Macroalgal extracts improve dairy cow health status and performance

As demonstrated in many scientific studies, the onset of infectious pathologies during the first weeks of lactation (60-80% of total pathologies in the dairy herd) is linked to immunosuppression derived from nutritional/metabolic stress and hormonal changes that take place around calving.

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The increase in NEFAs during the transition period and the increase in steroid hormones (cortisol) at the time of calving have been correlated with two negative impacts on the immune response. Firstly, a decrease in the defence activities of immune cells and secondly, a reduced ability of immune cells to migrate to infection sites.

The lower feed intake experienced during the dry-off period leads to a higher degree of oxidative status which contributes to immune dysfunction. Indeed, a reduction of 50% in the activity of neutrophils is being confirmed in several studies. The glucose requirements of an exacerbated inflammatory immune response are more than 1kg of glucose within 720 minutes in lactating dairy cows, glucose being the substrate for lactose synthesis.

A compromised barrier function in the gut caused by acidosis and subsequent LPS infiltration, will be followed by a local or systemic inflammatory response and a negative impact on the technical performance.

A decrease in feed intake during heat stress is only responsible for 50% of reduced milk yield, gut barrier function and LPS infiltration will induce an immune response that will consume glucose contributing to the reduction in the milk yield since lactose is the main osmoregulator of milk yield.

It is paramount to support the immune function and gut barrier function during phases in which cows are exposed to high levels of stressors, among others the dry period, early lactation and in heat stress, in order to reduce or prevent the negative consequences in animal welfare, milk yield and fertility.

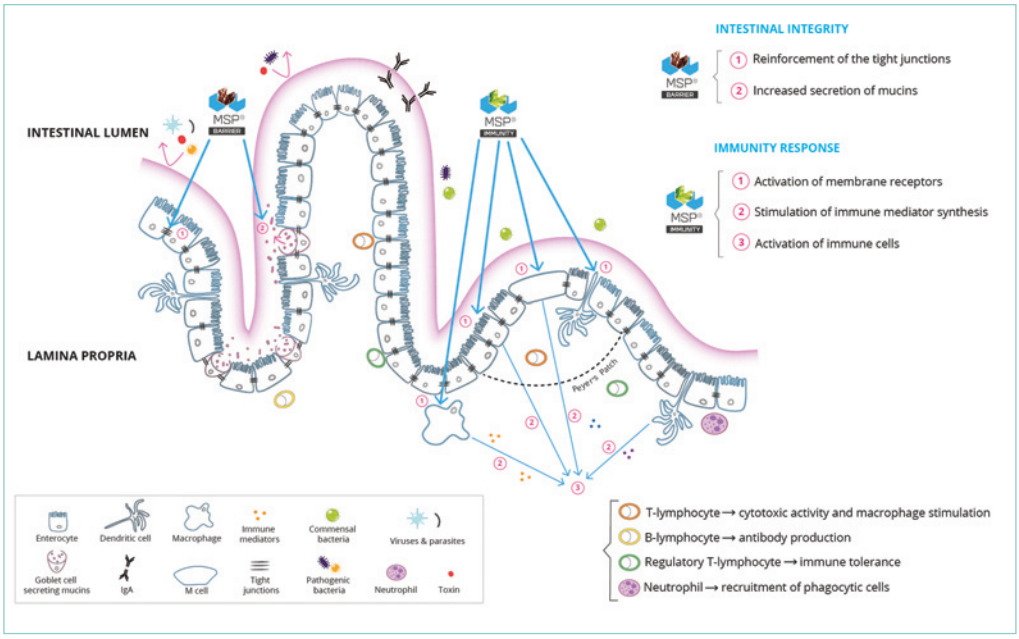

Fig. 1. Mode of action of MSPIMMUNITY and MSPBARRIER.

Unique structural features of marine macroalgal polysaccharides

Parietal polysaccharides of seaweeds present structural complexity and unique composition that make them very reactive and explain their biological activities towards animals. The complexity and reactivity of seaweed polysaccharides derive from the nature of the sugar units, which are diverse and sometimes rare, like uronic acids, xylose and rhamnose, the variety of glycosidic bonds leading to their branched structure and the presence of sulphate groups.

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 fresh water microalgae or yeast cell walls).

Olmix Group, France, has been studying marine biotechnologies for more than 20 years and has focused on the extraction and use of specific macroalgal polysaccharides to support immune and gut barrier functions.

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 biologically active macroalgal extracts: MSPIMMUNITY, a green algal extract that modulates innate and adaptive immune responses; and MSPBARRIER, a red algal extract, which enhances the barrier function of the intestinal mucosa (Fig. 1).

MSPs cannot be digested by enzymes in terrestrial animals (the only organisms that can do so are marine micro-organisms), so Algimun will pass the rumen and act as expected on the intestinal mucosa.

Immunomodulating properties of macroalgal polysaccharides

A research project in collaboration with INRA (France) led to the demonstration of the effect of MSPIMMUNITY on immune mediators' transcription 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 MSPIMMUNITY 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 antigen-presenting cells, the differentiation and proliferation of lymphocytes B and lymphocytes T, while inducing immune tolerance thanks to its anti-inflammatory properties.

In-vivo scientific studies further confirmed the immunomodulating properties of MSPIMMUNITY, namely by improving the defence activities of monocytes and neutrophils, by favouring the immune transfer through colostrum and milk and by improving the phagocytic activity of macrophages and neutrophils.

MSPIMMUNITY also upregulates the gene expression of immune

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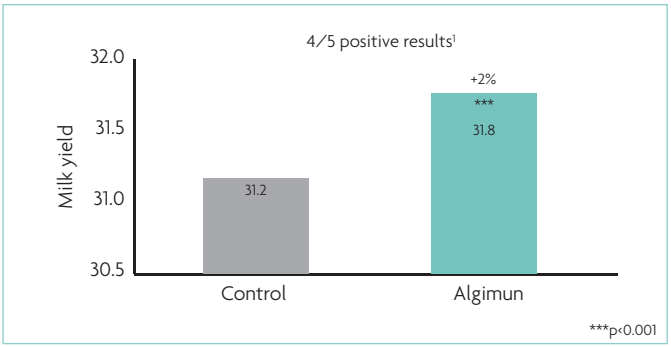

Fig. 2. Milk yield during early lactation. [1]Number of farms in which test group results in 2020 were better than control group results in 2019.

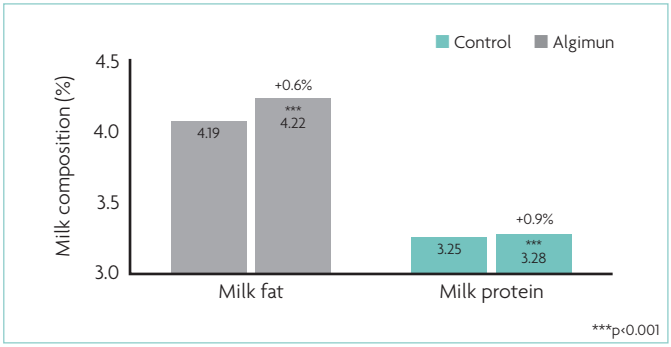

Fig. 3. Milk composition during early lactation.

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mediators with anti-inflammatory activities.

Gut barrier function preserving properties of macroalgal polysaccharides

The effect of MSP$_{BARRIER}$ on the intestinal barrier function was assessed by measuring the expression of tight junction proteins and mucin-related genes using epithelial cell lines.

Results showed that MSP$_{BARRIER}$ upregulates the expression of genes that determine transmembrane (CLND-2) and scaffolding protein (ZO-1) 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$_{BARRIER}$ plays an important role in the maintenance of gut mucosa integrity by rendering the tight junctions stronger and promoting a more functional mucus layer.

MSP$_{BARRIER}$ strengthens gut integrity as observed by an increase in trans-epithelial electrical resistance (TEER) in IPEC-1 cell line incubated with E. coli K88 1305. These findings were corroborated in an in-vivo scientific study.

MSP$_{BARRIER}$ reduced the para-cellular passage of FITC-dextran (gut permeability biomarker) to the blood stream in an animal model known to induce specific stress leading to an inflammation of the gut epithelium and consequently a higher degree of permeability.

MSP$_{BARRIER}$ supplementation reinforced the intestinal barrier function of the gut epithelium (significant reduction of the passage of the marker).

Effect of a combination of macroalgal extracts on health and performance

The inclusion of Algimun in cows' feed during the early lactation period was evaluated in a study conducted simultaneously in five commercial farms in France. The results obtained were compared with farm data from the previous year (control group) and herd management between the two years remained unchanged in each farm.

In total, 500 Holstein breed cows received Algimun during the first 90 days of lactation at a dose of 20g per cow per day.

An increase of 2% in the milk yield (Fig. 2) and improved milk composition (Fig. 3) were observed in the cows receiving Algimun when compared to the control group.

In addition, the number of dairy cows treated for clinical mastitis was lower in the Algimun group (n=5) when compared to the control group (n=25), reflecting an improvement of the immune status.

Thanks to this improvement of performance, the addition of Algimun is profitable (ROI= 2:1).

The positive effect of Algimun during early lactation (20g/cow/day) has been confirmed in Italian commercial farms during heat stress periods (summer). Algimun has proven to support the health of the herds as seen by lower somatic cell counts, lower or no drop in milk production and improved fertility rate in autumn.

The dry period is another risk period in which Algimun use (10g/cow/day) brings benefits too, as seen by an improvement of the colostrum quality: >28% Brix value when compared to the control group that had 22% Brix value.

Conclusion

In short, Algimun, a macroalgae based solution, can be used as a natural alternative in-feed strategy to support the health status of the gastrointestinal epithelia by reinforcing the barrier function of the digestive mucosa and the immune function.

A healthier digestive tract will be less prone to pathologies and more nutrients will be used towards production. ■

References are available from the author on request