The important role of the immune system in gut health

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Health control has always been a major concern in pig farms. The gut is a very crucial organ for maintaining animal health. Apart from absorbing nutrients, the gut is also the barrier against unwanted compounds and germs. The immune system in the intestine plays an important role in this. Immune cells such as inflammatory cells were thought to be central, and until recently, the enterocyte layer was considered a simple physical barrier.

Nowadays, it is known that enterocytes are immunocompetent cells as well, in particular in the innate part of the immune system.

Enterocytes play an important role in the crosstalk with intestinal microbiota. Enterocytes, dendritic cells and macrophages are involved in achieving a balanced response.

Furthermore, the presence of numerous nerve endings suggests involvement of the central nervous system.

Risk factors

As the intestines are constantly exposed to foreign substances such as feed, it is not surprising that the body has evolved an intestinal system to control inflammation and immunity. However, this mechanism can be overwhelmed by risk factors. One of the best studied disturbing factors is weaning. In this period, piglets suffer an important alteration to the intestinal wall.

Abrupt separation from the mother, cross-fostering, transports and change to a solid feed, which in most of the cases is more difficult to digest, are some of the challenges that weaned piglets must face. The highly digestible nutrients in milk are substituted by complex carbohydrates and proteins mainly from vegetable origin. In consequence, feed intake drops during the first week after weaning and the scarce body reserves are mobilised.

Villi height is reduced and the proportion of immature enterocytes increases, therefore the enzymatic activity of the gut is reduced. The gut microflora also suffers from this situation, Lactobacilli population decreases and at the same time E. coli numbers increase due to the abundance of undigested fermentable substrates in the intestine.

This scenario results in a major imbalance in gut homeostasis that causes digestion and nutrient absorption problems and diarrhoea. In this context, the modulation of gut microflora as a tool to ameliorate these stressing circumstances arises as a suitable strategy.

The intestinal microbiome of the animal host is a complex ecologic system that produces a significant impact on the host. Aerobic and anaerobic bacteria of the intestinal flora influence numerous anatomic, physiologic, and immunologic parameters.

Normal intestinal flora consists of a diverse population of bacteria competing for survival and represents an important natural defence mechanism.

An early supplementation with DFM (Direct Fed Micro-organisms) can help control the gut microbiota avoiding undesirable imbalances. The mechanisms used by probiotics to enhance gut health are numerous. In this case we will focus on lactic bacteria.

Table 1. Multiplication of micro-organisms.

Micro-organism	Time to double population (mins)
Lactobacillus acidophilus	64
Lactobacillus bulgaricus	40
Streptococcus thermophilus	46
Enterococcus faecium CECT 4515	19
Escherichia coli	18-20
Bacillus subtilis	60
Saccharomyces cerevisiae	200

	Pre-starter	Starter	Overall
ADG			
Control	84	371	276
Fecinor	91	436	324
ADFI			
Control	179	615	470
Fecinor	179	662	501
FCR			
Control	2.33	1.69	1.79
Fecinor	2.19	1.53	1.56

Table 2. Performance results.

Lactic acid bacteria

Lactic acid bacteria (LAB) is the term used to denominate the group of micro-organisms capable of producing lactic acid through sugar's fermentative metabolism. Lactic acid acidification capacity is higher than that of most organic acids and therefore inhibits the proliferation of pathogenic bacteria in the gastrointestinal tract.

Lactobacillus genus is the most abundant LAB in healthy animals' small intestine. The main inconvenience is that this genus shows a low growth rate and they perish if the pH increases above a certain level. The vulnerability of this genus makes it unsuitable to modulate intestinal microflora in stressful situations.

Enterococcus faecium is another well known LAB. Being a typical bacteria present in animals' gut, it has a higher growth rate and a better resilience to adverse ambience.

This bacteria presents superimposed layers of polysaccharides on its surface that permits them to pass through the stomach without being affected by the acid pH.

Once they reach the intestine, they multiply at a rapid rate (doubling in CFU count every 19 minutes), and adhere to the intestine epithelium forming together with lactobacilli, the 'biological barrier' to protect the body against disease-causing germs.

The fast rate of colonisation and affinity for the environment makes it possible for E. faecium to successfully compete with the enterobacteria for the loci and nutrients in the intestinal environment, rapidly forming the protective coating and thus preventing undesired bacteria from multiplying.

In addition, it has been proven that during its multiplication, E faecium produces a large quantity of enzymes in sufficient amounts to make feed nutrients more digestible.

Most part of acid production by the fermentative metabolism of E. faecium corresponds to L-lactic. However acetic and D-lactic acids can also be found.

More than half of the available sugars can be transformed to acids by E. faecium. Besides the antibacterial effect, these acids can be used to control the intestinal pH (pathogens bio-control) and/or as carbon source and available energy.

The lactic acid formed in the intestinal tract penetrates the non-lactic enterobacteria (Gram negative) and then reacts inside, being converted into lactate, affecting the proteins and DNA of the bacteria oxidising them. This also causes a reduction of the intracellular pH in the bacteria cells, disrupting their metabolism.

Lactic acid also reduces the external pH to levels which are damaging for many enterobacteria. The drop in the pH in the digestive tract also promotes the conversion of pepsinogen into pepsin in young animals, thus increasing the endogenous proteolytic capacity.

This bacteria also produces different enzymes in sufficient amounts to increase the digestibility of the feed. Proteases, lipases, amylases and some disaccharidases (for example α-glycosidase, invertase, etc) are produced in significant amounts.

E. faecium seems to also have an impact on the active transport of nutrients, especially when this mechanism is impaired by salmonella infection. An increase in glucose and phosphorus uptake from the jejunum was observed in a recent study in which salmonella challenged animals were treated with E. faecium.

The supplementation in the weaning period with a high growth rate LAB makes the adaptation to the new condition easier for piglets. Having a healthier gut with a proper microflora and an active proteolytic capacity makes the process smoother.

Trying to confirm these effects, Norel SA conducted a trial in a commercial farm in Spain.

A total of 144 animals were enrolled in the test, a standard diet without any kind of medication was used and half of the animals were supplemented with 1kg/t of Fecinor (E. faecium CECT 4515 1×10^9 CFU/g). Regular performance parameters were monitored such as body weight, feed intake, culling and mortality.

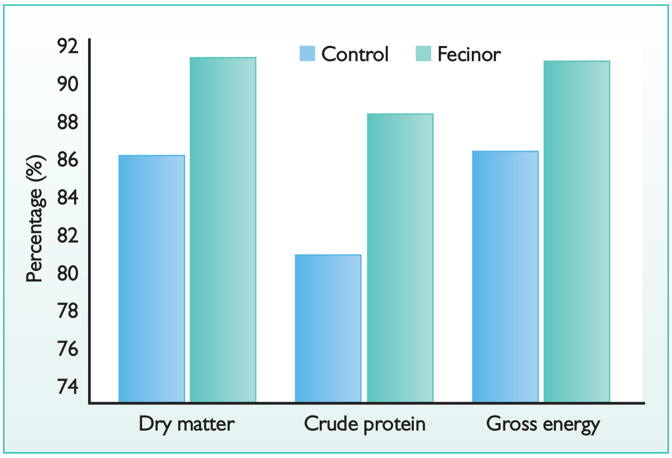
Average Daily Feed Intake (ADFI), Average Daily Growth (ADG) and Feed Conversion Rate (FCR) were calculated accordingly.

Furthermore, 72 pigs housed in 12 pens (six replicates per group) were fed diets mixed with chromic oxide from day 7 to 14 and from day 35 to 42. Then, faecal samples were collected daily for three days from every pen, to determine the Apparent Total Tract Digestibility (ATTD) of dry matter (DM), crude protein (CP) and gross energy (GE).

As can be observed in Table 2, overall growth rates (ADG) of the animals fed Fecinor were higher than the negative control group ($p>0.05$). Feed consumption was similar between groups, therefore feed efficiency was improved by Fecinor ($p<0.05$).

Apparent total tract digestibilities of the dry matter, crude protein and gross energy tended to improve with Fecinor ($p<0.10$) at the end of the nursery period (from days 40-42 post-weaning).

Fig. 1. Digestibilities of dry matter, crude protein and gross energy.



It was concluded that Fecinor resulted in better performance variables.

It could be explained, according to the study results, by the better digestibilities achieved by animals receiving Fecinor.

In summary, the benefits of using Fecinor are:

- Naturally found in the intestine, which makes it more environment-friendly. High replication rate compared to other LAB or yeasts.
- Forms a protective coating on the intestinal epithelium, thus contributing to avoid the development of the pathogenic bacteria.
- Produces large amounts of enzymes, especially proteases and amylases.
- Synthesises large quantities of lactic acid, a well known pathogen antagonist, and at the same time a readily absorbed energy source.
- Enhances the effects of endogenous proteolytic enzymes in the intestine.
- Improves production parameters. Average daily weight gain and feed conversion ratio.
- Helps in restoring the intestinal flora following treatments with antibiotics and in situations of stress. ■

References are available from the author on request