Immunonutrition: taking swine farming to the next level

Dietary formulation in swine farming has advanced enormously over the years. For example, currently diets with higher nutrient concentration are used. This is intended to meet the demands brought about with genetic improvement. These diets are effective: nutrition has contributed to the great success of the swine sector and the production cycle has become increasingly shorter.

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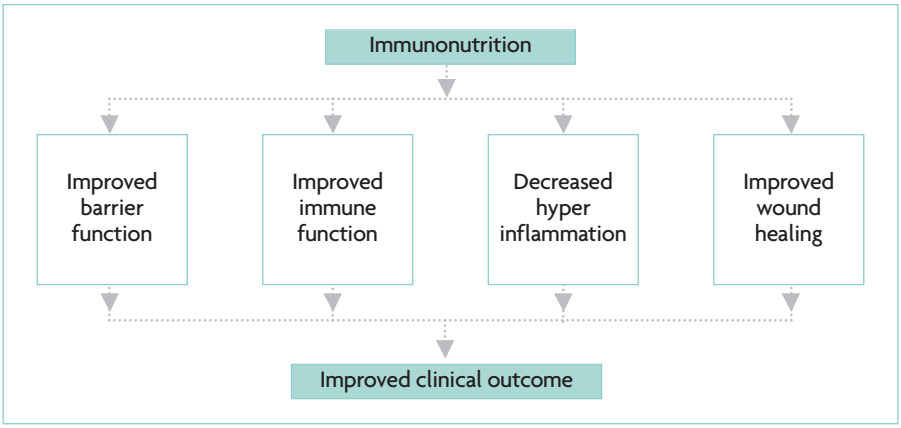

Fig. 1. Objectives of immunonutrition. The central objective is to improve clinical and, consequently, productive outcomes. Note that it is not just a matter of enhancing immune responses but executing them in the most efficient manner as possible (Modified from Immunonutrition in surgical and critically ill patients).

However, as the nutrition textbooks teach, the diets used in swine farming are formulated based on the animals' demands under balanced conditions. What happens nutritionally outside of homeostasis is the object of immunonutrition.

Immunonutrition was born as a discipline of human health, with the aim of improving recovery rates in diseases with high immune demand, for example ICUs, where there is a high occurrence of antibiotic-resistant generalised infections, etc.

Intuitive concept

The concept is intuitive from the name: 'immunonutrition' means improving an individual's defences through the use of specific dietary formulations. There are amino acids, vitamins, and micronutrients whose nutritional supplementation alters immune responses in clinically measurable ways during stress or illness situations.

This is because the immune demands during inflammatory processes are very high. Thus, dietary patterns must differ during conditions of health and disease.

Immune cells obtain their nutrients as they become available in the blood, like other cells. However, nutrients partition by the organism is not homogeneous.

The central nervous system, for example, demands and receives more carbohydrates than any other tissue. This demand from the nervous system must always be met, otherwise the viability of the animal's life may be at risk. Likewise, providing the immune system with a sub-optimal nutrient balance is not advisable: immune failures are routinely fatal, or result in prolonged infections and unnecessary productivity losses.

It should be clarified that the purpose of immunonutrition is not to achieve a more intense immune response, but rather to obtain the best immune response, for example, a response that 'solves the problem' without being excessive. (Fig. 1).

Human immunonutrition began with supplementation of amino acids, especially glutamine and arginine, unsaturated fatty acids, nucleotides, and essential micronutrients for the detoxification of oxidative stress.

An intense immune response generates a variety of oxidising agents – the 'free radicals', as they were called a few years ago.

The removal of these radicals takes place in an ongoing basis, but it needs to be intensified during immunity activation, since the leukocytes produce them with great intensity. Other compounds in this 'classic' immunonutrients diet have an anti-inflammatory function (such as unsaturated fatty acid) or support of immune cells and mucosal epithelial cells (such as amino acids and nucleotides).

In animal health, we can extend the concept of immunonutrition beyond substances that have a nutritional purpose.

There are substances that, even not being used as nutrients, can be added to the swine diet with the purpose of improving the animal's defence barriers, be they immune cells or other resistance mechanisms, such as the quality of the mucous membranes.

Most infections occur through the digestive mucosa or the respiratory mucosa. If the mucosal epithelium is coated with a protective layer of commensal bacteria, the chance of an infection via this route, for example, is reduced.

It is possible to provide nutrients to enrich the microbiota – these compounds are called prebiotics. It is also possible to change it through the dietary administration of bacteria – using probiotics.

Note that the administration of pre/probiotics is not nutritious for the animal: these substances are not absorbed like the nutrients in the feed. However, the purpose of its use is the same, for example, to improve defence against challenges.

There are several dietary compounds intended to modify immunity, including those derived from yeast. Dietary supplementation with yeast can benefit animal defence either directly (acting directly on immune cells) or indirectly (acting

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on the microbiota, on epithelial barriers, etc).

Yeast administration can provide nutrients, such as nucleotides. These are the 'building blocks' that make up DNA and RNA, and there is a great demand for them in cell proliferation phases, such as during the expansion of immune cells to fight a pathogen.

The intestine also proliferates intensely when it is injured, and its cells start to demand nucleotides to maintain this process of cell proliferation mainly during the growth of young animals.

Furthermore, yeasts can interfere with pathogenic bacteria.

The yeast wall contains compounds, mannans, which agglutinate bacteria, trapping them in the yeast and preventing them from replicating. This is a natural mechanism that yeasts use not to succumb to the bacteria around them. Bacterial agglutination is extremely effective. Once immobilised, bacteria cannot migrate, invade the host, or compete for nutrients.

Finally, we mention β-glucans, a second component of the yeast wall. This substance is treated as the 'gold standard' in inducing an immune mechanism called 'cell training'. The term refers to the possibility of inducing something similar to an immune memory even in cells where it was believed to be impossible to do so. As we know, 'memory' is the immune capacity to improve itself in the fight against a pathogen. Until recently, it was believed that only processes like vaccination – or infection – could induce memory.

Macrophages and neutrophils are the leukocytes most used during infections. These cells migrate to pathogens' entry sites and carry out phagocytosis, eliminating infectious agents. Crucially, it is also up to macrophages to activate lymphocytes, which will produce antibodies, memory cells, etc.

However, it was believed that macrophages and neutrophils themselves were not capable of having memory, which is equivalent to not being able to prepare them for a challenging situation. β-glucans modify the metabolism of these phagocytic cells in order to make them more effective in fighting pathogens. This process lasts for days and even weeks, thus representing a memory mode for phagocytes.

Conclusion

In human health, there are already several situations in which the use of immunonutrition is a clinical recommendation, for example, the concept has already become current practice. In animal health, the proposal of immuno-nutrition is still in its infancy – we will still develop this science over the years to come. In particular, we must learn to implement specific diets according to the herd's demand. Even in medicine, this area of nutrition is new: there are situations in which immunonutrients can generate very intense immune responses, for example.

However, there seems to be a great potential benefit from the application of immunonutrition in practice: under production conditions, immune challenges are numerous and constant. There is probably no productive phase in which there is not a high immune stimulus during pig breeding.

This is a science that should bring together all the professionals involved in the production. Veterinarians, zootechnicians and agronomists will need to work together to identify the best times to apply an 'immunodiet'. It will be up to producers and extension workers to identify the moments of immune challenge in everyday life.

Swine farming is an organised and innovation-oriented industry. Therefore, there is already a range of additives on the market aimed at this purpose.

Thus, the tools to use immunonutrition are already in our hands. It is up to us to apply them and contribute to the evolution of this new science – and with that, we will contribute to taking swine farming to the next level. ■

References are available from the authors on request