How gut health impacts producing a quality piglet

Despite disagreement over what constitutes a quality piglet versus a healthy piglet, these terms should be used interchangeably. Determination of quality is based on the piglet's ability to develop, survive, and grow, all of which require a healthy start. Accordingly, health is integral to establishing piglet quality, anchors early development in the pre-weaning phase, and yields more resilient piglets as they enter future phases of production.

by Aivija Midega and CallaBria Putrino, Tonisity.
www.tonisity.com

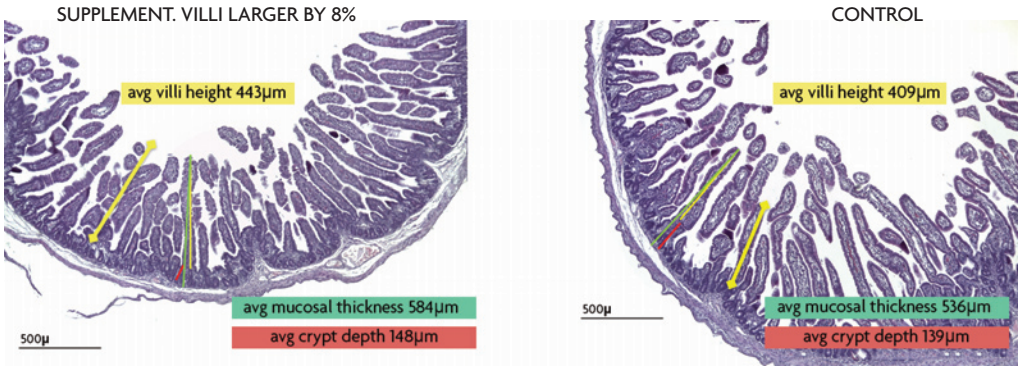

Fig. 1. The difference in the height of the villi when a supplement is given to piglets pre-weaning (left) versus no supplement present in the gut (right).

Healthy piglets are able to consume nutrition needed for consistent weight gain, inhibition of disease onset, and positive production performance. As average farm pre-weaning mortality ranges from 5-35%, proper nutrient provision is critical for maintaining physical health and viability.

The early development stage requires a focus on nourishing physical and intestinal health by fostering the colonisation and balance of the gut microbiota.

Given the gut's function in nutrient absorption, maintenance of gut health increases the piglet's immune defence while improving and increasing its ability to digest and absorb feed.

Intestinal development focusing on villi growth

The underdeveloped immune system with which piglets are born requires antibodies, health responses, and systematic protection that is passively acquired through the sow. Additionally, optimal nutrient absorption in the gastrointestinal (GI) tract is crucial to the pre-wean pig development. A piglet's highly specialised gut contains the majority of immune cells found within the intestine. These cells prevent absorption of harmful agents during gradual immune system maturation.

From birth, the piglet's intestine is in constant flux, structurally developing and increasing its quantity of micro-organisms. Such micro-organisms are responsible for piglet health and form the gut barrier function and physiology. They create the foundation for colonisation by healthy microbiota, fuelling suitable development of key immune cells, intestinal structures and digestive capacity.

● **Purpose of the villi:**
Within the gut, the small intestine is lined with finger-like projections called villi, which rapidly grow in length and increase in surface area. Enterocytes, cells responsible for nutrient absorption, cover approximately 80% of the villi's surface, while microvilli further increase the overall surface area of the enterocyte, thus maximising and enhancing nutrient absorption.

Enterocytes contain several mechanisms that provide pathways for nutrients to cross the barrier from the interior of the intestine to the bloodstream. Each of these systems absorbs targeted nutrient classes of carbohydrates, amino acids and fats. A well-nourished gut in a developing piglet leads to higher villi production that promotes optimal absorption of nutrients. This production increase results in larger individual villi, providing greater surface area to better augment nutrient digestion, absorption, transportation throughout the body, and an increased immune defence response. Building a healthy intestinal structure and microbiota environment in the pre-weaning pig shapes the gut to maintain this environment, while enduring the stressors weaning places on the immune system.

Gut microbiota

Bacteria, fungi, viruses, parasites, archaea and protists coexist in the pig's gastrointestinal tract, forming a diverse and complex microbial community. This community is referred to as microbiota or microbiome. This vast population has been estimated to be 1 x 10^{11} per gram in the pig colon, forming a complex ecosystem and a symbiotic relationship with the host.

Newly born piglets gradually establish the intestinal microbiota even before birth. The first contact with micro-organisms is through the sow's birth canal and her faeces.

Once piglets start to consume colostrum and milk, further colonisation will occur. The main initial bacteria that will colonise belongs to the genus lactobacillus, which is a lactic acid bacteria.

The microbial composition continues to be shaped by internal and external influences until it finally stabilises. These influences can be due to diet and environment changing, probiotic and prebiotic supplementation, and in-feed antibiotics.

● **Importance of the microbiota for the piglet:**
The gut microbiota resides outside the mucosal layer of the intestine and performs a variety of symbiotic functions for the pig. The intestinal microbiota is involved in developing the pig's immune system, production of volatile fatty acids, vitamins, and fibre fermentation. It also plays an important role in communication between the gut and the brain.

The gut microbiota is critical in shaping piglets' growth and will have an impact on the piglet's entire life. It is essential for the early piglet to establish a healthy intestinal microbial community, minimising the negative effects of the changing diet and environment at weaning.

Beneficial bacteria in the gut

As mentioned above, the microbiota is a diverse and complex ecosystem with many different micro-organisms. Such micro-organisms have the potential to be beneficial to the piglet, become potentially pathogenic, or have various roles depending on the species, sub-species or gut condition.

● **Lactobacillus species:**
Lactobacillus bacteria is seen as beneficial to the gut, being one of the first to colonise within the intestine. Intestinal goblet cells create a dense mucus layer by

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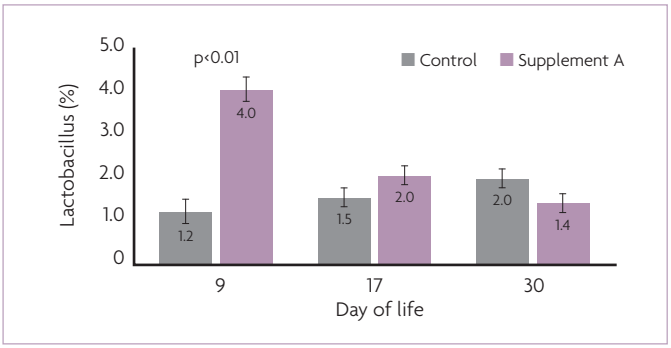

Fig. 2. The abundance, in percentage, of beneficial lactobacillus in the gut when sampled at 9, 17, and 30 days of age. Significant difference observed at day 9.

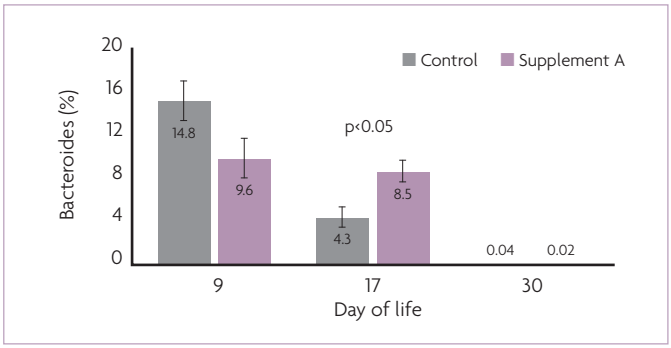

Fig. 3. The abundance, in percentage, of the beneficial Bacteroides bacteria (belonging to the phyla Bacteroidetes) in the gut with significant difference being seen at day 17. Bacteroides was found in almost two times more abundance in the gut of the test pig.

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producing mucin, creating an impermeable layer to pathogens and toxins. Lactobacillus stimulates mucin production, which improves the gut barrier.

As a result, it is critical for piglets to consume colostrum and milk early in life, to colonise the intestinal microbiota and develop the immune system. It has been shown that increased numbers of Lactobacillus will decrease the number of Escherichia coli (E. coli) in the microbiota.

● **Bacteroidetes and Firmicutes:**
Another major function of the gut microbiota is the ability to provide energy to intestinal cells. The preferred energy substrate is short-chain fatty acid (SCFA) butyrate that is produced by fermenting carbohydrates that are otherwise not digestible by the pig. Bacteroidetes and Firmicutes phyla start to colonise a week after birth and eventually become the dominant microbes in the pre-weaning piglet's gut. Bacteroidetes phyla mainly produce SCFA of acetate and propionate which have been shown to improve gut function. Firmicutes phyla mainly produce SCFA butyrate which promotes normal proliferation and differentiation of intestinal cells. It has been shown that SCFA in adequate quantities can have a direct antimicrobial effect against pathogenic bacteria. For example, the production of propionate meditates the colonisation of salmonella bacteria.

Potentially pathogenic bacteria in the gut

The potentially pathogenic bacteria in the piglet's gut are present in low numbers under normal conditions. This is usually due to needing the same resources as beneficial bacteria such as habitat and nutrition. Stress or external changes can cause imbalance to the microbiota, giving the potentially pathogenic bacteria opportunities to thrive and cause diseases such as diarrhoea.

● **Escherichia coli:**
E. coli is commonly present in the piglet's microbiota, a potentially pathogenic bacteria waiting for the opportunity to devastate the intestinal environment.

Enterotoxigenic E. coli is well known throughout the swine industry as the main infectious agent of diarrhoea in pre-weaning and post-weaning piglets. The colonisation in the mucosal layer of intestine by E. coli has been shown to shorten the villi and the development of epithelial lesions in the intestines. The increased numbers of E. coli during diarrhoea leads to decreased numbers of the beneficial bacteria lactobacillus and vice versa.

● **Clostridiales:**
There are several species belonging to the order Clostridiales such as Prevotellaceae and Ruminococcus species which can be beneficial to the piglet. However, some species are well-known to cause diarrhoea in newly born piglets, Clostridium perfringens (C. perfringens) Type C being one of them. C. perfringens releases toxins that cause necrosis of the structural components of the villi, leading to severe diarrhoea.

Clostridioides difficile is another type of bacteria known to cause diarrhoea in newly born piglets, creating lesions in the intestinal tract. Both Clostridiales bacteria and E. coli have been detected in the first six hours of a piglet's life. Therefore, it is important for piglets to consume colostrum to allow the lactobacillus bacteria to colonise, removing the nutrients and habitat of the potentially pathogenic bacteria. The gut contains many more beneficial and potentially pathogenic bacteria, however, not all functions are currently known.

Benefits of using a nutritional supplement

When fed a diet containing the key nutrients of carbohydrates, amino acids, and fats, a piglet's intestinal environment is better suited to properly function by forming structural and bacterial components. However, gut functions are potentially amplified using an electrolyte solution or other nutritional supplements.

Such supplements often augment hydration delivery, foster increased production of healthy gut microbiota, and catalyse digestion and absorption. The resulting environment further promotes cell growth and encourages early gut development and function substantially more so than in piglets for whom the supplement is withheld. These supplements are generally given in the pre-wean stage, improved results being observed during the piglet's transition into the weaning phase.

Nutritional supplements targeted at further improving intestinal health greatly benefit gut structural integrity and growth. In a study that used an isotonic protein solution in a pre-wean piglet's first days, a positive change in its gut microbiota and intestinal function was observed.

Gut microbiota and structural changes were evaluated through intestinal and faecal samples collected at 9, 17, and 30 days of age. Analysis of its microbiota showed an increase in beneficial bacteria (see Figs. 2 & 3), decrease in potentially pathogenic bacteria (see Fig. 4), and improved intestinal development, as a result of the supplemental solution. The solution also caused structural change to the intestine as observed in broad increases in villi height (see Fig. 1). Therefore, taller villi will provide greater surface area for more enterocytes to develop, thus leading to increased nutrient absorption and improved enterocytic function.

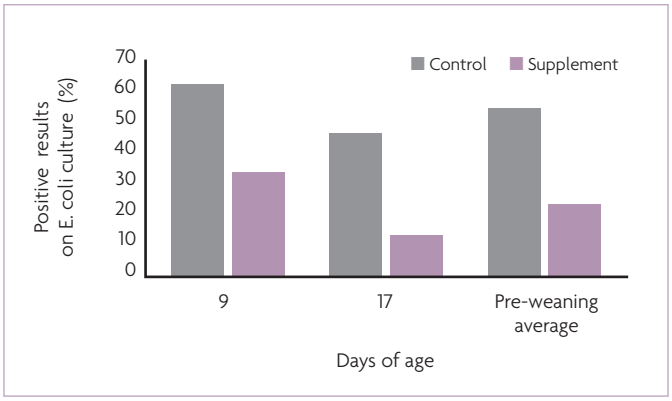
The key to producing quality piglets is using a nutritional supplement like Tonisity Px, an isotonic protein drink that draws the piglets to drink from day two.

The solution is scientifically formulated to provide the right combination of electrolytes, amino acids and energy to the enterocytes to make them work harder.

Tonisity Px helps to stimulate and boost the growth of the small intestinal villi and promotes a beneficial gut microbiome profile from early life, supporting the piglet through productivity hurdles.

Development of a healthy gut encourages piglets to consume the nutrition needed for consistent weight gain, improve mortality, and positive production performance. ■

Fig. 4. The percentage of positive cases of E. coli both on individual collection days as well as the average percentage of cases during the pre-weaning stage.



References are available from info@tonisity.com on request