Optimising pig gut health with macroalgal extracts

The intestinal mucosa converges various functions: digestion and absorption of nutrients; as well as a physical barrier against microbes and toxins thanks to the presence of a protective mucus layer and tight junction proteins that seal the paracellular space. The intestinal mucosa hosts both gut microbiota and immune cells (70% of the total number of immune cells are residents of the gut mucosa and gut-associated lymphoid tissue).

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In modern production systems, the gastrointestinal tract is being challenged and the subtle balance gut health relies on can be impaired. The components that define gut barrier and immune function can be weakened and lead to higher occurrence of digestive troubles associated with dysbiosis.

This imbalance will trigger local and systemic inflammation, affecting the global health status and the growth performance of the animals.

The challenge in the industry is to find solutions capable of supporting the epithelial barrier function and the gut-associated lymphoid tissue (GALT) in order to maintain proper gut health and thus ensure good performance without the need for antibiotics.

Unique structural features of marine macroalgal polysaccharides

Parietal polysaccharides of seaweeds present structural complexity and a unique composition that confer them high reactivity and explain their biological properties when used in animals.

The complexity and biological reactivity of seaweed polysaccharides derive from the nature of the sugar units, which are diverse and sometimes rare, such as uronic acids, xylose and rhamnose; the variety of glycosidic bonds leading to their branched structure and the presence of sulphate groups (Fig. 1).

Furthermore, their polyanionic structure and solubility increases their reactivity and facilitates their recognition by host cells. Sulphated polysaccharides are characteristic of macroalgae (they are not found in terrestrial plants, nor freshwater microalgae or yeast cell walls).

Olmix Group marine bioactive ingredient extraction know-how has led to the development of an in-feed product, Algimun, which is based on the combination of two bioactive macroalgal extracts: MSP BARRIER, a red algal extract, which enhances the gut barrier function; and MSP IMMUNITY, a green algal extract, that modulates innate and adaptive immune responses. Algimun bioactive molecules proved to be resistant to feed processing, especially to heat treatment and extrusion.

Gut health promoting properties of macroalgal extracts

Recent research has shown, in vitro, that MSP BARRIER upregulates the expression of tight junction and mucin-related proteins which are essential for the proper functioning of the intestinal epithelial barrier. MSP BARRIER has proven to upregulate the expression of genes that determine transmembrane (CLND-2) and scaffolding (ZO-1) protein synthesis which are essential for optimal functioning of the tight junction complexes.

Moreover, MSP BARRIER upregulates the expression of genes that are necessary for the establishment of the mucus layer (MUC-2 and MUC-4) and the prevention of pathogen colonisation.

MSP BARRIER strengthens gut integrity as observed

by an increase in trans-epithelial electrical resistance (TEER) in differentiated and polarised intestinal porcine epithelial cells (IPEC-1) isolated from the intestine of newborn piglets when incubated with the enterotoxigenic strain Escherichia coli K88 1305.

Results showed that when the IPEC cell line was in contact with MSP BARRIER in addition to the E. coli K88 1305, TEER was maintained at a higher level than in the positive control in the first 10 hours post-infection. This indicates that MSP BARRIER preserves the epithelium integrity and barrier function in the first 10 hours post-infection.

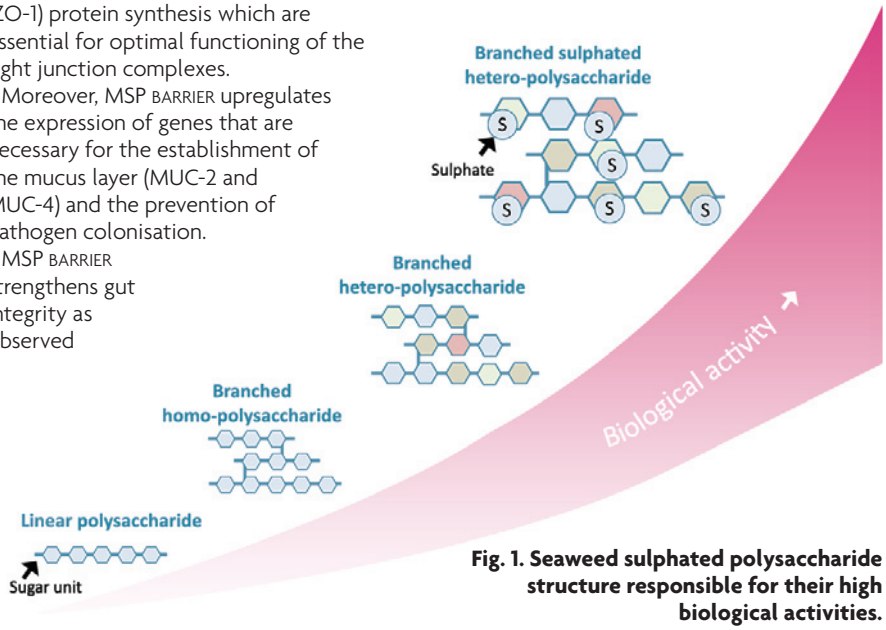

Fig. 1. Seaweed sulphated polysaccharide structure responsible for their high biological activities.

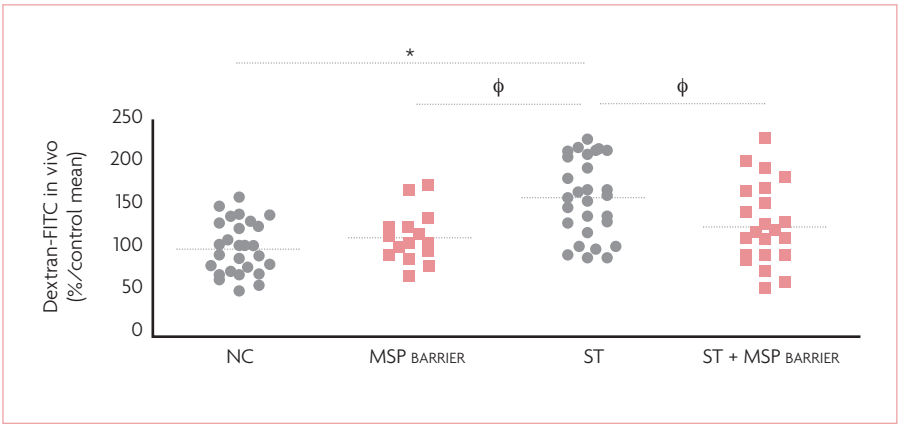

Fig. 2. Evaluation of the intestinal paracellular permeability in vivo (FITC-dextran levels in blood) (INSERM, 2018). NC: Negative control (without stress), MSP BARRIER: without stress, ST: Positive control (with stress), ST+MSP BARRIER: Test group (MSP BARRIER with stress). Bonferroni test P<0.001*; Mann and Whitney test p=0.0036.

Gut integrity promotion bioactivities of MSP BARRIER were corroborated in an in vivo scientific study. MSP BARRIER reduced the paracellular passage of FITC-dextran (gut permeability biomarker) to the bloodstream in an animal model known to induce specific stress leading to a strong proinflammatory response in the gut epithelium and consequently a higher degree of permeability (Fig. 2).

MSP BARRIER supplementation reinforced the intestinal barrier function of the gut epithelium which is the frontline of the innate immune defence against pathogens and toxins (significant reduction of the passage of the marker).

A research project in collaboration with INRA (France) led to the demonstration of the modulating bioactivities of MSP IMMUNITY in terms of immune mediators' expression in an in vitro model (IPEC-1 cell line), including the identification of the metabolic pathways involved in this activation.

Berri et al. (2016) first highlighted that MSP IMMUNITY could positively influence the gene transcription of a broad array of immune mediators involved in defence mechanisms within the innate and the adaptive immune response, among others, the recruitment and activation of phagocytic and antigen-presenting cells, the differentiation and proliferation of B and T lymphocytes, while inducing immune tolerance thanks to its anti-inflammatory properties.

In vivo scientific studies further confirmed the immunomodulating properties of MSP IMMUNITY in swine, namely by favouring the immune transfer through colostrum and milk from sows to piglets.

Effect on intestinal health and technical performance

Supporting the integrity of the intestinal mucosa and modulating the immune system is essential to ensure gut health in piglets during the transition period. In commercial conditions, Algimun use during the transition period in piglets at an inclusion rate of 2kg/ton of feed in the pre-starter period (from day 21 until day 35) and 1.5kg/ton of feed in the starter period (from day 35 until day 64) respectively resulted in a lower inflammatory status (-16% haptoglobin level), a significantly lower percentage of animals needing a veterinary treatment (-57%, P<0.01) and improved growth performance (+300g at the end of the trial) when compared to the control group.

Algimun use renders a high profitability with a return on investment of 3:1.

The benefits of Algimun inclusion in sow's lactating feed (from seven days prior to farrow to weaning day) can be observed in the health status of sows (+25% of IgG levels in colostrum when compared to control animals) and in the suckling piglets.

Litters from sows supplemented with Algimun needed fewer veterinary treatments related to enteric disturbances (-25%, P<0.01) and presented higher body weight at weaning when compared to piglets from control sows (+360g, P=0.056) and better ADG (+18g/day, P<0.05).

Thus, sows supplemented with Algimun presented a higher immune status that favourably affected the health and technical results of their litters, generating a 10% higher net benefit (+€7.75/sow).

In short, Algimun can be used as a natural alternative in-feed strategy to promote health and growth performance by reinforcing the gut barrier function, supporting the development of the immune system in young animals and during challenges; and increasing the immune transfer from the mother to the progeny.

By doing so, it can play an important role within the reduction of antibiotics and high dosing zinc oxide use in farms. ■

References are available from the author on request