

Reinforcing natural defences and performance with algae

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Algae: a source of biological treasures

Macroalgae, or seaweeds, are eukaryotic and pluricellular organisms, divided into three different groups: green, red and brown. Detailed screening of macroalgae functions revealed new ranges of biological activities including anticoagulant, antiviral and antibacterial, anti-tumoral, anti-proliferative and immunomodulatory activities. All of them could be of relevance in nutraceutical functional food. Indeed, green, brown and red macroalgae cell walls contain large amounts of sulphated polysaccharides, named respectively ulvans, fucoidans and carrageenans, ranging from 4 up to 76% of seaweed dry weight. The high content of these sulphated polysaccharides, their unusual structure, and their biological properties shed a new light on these compounds as promising natural products for medicinal and dietary applications. The specificity of marine sulphated polysaccharides is in the complexity of their structure. Indeed, they are mainly branched polysaccharides, in contrast with linear polysaccharides like cellulose which contain only one type of linkage between sugars. Also, they are composed of various and some rare sugar units (xylose, rhamnose), unlike homopolysaccharides, such as starch, which are exclusively composed of glucose units. Finally, these sugars can be sulphated, conferring them a special reactivity. All of these parameters show a phylogenetic similarity with polysaccharides from the animal kingdom (GAGs – glucosaminoglycans) such as heparin, known for its numerous biological properties, thus explaining their unique activities. Sulphated polysaccharides reactivity, hence their biological properties, varies a lot according to the type of sugars and linkage they contain, their level of sulphation and also their molecular weight. Therefore, several macroalgal sulphated polysaccharides with distinct biological activities can be found in macroalgae. It is important to note that sulphated polysaccharides are specific macroalgae (they are not found in terrestrial plants, microalgae or yeast cells walls) as the marine environment is the only one where sulphur in a proper chemical form is abundant enough to be integrated in the structure of organisms. Then, the key is to be able to selectively extract them to ensure a targeted effect on animals.

ALGIMUN: unique technology and formulation

Olmix has been studying marine biotechnologies for more than 20 years and has focused in the past 10 years on the extraction and use of specific sulphated polysaccharides (Olmix MSP®) extracted from macroalgae to meet the challenges faced by animal production. This has led to the development of an in-feed product, ALGIMUN®, which is based on the combination of two biologically active macroalgal extracts: MSP®IMMUNITY which constitutes an innovative modulating agent that reinforces innate and adaptive immune responses and MSP®BARRIER which enhances the barrier function of the intestinal mucosa. Improving intestinal health and immunity is paramount to ensure that animals are efficient in the use of feed. Providing animals with good intestinal integrity will have a positive impact on



the immune status and overall technical performance. ALGIMUN's potential and reliability has been thoroughly tested in research stations and in the field. It can be used during the whole cycle. To make the most of ALGIMUN's benefits, it has to be used in starter and grower phases or during high production or stress phases.

Supporting gut health with seaweed extracts: a targeted approach

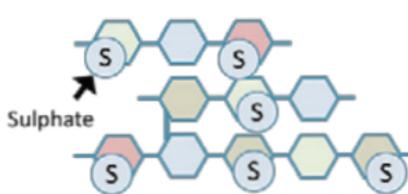
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The intestinal mucosa converges various functions: digestion and absorption of nutrients; it constitutes a physical barrier against microbes and toxins and a host to both gut microbiota and immune cells. The challenge is to find solutions capable of supporting the epithelial barrier function and the gut-associated lymphoid tissue in order to maintain a proper gut health to ensure good performance without the need for antibiotics.

ALGIMUN®: dedicated action to support gut health

Macroalgae polysaccharides present a complex structure and unique composition that explains their various biological activities towards animals, plants and humans. Identifying which types of polysaccharides are responsible for a given biological activity in view of extracting them (Olmix MSP) and using them to support gut health has been at the core of Olmix Group research and development activities for the past 10 years.



Branched sulphated heteropolysaccharides from macroalgae

MSP®_{IMMUNITY}

Extracted from the green algae *Ulva* sp, MSP_{IMMUNITY} was identified as an immune modulator. A research project in collaboration with INRA (France) led to the demonstration of its effect on immune mediators in cellular models, including the identification of the metabolic pathways involved in this activation. Berri et al. (2016) first highlighted that MSP_{IMMUNITY} could stimulate the gene expression of several immune mediators (cytokines and chemokines). Among others, the extract was shown to upregulate the expression of TNF α , involved in the innate immune response, CCL20 and IL-1 α , working on the adaptive immune response, and PPAR γ which has anti-inflammatory properties. In vivo studies further confirmed that MSP_{IMMUNITY} could support the development of the adaptive immune response in broilers (decreased heterophil to lymphocyte ratio) and higher production of immunoglobulins (IgA).

MSP®_{BARRIER}

Olmix Group also identified some extracts of interest targeting gut barrier function. A set of experiments was implemented with IBD in Lille (France) to define if the identified extracts would trigger the production of mucins and improve tight junction protein expression, using in vitro models (mucus-secreting HT-29 MTX cells for mucin evaluation and enterocyte-like Caco-2 cells for tight junction evaluation). Results showed that MSP_{BARRIER} (from *Solieria chordalis*) induced the expression of both mucins and tight junctions.



MSP_{IMMUNITY} and MSP_{BARRIER} are used in combination with Algimun, an in-feed solution to strengthen both the intestinal barrier and animal defences, all along their cycle, particularly in the early stages when they are the most sensitive.