Heat stress in dairy: how macroalgal extracts alleviate damages

The dairy industry suffers every year from heat stress episodes which cause severe economic consequences that stem from impaired reproductive performance, lower milk yield, and increased health-related costs.

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Global warming is a major concern for agriculture and livestock. Productivity and livestock health are expected to be affected with the future changes in climate. The annual global losses associated to poor performance during periods of heat stress in the livestock industry are approximately >$500 billion/year.

Several thermoregulatory mechanisms are used by cows during heat stress episode to dissipate heat.

Among other consequences of these changes, cows reduce their feed intake, what is estimated to explain 50% of the milk yield reduction during heat stress.

Other physiological thermoregulatory mechanisms occur, such as diverting blood flow to skin and extremities.

These mechanisms have repercussions on cows' organism, they lower the delivery of oxygen to the enterocytes, creating hypoxia.

Hypoxia increases the amount of reactive oxygen species production (ROS) and ultimately damages the tight junction complexes in the intestinal villi what impairs nutrient uptake and lowers productivity.

Moreover, Baumgard and Rhoads (2013) showed that this loss of gut barrier function leads to a higher translocation of pathogens and a pro-inflammatory response that will consume glucose, contributing to the reduction in the milk yield as lactose is the main osmoregulatory factor of milk yield.

Within the heat stress management tools that exist, the use of macroalgal extracts is an efficient strategy to alleviate the damages, since they have positive effects on gut barrier function and modulation of the immune response.

What are marine macroalgal polysaccharides?

Seaweeds polysaccharides are unique in terms of composition and in structural complexity, what confers them biological properties when used in animals.

Indeed, the nature of the sugar units that compose them, 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 sulfate groups give macroalgal polysaccharides their unique features (Fig. 1).

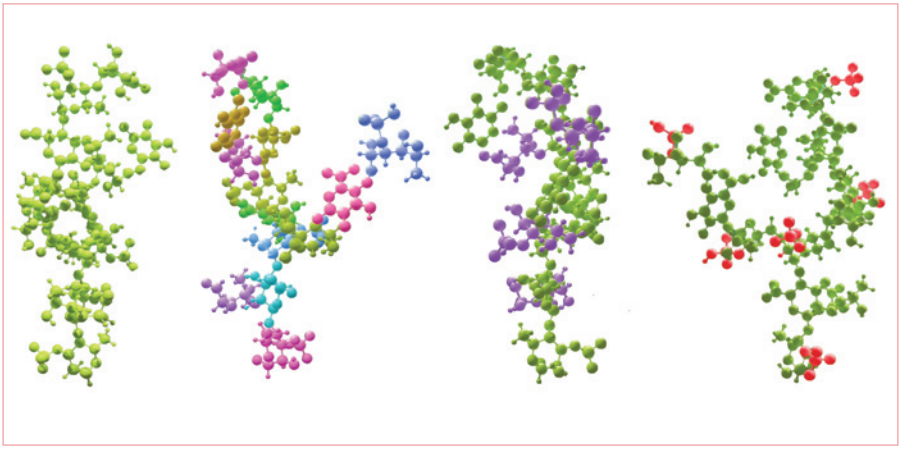
Furthermore, their polyanionic structure and solubility increase their reactivity and enable their recognition by host cells. Sulfated polysaccharides are found only in macroalgae (they are not present in terrestrial plants, nor freshwater microalgae nor yeast cell walls).

Olmix group has developed an in-feed product called Algimun thanks to its know-how on marine bioactive ingredient identification.

Algimun is based on two macroalgal extracts: MSPBARRIER, a red algal extract which improves gut barrier function; and MSPIMMUNITY, a green algal extract that modulates innate and adaptive immune responses.

Algimun bioactive molecules are resistant to heat treatment and extrusion and can thus be used in any type of feed.

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 sulfate groups.



Enhancing gut barrier and immune functions

In 2018, an in vivo scientific study conducted at INSERM demonstrated the effects of MSPBARRIER on intestinal barrier function.

MSPBARRIER reduced the passage of a gut permeability biomarker (FITC-dextran) through intestinal cells to the blood stream in an animal model triggering inflammation in the gut mucosa directly related to leaky gut syndrome, hence highlighting the MSPBARRIER effect of gut integrity.

Other in vitro studies showed that MSPBARRIER upregulates the expression of genes encoding proteins 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 (IBD, 2017), both playing key roles in gut functionality.

Another study with INRAE demonstrated the strengthening effects of MSPBARRIER on intestinal mucosa in the presence of a

pathogenic strain of Escherichia coli, as observed by an increase of transepithelial electrical resistance (TEER) when compared to the positive control group. Additional studies have shown that MSPIMMUNITY modulates the synthesis of the immune mediators involved in innate and adaptive immune responses, such as the differentiation and proliferation of the various immune cell populations, the recruitment and activation of antigen-presenting cells, and in the inducing of immune tolerance thanks to its anti-inflammatory properties.

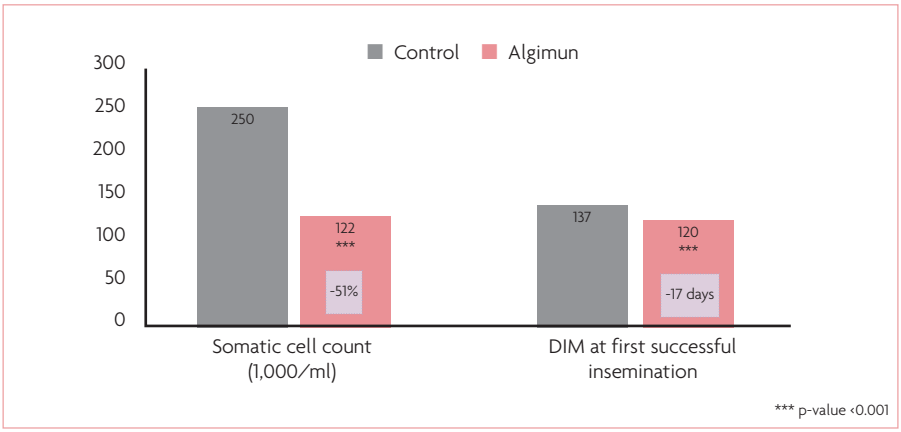


Fig. 2. Somatic cell count (*1,000/mL) at 90 days in milk and average days in milk at 1st successful artificial insemination (Spain).

Algimun during heat stress proved its efficiency and profitability

Algimun has demonstrated to improve performance of dairy herds suffering heat stress.

In Spain, under heat stress conditions (average 33°C during the trial), the use of Algimun during the dry period (60 days before calving) significantly improved the performance of the herd: haptoglobin level in serum (marker of inflammation) at day 3 post-calving was reduced, so as somatic cells count (Fig. 2); milk yield was increased by +2% (0,84kg/cow/day at 90 days in milk p<0.001) and the number of days in milk at first successful artificial insemination when compared to control group was lowered by 17 days (p<0.001) (Fig. 2).

All these performance improvements in the group of cows that received Algimun led to a €52 extra income per cow.

Fresh cows during heat stress periods can also benefit from the use of Algimun, as observed in a 500 dairy commercial farm in Wisconsin (USA).

In this experiment, fresh cows maintained their feed intake and rumination time even under heat stress conditions.

The quality of colostrum was improved (brix values >28 in Algimun group when compared to control group that was at brix values of 22), 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) were observed when given in the dry period feed in Italian farms.

Algimun can be used as a natural alternative in-feed strategy to support dairy herds coping with heat stress. ■

References are available from the author on request