The use of algotherapy in modern pig production

There is no doubt that antimicrobial resistant bacteria are a major threat to animal and human health. In order to slow the increase in antimicrobial resistant bacteria, it is important to start considering how to eliminate antimicrobials from modern day animal production.

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Many countries are implementing measures to reduce the use of antibiotics. The success of these measures will require the involvement of all stakeholders of the production chain and will require the modification of current production practices. To assist in the transition to 'antibiotic free' production many 'alternatives' to antibiotics are being developed and tested and among them, the use of algae is very promising.

A source of biological treasures

Macroalgae, or seaweeds, are eukaryotic and pluricellular organisms, divided into three different groups: green, red and brown. They contain various carbohydrates, proteins, minerals, lipids and vitamins. Nutritional studies on marine algae indicate that green, brown and red seaweeds possess characteristics that allow them to be used as an alternative source of dietary fibre, protein, vitamins and minerals.

Additionally, detailed screening of macroalgae functions has revealed new ranges of biological activities including anticoagulant, antiviral, antibacterial, anti-tumoral and immuno-modulatory activities.

These various biological activities may enable macroalgae to function as a nutraceutical food. Indeed, macroalgae cell walls contain large amounts of sulphated polysaccharides. These sulphated polysaccharides are specific to each type of macroalgae, and are identified as ulvans, fucoidans and carrageenans, within green, brown and red algae, respectively. The sulphated polysaccharides range from 4 to 76% of the seaweed dry weight.

The high content, unusual structure and biological properties of sulphated polysaccharides shed new light on these compounds as potential natural products for medicinal and dietary application.

The specificity and function of these algal polysaccharides results from the complexity of their structure. In contrast to linear polysaccharides (i.e. cellulose), they are branched polysaccharides, meaning they contain more than one linkage between some sugar molecules.

Further, macroalgal polysaccharides are composed of different types of sugar units, including some rare types such as xylose and rhamnose, rather than being composed exclusively of glucose units like amylopectin.

Finally, as mentioned, the sugar molecules can be sulphated, which enables them to have special reactivity. All of these properties enable macroalgal sulphated polysaccharides to have a phylogenic similarity with polysaccharides present in animals, including heparin, which partially contributes to their unique activities of macroalgal sulphated polysaccharide in animals.

The specific biological properties of each varies according to the type of sugars and linkages they contain, their level of sulphation, and their molecular weight.

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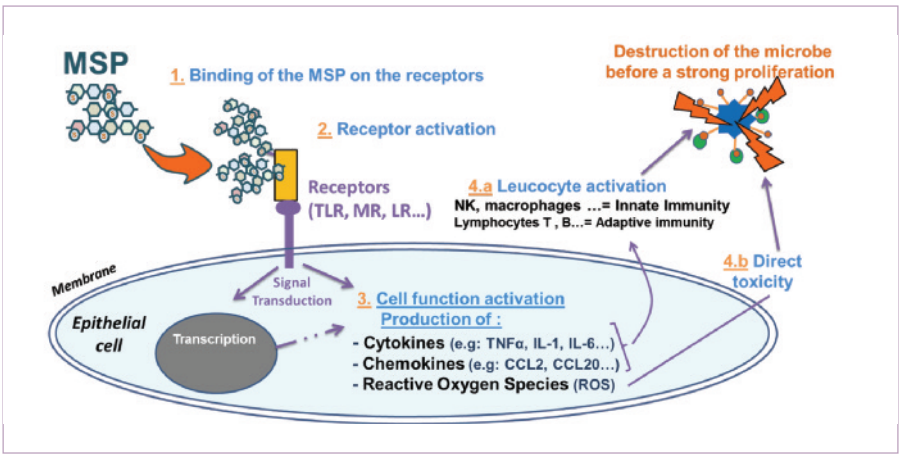
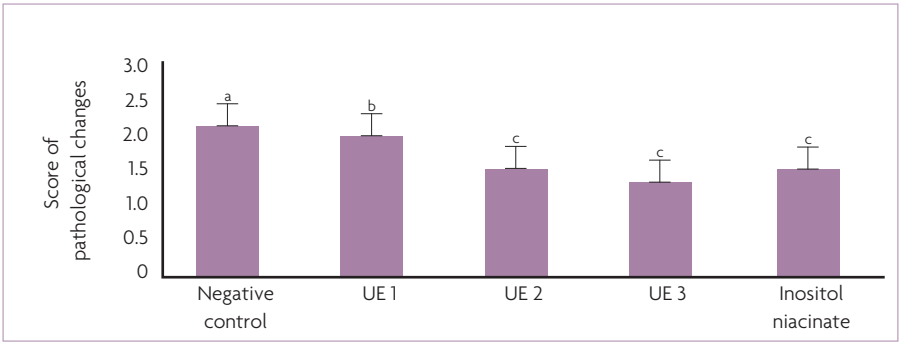


Fig. 2. Mode of action of MSPIMMUNITY.

Fig. 1. Effect of various green algae MSP: ulvan extracts (UE) on inhibiting pathological changes in the liver, in comparison with negative control and positive control (inositol niacinate). Scoring: mild = 1, moderate = 2, severe = 3. Different alphabets are significantly different (P<0.05 by one-way ANOVA) (Adapted from Pengzhan et al., 2003).



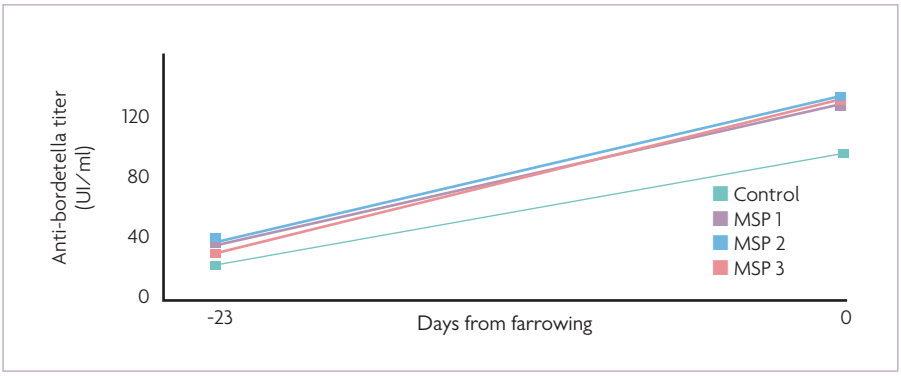


Fig. 3. Effect of different doses of MSPIMMUNITY on IgG anti-bordetella in gilts' serum 23 days before farrowing and in the colostrum on farrowing day.

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Therefore, several with distinct biological activities can be found in algae and the extraction of each of them is key to ensure a targeted effect on animals.

Olmix has been studying in the field of marine biotechnology for more than 20 years and for the past 10 years, has focused on the extraction and use of specific MSPs (Olmix MSPs) to service animal production challenges. Recently, three key algal sulphated polysaccharides have been studied for application towards improving digestive efficiency, immunity and digestive welfare.

Improving lipid metabolism

The energy requirement of a sow around farrowing is generally in excess of what she is able to consume. This causes the body to breakdown adipose tissue to provide adequate energy for maintenance and production, which can put a lot of pressure on the liver.

Further, a sudden high demand for energy (the transition to lactation following farrowing), can result in an accumulation of toxins due to improper lipid metabolism.

This can negatively impact sow performance, decreasing nutrient utilisation and milk production. To prevent such effects, specific products that support hepatic metabolism and stimulation of liver detoxification may be used.

The capacity of algal polysaccharides to improve liver metabolism was first demonstrated by Pengzhan et al. (2003), who highlighted the capacity of ulvans (sulphated polysaccharide from green algae Ulva sp) to lower the level of liver pathologies of rats (Fig. 1), while decreasing the levels of triglycerides (TG) and increasing the excretion of bile acids in the faeces.

Qi et al. (2011, 2012) also highlighted the anti-hyperlipidemic properties of ulvans. While the positive control group (fed a hyperlipidemic diet) had a disbalanced profile of lipids, the supplementation with ulvans significantly improved it.

These findings motivated Olmix to research the extraction of a specific MSP that had enhanced anti-hyperlipidemic properties (MSPLIPIDS) and determine its ability to stimulate liver metabolism and detoxification via enhanced bile acid excretion from the intestine in sows.

The product that Olmix developed is known as DigestSea, which contains MSPLIPIDS. This product was tested on 45 gestating sows (average parity 3.7; weaning at 28 days) on a commercial farm in France.

Twenty-three sows followed the standard farm prophylaxis (control group), while 22 sows received DigestSea (test group) starting five days before farrowing (15ml/sows/day).

Results showed that piglets were heavier in the test group compared to the control group, with 41% of piglets above 9kg at 28 days, compared to 27% in the control group. Other testimonies from France highlighted the reduction of farrowing duration when using DigestSea, along with a decreased rate of stillborn piglets.

Thus, using DigestSea in sows five days before farrowing improves reproductive performance by supporting liver functionality.

Supporting natural defences

In addition to MSPLIPIDS, attention was given to the extraction of another sulphated polysaccharide for its immunomodulating properties. This MSP, named MSPIMMUNITY, was the subject of several studies conducted by the French National Institute of Agronomic Research (INRA).

Tested in vitro, using an intestinal epithelial cell line (IPEC-1), MSPIMMUNITY stimulated the expression of many immune mediators such as cytokines and chemokines, via the activation of Toll-like receptors (TLR; Fig. 2).

The diversity of cytokines and chemokines that were up-regulated by MSPIMMUNITY suggests that the extract is able to activate both cellular-mediated and humoral immune pathways, involved either in innate (macrophages, neutrophils) or adaptive (T and B cells) immunity.

MSPIMMUNITY was then tested in vivo, by orally supplementing gilts around vaccination and prior to farrowing, to evaluate its capacity to improve the transfer of immunity from gilts to piglets.

The results showed that MSPIMMUNITY has the capacity to increase the amount of IgG-AB (anti-bordetella, marker of atrophic

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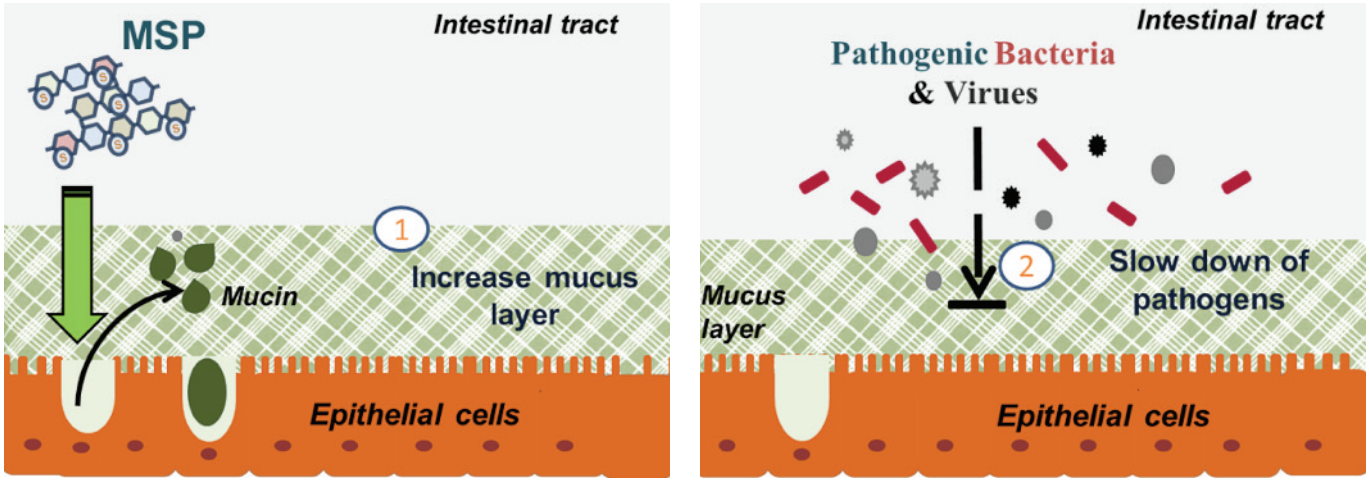
Fig. 4. Intestinal mucosa repairing and protective effects of MSPMUCIN.



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rhinitis vaccination) in colostrum via an increased transudation from the serum.

The study also demonstrated an increased level of IgA in milk, at day 7 and day 21 after farrowing. MSPIMMUNITY may be activating the migration of IgA producing plasma cells from the intestine to the mammary gland, leading to the increased IgA in milk. Thus, MSPIMMUNITY has the ability to improve systemic and mucosal immunity for improved piglet immune protection.

MSPIMMUNITY is commercially available in Searup, and is used to reinforce the animal's natural defences and resistance to infection. It is used to support vaccination programs and during stressful periods of production.

Improved digestive welfare

Olmix has also worked on the extraction of a third MSP that could stimulate intestinal mucin production to help protect the intestinal epithelium, known as MSPMUCIN. Intestinal mucins are large glycoproteins secreted by goblet cells in the intestine. They constitute the mucosal barrier that coats and protects the intestinal epithelium. This barrier prevents the attachment and colonisation of bacteria on the epithelial cells, and limits the intestinal absorption of toxins and pathogenic bacteria. Therefore, stimulating the production of mucin to protect the intestine is a strategy to support intestinal development of young piglets and to prevent digestive disorders.

In 2000, Barcelo et al. observed that sulphated polysaccharides from Ulva sp. stimulated the excretion of mucin from goblet cells, thus demonstrating its potential use to supplement the mucosal barrier and protect the pigs against various intestinal diseases.

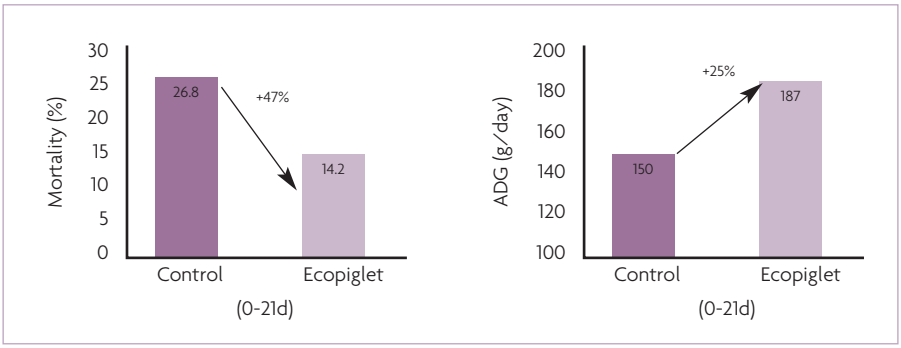

Fig. 5. Effect of Ecopiglet on piglet performance in maternity, under a PEDv context.

Olmix has developed two products for pigs containing MSPMUCIN, SeaGut paste and Ecopiglet. SeaGut paste is used for neonatal diarrhoea and helps control early digestive troubles and prevent dehydration.

Tested on 67 litters on 10 French farms, the product was given as digestive problems appeared (average age: four days old). SeaGut paste administration was able to stop diarrhoea in 76% of cases. In 67% of those cases, SeaGut paste was able to stop the diarrhoea with only one application, with the remaining cases needing two days of treatment.

Ecopiglet, on the other hand, is administered proactively, to support the intestinal development of sucking piglets. Ecopiglet is provided to piglets at five days old to decrease the incidence of digestive troubles in the farrowing unit. Tested in Spain by a private research centre on a commercial farm, Ecopiglet reduced the incidence of digestive troubles by 50% and the use of medication by 56%. Intestinal morphology of piglets receiving Ecopiglet was improved (higher villi height and surface compared to control), and weaning weight was higher in piglets supplemented with Ecopiglet (+200g/piglet).

In a separate trial conducted in Mexico, Ecopiglet was an efficient tool in controlling Porcine Epidemic Diarrhoea virus (PEDv). Indeed, the use of Ecopiglet reduced mortality by almost 50% (+0.9 piglet/litter at weaning) and infected piglets recovered more quickly and had a daily weight gain that was 25% higher than the control (Fig. 5). In the six months following the trial, the continuous use of Ecopiglet helped minimise the mortality rate of the barn until the PEDv outbreak was completely controlled.

Pig producers, and all supporting professions, are continually seeking to improve pig performance while decreasing input costs. Additionally, with the rise in antimicrobial resistant bacteria, producers are looking for solutions to help maintain pig performance and health, while decreasing the use of antimicrobials.

Through the development of MSPs, Olmix is providing viable options for producers to achieve this goal in an increasingly challenging environment. ■

References are available from the author on request