Macroalgal extracts improve dairy cow health status and performance

The onset of infectious pathologies during the first weeks of lactation (60-80% of total pathologies in a dairy herd) is linked to immunosuppression derived from nutritional/metabolic stressors and hormonal changes that take place around calving.

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This immunosuppression is seen as a decreased activity of phagocytic cells, in several studies a reduction of 50% in the activity of neutrophils is being confirmed; and as a reduced ability of immune cells to migrate to infection sites.

Additionally, there are predisposing factors, such as acidosis that will compromises gut barrier function leading to subsequent lipopolysaccharides (LPS) infiltration that will be followed by local or systemic inflammatory response and a negative impact on the technical performance. Moreover, during heat stress, milk yield can be reduced up to 50% due to a decrease of feed intake.

Besides this, heat stress will induce a loss of gut barrier function and pro-inflammatory response that will consume glucose, contributing to the reduction in the milk yield since lactose is the main osmoregulatory factor of milk yield.

In conclusion, 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 during heat stress, in order to prevent or reduce the negative consequences in animal welfare, milk yield and reproductive performance.

Special structural traits of seaweed extracts

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 stem 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).

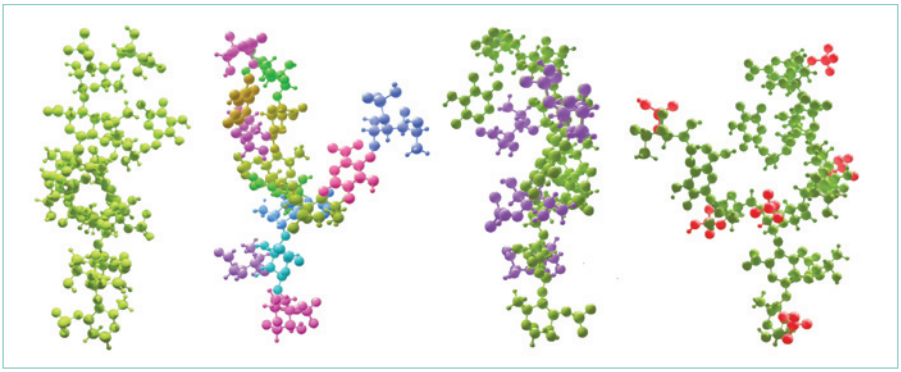
Furthermore, their polyanionic structure and solubility increase their reactivity and enable their recognition by host cells. Sulphated polysaccharides are characteristic of macroalgae (they are not found in terrestrial plants, nor freshwater microalgae nor yeast cell walls).

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: MSPBARRIER, a red algal extract, which enhances the gut barrier function; and MSPIMMUNITY, 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.

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.

Fig. 1. Macroalgal polysaccharide structure responsible of their bioactivities. From left to right: branched structure, sugar unit diversity, presence of rare sugars and presence of sulphate groups.



Immunomodulating properties

Further research has shown that MSPIMMUNITY has the capacity to modulate the synthesis of immune mediators in intestinal epithelial cells which are 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 different immune cell populations, 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 which play an important role in neutralising pathogens, by favouring the synthesis and transfer of passive immune components such as immunoglobulins G and A through colostrum and milk respectively.

MSPIMMUNITY also upregulates the expression of immune mediators with anti-inflammatory activities.

Gut health promoting properties

The effects of MSPBARRIER on intestinal barrier function were demonstrated in an in-vivo scientific study.

MSPBARRIER reduced the paracellular passage of FITC-dextran (gut permeability biomarker) to the blood stream in an animal

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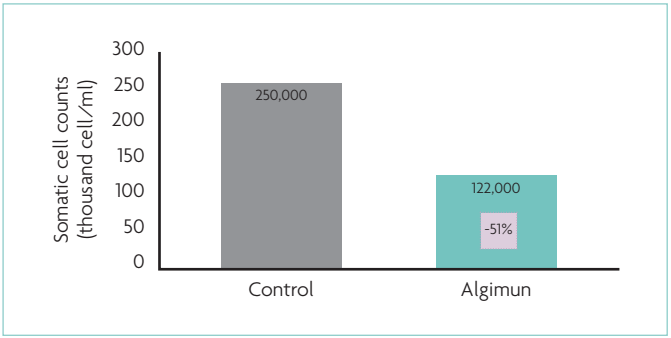

Fig. 2. Somatic cell counts (cell/ml).

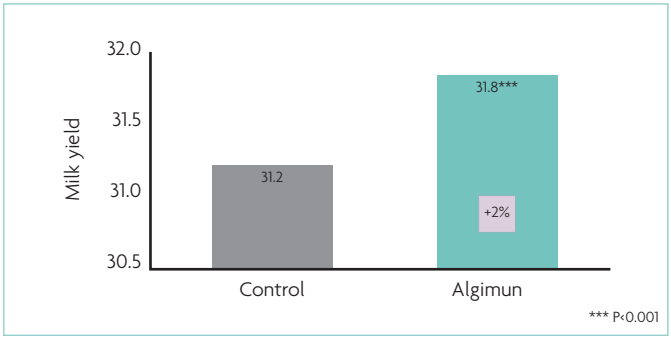

Fig. 3. Milk yield during early lactation.

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model known to trigger a strong proinflammatory response in the gut mucosa and consequently a loss in its integrity.

Other studies have proven, in-vitro, that MSPBARRIER upregulates the expression of genes encoding transmembrane and scaffolding proteins which are required for an optimal functioning of the tight junction complexes; and the expression of genes encoding for major mucus proteins which prevents pathogen attachment and colonisation of the gut epithelium.

New scientific evidence has corroborated the role of MSPBARRIER on the strengthening of the gut mucosa as observed in an in-vitro assay, using differentiated and polarised intestinal epithelial cells (IPEC-1) (INRAE 2020, unpublished data).

IPEC-1 cells were incubated in the culture medium alone (negative control) or with MSPBARRIER prior to inoculation with the enteropathogenic strain E. coli K88 1305. Results showed that the transepithelial electrical resistance (TEER) which is a marker of the epithelium integrity was stable in the negative control (non-infected) in the first 10 hours of monitoring, while it rapidly decreased (within four hours) in the positive control.

When the IPEC-1 cell line was in contact with MSPBARRIER prior to be inoculated with E. coli K88 1305, TEER was maintained at a higher level than in the positive control in the first 10 hours post-infection.

This fact indicates that MSPBARRIER preserves the epithelium integrity and barrier function in the first 10 hours post-infection.

Effect of a combination of macroalgal extracts

The benefits derived from Algimun in terms of immunodulation, health status and technical performance have been confirmed in herds worldwide in the dry period, lactation and during periods of heat stress.

The inclusion of Algimun in the dry period feed (60 days at 10g/cow/day) has proven to support the immune status of Italian herds as seen by an improvement of colostrum quality (›28% brix values in Algimun group when compared to control group that was at 22% brix values), and a reduction of pathologies in the post-calving period (-19.4% of placenta retention occurrence and -47.2% of mastitis occurrence ‹60 DIM vs control group).

Moreover, the inclusion of Algimun in the dry period feed (60 days at 10g/cow/day) during heat stress periods supported the health and performance in Spanish commercial farms.

In a 403 cow farm, Algimun use resulted in a lower inflammatory status in the post-calving period: -33% of serum haptoglobin levels (control group: 1.2mg/ml vs Algimun group: 0.7mg/ml) at day 4 post-calving; -51% of somatic cells counts (control group: 250,000 cells/ml vs Algimun group: 122,000 cells/ml) (Fig. 2); and a consequent improvement of the fertility rate in autumn (-17 open days in Algimun group vs control group).

Fresh cows during heat stress periods can benefit from the use of Algimun (40 days at 25g/cow/day) as recently observed in a commercial farm in Wisconsin, USA in which 240 fresh cows maintained feed intake time and rumination time despite of the challenging environmental temperatures.

The inclusion of Algimun in the feed of 500 cows during early lactation (90 days at 20g/cow/day) in France resulted in an increase of 2% in the milk yield when compared to previous year (Fig. 3) and -80% occurrence of clinical mastitis when compared to the control group.

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

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