Micronutrient nutrition: an opportunity to fine-tune swine immunity

Disease has never been more at the front of swine producers' minds as it is today. Even in recent years, the global pork industry has experienced severe disease challenges, such as PED virus and more recently African Swine Fever, that have threatened the very future of swine production in some regions.

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The safety net of AGPs once relied upon as the cornerstone of intestinal health management are no longer a viable option to support sustainable pig production. The industry must look elsewhere for strategies to optimise swine health which ultimately drives production efficiency.

Immunity is the best defence

However, often this search overlooks the most critical defence mechanism of all, the pig's own immune system. While immunity is vital for life, it comes at a cost to production efficiency and, as such, warrants due consideration. The greatest energetic cost associated with immunity is for development and activation.

There are two main categories of immunity, innate immunity is the type that pigs and other animal species are born with and adaptive immunity is the type that develops over time in response to foreign antigens.

Innate immunity, which is rapid but non-specific, is energetically cheap to develop but expensive to use. On the other hand, adaptive immunity is potent but slower to respond and is costly to create but economical to run.

The challenge with modern production practices

Piglets at birth are reliant on the sow's colostrum to supply protective factors in the form of immunoglobulins and their own innate immune response to protect against pathogens until their adaptive immunity develops.

However, modern swine production practices result in pigs being weaned from sows before their own adaptive immunity is fully developed (Fig. 1).

This creates a window of susceptibility during that immediate post-weaning period when the pig is particularly vulnerable to infection.

At weaning, pigs are confronted by a new wave of antigens coming from an abrupt change in their diet from their mother's milk, which is rich in protective factors, to solid feed that is full of proteins that the pig's immune system has never experienced before. This new environment causes dramatic shifts in the gut microbiome.

Taken together, these can all lead to over activation of the innate immune response at gut level.

The mucosal immune system, predominantly localised to the gut has a significant role to play in protecting the pig from external threats.

The intestinal mucosa has dual roles of nutrient and fluid absorption and defence against infection which are seemingly at odds with one another.

The success of this relationship hinges on the ability of the mucosal immune system to distinguish between genuine threats in the form of pathogens and low risk antigens coming from feed and commensal bacteria which are normal gut residents. This arm of the immune system is referred to as immune tolerance.

Ideally, the mucosal immune system should be highly reactive to enteric challenges, such as E. coli and salmonella, instigating an inflammatory response that clears these threats fast, while remaining largely unreactive to low-risk threats.

Timing is everything

Returning to the timing dilemma with modern weaning practices, not only is the pig's adaptive immune system underdeveloped at this time but so too is their immune tolerance. Immune tolerance is not fully developed until at least eight weeks of age.

Therefore, the potential exists for the stress associated with weaning to initiate an immunological crisis in the gut resulting in excessive inflammation and damage to the

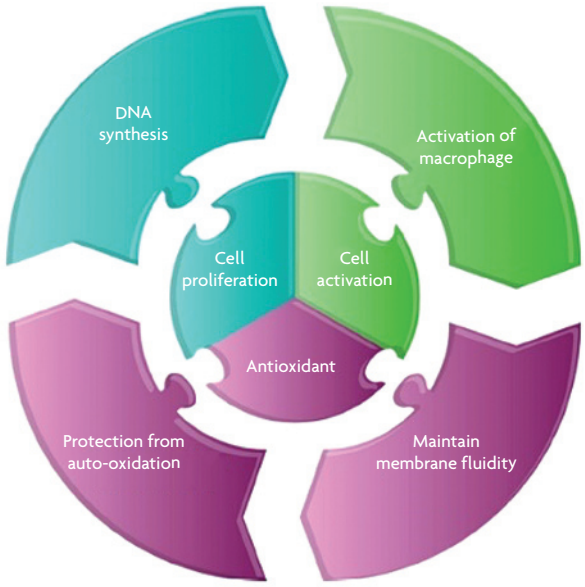
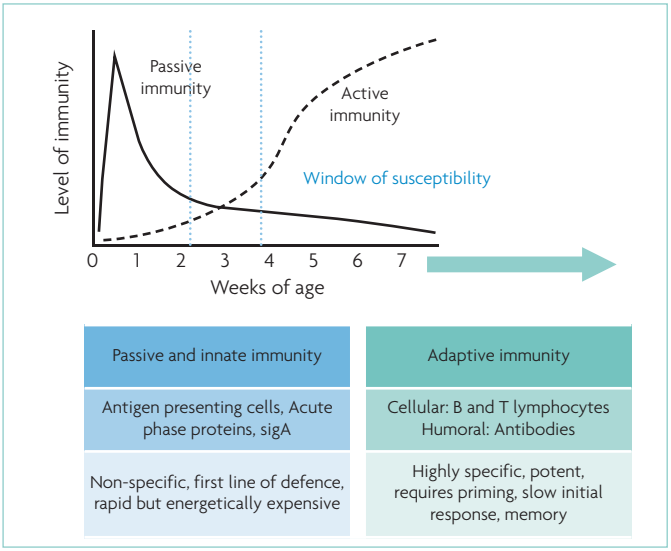
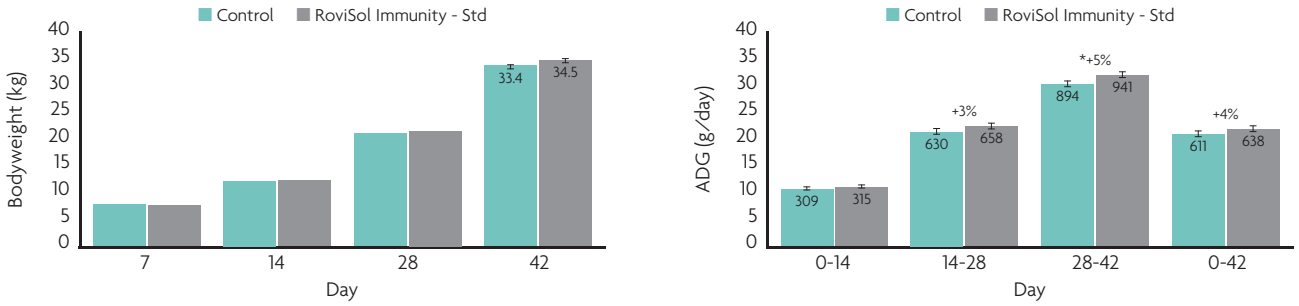


Fig. 2. A multi-component approach to optimising immune function through nutrition.

Fig. 1. At weaning, passive immunity from the sow has diminished and the pig's own active immunity has not fully developed creating a window of susceptibility when pigs are particularly vulnerable to disease.





Standard inclusion rate of RoviSol Immunity increased ADG of healthy pigs by 5% in the last two weeks of the post-weaned period and 4% improvement overall. Pigs fed the standard RoviSol Immunity solution were >1kg heavier on day 42. (* P < 0.05)

Fig. 3. RoviSol Immunity supports immune function in weaned pigs which resulted in improvements in growth performance (DSM CAN, Bazhou, China, 2020).

intestinal barrier. The consequence of this response is often seen in herd performance moving further away from the production frontier.

Immune optimisation through nutrition

The ultimate goal is to support immune development in pigs that is highly effective when it is needed but does not detract from growth when it is not. When considering immunocompetency development, vaccination programmes are a critical component of this. However, vaccines are expensive not only to purchase but also in terms of the productive loss due to the associated immune response.

Their use can only be justified against virulent pathogens that cause high mortality rates.

Therefore, we are reliant on the pig's own immune system to impede challenges from most pathogens.

Balanced nutrition is a prerequisite for maintaining good health status. When nutrition is inadequate, the frequency, duration or pathogenicity of infectious diseases increases.

Feed formulation for swine is driven very much by least cost and is targeted to promote efficiency of lean gain.

The question is, are these diets also optimised to promote disease resistance across a spectrum of potential pathogens? Similar to all other cells in the body, immune cells require nutrients in the correct amount and balance to multiply and carry out their function when needed.

However, the nutrient's immune cells such as acute phase proteins need to support expansion and activation may be greater than quantities required to build lean muscle. The immune system is sensitive to moderate deficiencies in some nutrients which can impact its effectiveness.

A multi-component approach

The structure and function of the immune system is highly complex, this goes without saying. However, there are a number of key elements that are integral to its proper functioning.

These include appropriate stimulation and enhancement of different immune cells and, due to the nature of the immune system, this can only be achieved effectively with a multi-component nutritional approach.

This multi-component approach centres around supporting immune cell proliferation, activation and protection via optimised nutrition (Fig. 2).

Micronutrients including some vitamins and minerals, together with some feed additives, are known to have immunomodulatory effects.

Vitamins, such as vitamin D3 have classical benefits around skeletal health that have long since been recognised. More recently, however, the role of vitamin D3 or more importantly its main metabolite, 25-hydroxy (OH) vitamin D3 in immunomodulation is just starting to be understood. The regulatory arm of the immune system is critical in helping to dampen down the inflammatory response and facilitate the return to homeostasis.

While inflammation is vital for disease resolution, the resulting collateral damage is often more costly to the pig than the initial pathogen if left unchecked.

One of vitamin D3's primary roles is to not only support the activation of immune cells and production of antimicrobial peptides but also to limit excess responses.

There are numerous studies in weaned pigs supporting the role of vitamin D3 and the 25-OH vitamin D3 form in particular in increasing immune cell number and activation. Pigs are born with very low levels of blood 25-OH vitamin D3 which seldom reach the minimum much less the optimum range to support immunity.

Now understanding the critical role of vitamin D3 to immune function, weaned pigs can be at a disadvantage without adequate supplementation during a very stressful period in the production cycle.

Vitamins such as E and C have long since been recognised for their ability to act as potent antioxidants that prevent oxidative damage of immune cells. The pigs requirement for vitamin E is elevated during immune development and activation.

At birth, vitamin E level of piglet blood is highly dependent on the vitamin E status of the sow. Piglet viability can be enhanced through optimum vitamin E supplement of sows through gestation and into lactation. Blood vitamin E levels also decline in piglets post-weaning which can impact their ability to fight infections such as E. coli.

Piglets have also been shown to benefit from supplemental vitamin E post-weaning.

Vitamin C is a well-known nutrient effecting immunity. Low blood vitamin C is associated with reduced bacterial killing efficiency of white blood cells. Vitamin C is highly concentrated in white blood cells which stimulates their function and acts as a powerful antioxidant.

Some eubiotics such as yeast cell walls, some probiotics and algae have also demonstrated immunomodulatory potential in pigs. Beta-glucans in particular can increase the oxidative burst response in phagocytes.

Combination of vitamins and eubiotics

Growing evidence suggests that an optimised combination of vitamins E, C, 25-OH vitamin D3 and specific eubiotics (RoviSol Immunity) that support immune cell proliferation, activation and protection is key to creating a more robust immune system post-weaning boosting overall performance.

This combination proved to be a cost-efficient solution for producers after several trials run in recent months which delivered an attractive ROI of 3:1 (Fig. 3).

Viruses and pathogens, both new and old, will continue to threaten the future of pig production globally. The reliable strategies of the past, such as antibiotics, are becoming less sustainable options for the future, heightening the need to support the pig to better defend itself. The growing recognition of the importance of nutrition in the maintenance of immune functionality is providing opportunities for producers to build immune robustness into their herds from the beginning in a cost-effective manner. ■

References are available from the author on request