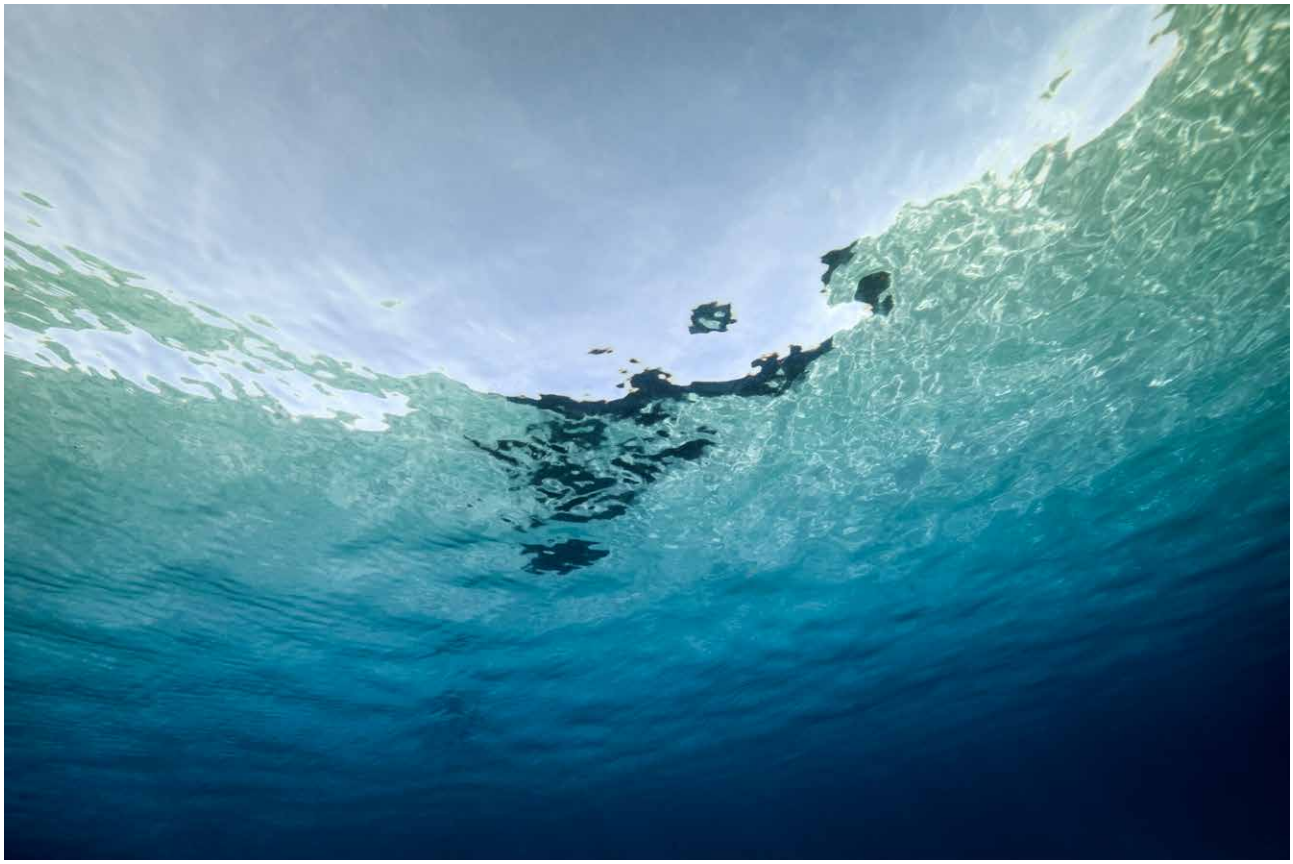
Fucoidans, which occur naturally in seaweeds, have previously been shown to have a range of possible clinical applications. In a review study, **Dr Helen Fitton** and her team from the biotechnology company, Marinova, discuss the breadth and depth of new fucoidan research – from their potential use in cancer treatment, to their possible effects on microbiome. Finally, they cover new techniques for the measurement, production and delivery of fucoidans, which are supporting the transition from research to clinical application.

Fucoidans are long chains of carbohydrate molecules, which occur naturally in the cell walls of seaweeds. They function to protect the plant from pathogens and other environmental challenges. A large body of research now exists to suggest that fucoidans could also have widespread application for human health. Indeed, their therapeutic benefits are now documented in the areas of gut and digestive health, immune modulation, integrative oncology, inflammation, viral inhibition and anti-ageing. In their latest paper, entitled 'Therapies from Fucoidan: New Developments', Dr Helen Fitton and her team from the Australian biotechnology company, Marinova, provide an update on the analysis, regulatory status and current clinical usage of these natural compounds.

One of the main factors limiting the study of fucoidans has been technical challenges involved in measuring their levels in biological tissues and fluids. In their paper, Dr Fitton and her team describe recent developments in measurement techniques, which have helped researchers to accurately measure fucoidans in the human body. These advancements have led to a better understanding of how these substances enter the bloodstream when ingested. Studies exploring the effectiveness of orally-delivered fucoidan for chronic renal failure have given much greater clarity over the compounds absorption into the bloodstream. This will be valuable in guiding the next stages of potential clinical use.

The use of fucoidans for treating kidney disease is just one of a wide range of potential medical benefits discussed in Dr Fitton's paper. Her team also recognises the first clinical trials on the intravenous delivery of fucoidan as an imaging agent. This particular fucoidan has a compound attached to it that emits radiation, allowing it to be used to detect and image blood clots in heart tissue.

Fucoidans also show potential in preventing scarring that can cause tissues and organs to stick together after surgery – an area that Dr Fitton and her team describe as an unmet clinical need.



In recent years, there has been a multitude of studies exploring the connection between human health and the microbiome, which describes the collection of microbes that live on and inside the body. Dr Fitton and her team describe a range of recent studies showing that oral, digestive and skin microbiomes can all be improved by the presence of fucoidans.

In one such study, the microbiome in a breast cancer-bearing rat model was favourably impacted by fucoidan intake. Harmful oral bacteria have also been shown to be reduced by fucoidans at low concentrations, indicating promise for their inclusion in dental products.

Other studies have shown that gastric damage can be reduced by ingesting fucoidans. Another new development indicates that these compounds can inactivate the highly infectious norovirus, for which there are currently no effective treatments. Fucoidans therefore appear to have potential for enhancing the microbiome and suppressing infectious pathogens. Dr Fitton suggests that much of the biological activity ascribed to fucoidans may be due to their effects on the microbiome and reducing inflammation throughout the digestive system.

Such modulation of immune activity by fucoidans, not only as anti-inflammatory agents but also as an addition to vaccines, could be highly promising. Dr Fitton and her team refer to a study involving elderly people, where ingesting a fucoidan extract enhanced their immune response to the flu vaccination.

This immune-modulatory effect may also represent an additional anticancer mechanism for fucoidans. Indeed, they could have a range of potential uses in oncology, as they appear to act both directly on tumour cells and indirectly, by potentially preventing the spread of cancer cells from one area of the body to another.

Other vastly different, but important, emerging areas of research include the potential of fucoidans in treating eye diseases and for improving taste sensitivity in diabetics. Further avenues explore their use as neuroprotective agents, with various studies on Parkinson's disease showing encouraging data. While the mechanism behind these results is unclear, recent work investigating connections between the microbiome and neurological conditions again points to a potential interaction with microbes in the human gut.

As well as potential direct benefits for the treatment of an array of health conditions, Dr Fitton and her team also describe an equally rich variety of new literature in the area of drug delivery. For example, studies have found that fucoidans could be used to develop wound dressings that allow drugs to penetrate through to the wound site, aiding the healing process. Another drug delivery system involving fucoidans has been used to deliver the anticancer drug, methotrexate. Fucoidans on a range of surfaces have also assisted in bone regeneration, while fucoidans on steel surfaces have been shown to inhibit infectious agents. This new approach may have potential for coating surgical instruments and implantable devices.

From treating cancer to managing diabetes, and from detecting blood clots to improving vaccines, it's clear from this global review that fucoidans show great promise across a wide range of clinical areas. Fucoidans continue to be developed as oral supplements and will likely increase their market presence in the future. Fucoidan extracts are already partly commercialised for use in humans and animals for gut health, oral health and anti-inflammatory applications. The recent suite of regulatory approvals for fucoidan extracts in the US, EU, Australia and Canada is likely to spur further growth in these markets.

Measuring fucoidans during extraction processes, and in biological tissues and fluids, remains technically challenging. These technical challenges have resulted in some preparations sold commercially for use in food and supplements not containing fucoidan as stated. This indicates a need to verify provenance and identity of fucoidan ingredients.

Fucoidans have enormous potential as part of drug delivery systems and devices, and show particular near-market potential in imaging and in treatments for blood clots. Oral therapies for neurological disease, bacterial and viral infections, and cancer treatment also appear to be commercial possibilities with research now progressing to the clinical trial phase.

This review demonstrates that the increasing body of research across a wide range of clinical areas, coupled with new methods of measurement and delivery, is enabling the application of fucoidans to move from theory to reality. However, we may only just be starting to recognise the full potential of fucoidans for human health.

This is a summary of the paper 'Therapies from Fucoidan: New Developments', from *Marine Drugs, an MDPI journal.*

http://dx.doi.org/10.3390/md17100571

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