An Ecological and Nutritional Strategy for Gastrointestinal Microbiota

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The swine industry is currently experiencing disease challenges with diarrhea and PRRS (Porcine Reproductive and Respiratory Syndrome), which have greatly frustrated both farmers and consumers alike. There are many potential causes of these diseases, such as pathogenic bacteria, blends of mycotoxins, environmental stress and ration changes, which are all linked to the health status of the gastro-intestinal tract.

1. Why Focus on Microflora for Gastrointestinal Health?

The concept of "Healthy feeding" concentrates on the health of the entire group as well as individual pigs.

Microflora exists in every part of the gastrointestinal tract, from the stomach to the rectum. The stomach however, generally contains a lower population, due to the presence of gastric acids. In comparison, the microbial population is larger in the small intestine (duodenum, jejunum, ileum) and reaches its highest level in the cecum and the colon in the large intestine. Microbe population numbers can reach up to 1×1014, which is 10 times the number of cells present in the human body. These bacteria are closely associated with growth, in particular, digestion, absorption and intestinal immunity.

Generally, microecology is the sum of microorganisms, diet and host ecology. Both the host and microorganisms can utilize the nutrients at the same time. Microorganisms are able to transform some nutrients into antimicrobial agents, which can then play an important role in immune response function. Besides, vitamins and short chain fatty acids, butyric acid, (which is the preferred energy source for development of intestine) can also be produced by the microorganism in the gastrointestinal tract. Therefore, it could be concluded that microecology plays an important role in maintaining the health status of the host.

2. Gastrointestinal Health

As a result of sudden dietary and environmental changes associated with weaning, the protection afforded by gastric acid in the stomach becomes weaker. As a result, there is an increase in pathogen numbers, allergens and abnormal fermentation in the intestine. This can lead to diarrhea and growth retardation in the young pig.

2.1 Gastric Acid Protects the Gastrointestinal Tract

A higher pH value (Figure 1) could be observed in the stomach after weaning with a related reduction in the protective function of gastric acids. Instead of reducing pathogen numbers, the higher pH values actually resulted in an increase in their numbers, possibly due to the poorer nutrient utilization. Therefore, a high gastric pH value indicates a decreased protective function in the stomach, causing the pathogens to become the predominant microorganism in the gastrointestinal tract. For example, three species of pathogens, *Escherichia fergusonii, Escherichia coli*, and *Streptococcus gordonii*, play a predominant role in the intestine three days after weaning. *Escherichia* is the main pathogenic bacterial genus that causes diarrhea. It damages the function of microvillus and adheres to the surface, causing a reduction in absorption

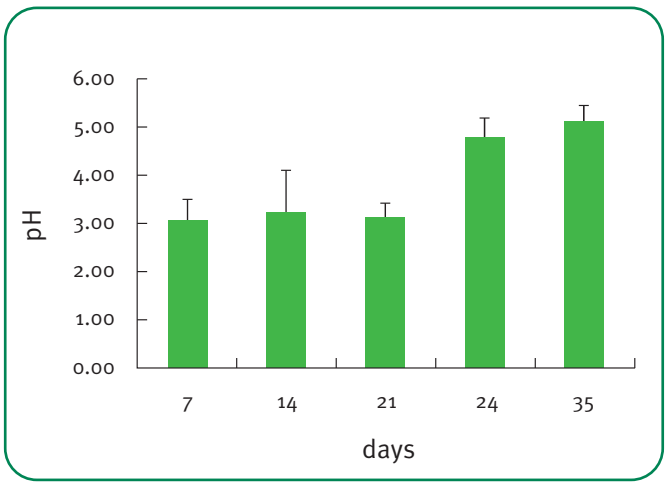

Figure 1. Digesta pH in stomach of nursery pigs

ability, which contributes significantly to diarrhea in weaning pigs. Previous studies have also shown high populations of *Streptococcus* in the gastrointestinal tract of healthy pigs, which may not necessarily cause disease. However in certain circumstances this can lead to disease and death both in pigs and in humans. Therefore, innovative micro-ecologics (probiotics) should be used to control *Streptococcus*.

2.2 Allergy and Gastrointestinal Microflora

Before weaning, breast milk is the main food for nursery pigs, its protein structure is simple and easily digested and utilized. The protein source for weaned pigs is mainly from soy, which is comparably complex (Figure 2); however, it also contains anti-nutritional factors, which can lead to allergy in the intestine and impair the health of young pigs. We also found that the adult pig can degrade soy protein completely but nursery pigs are unable to degrade it completely in vitro. In practice, the fermentation of soybean meal is the usual way to reduce the amount of antigens and avoid gastro-intestinal allergy. However, the effect varies amongst different products. Some of the fermented products may have a negative effect and even increase the rate of diarrhea in weaning pigs after feeding. Therefore, many factors should be considered e.g. anti-nutritional factors (those can be degraded and transferred); bacterial species (can be used to degrade soy protein); and the place where bacterial works.

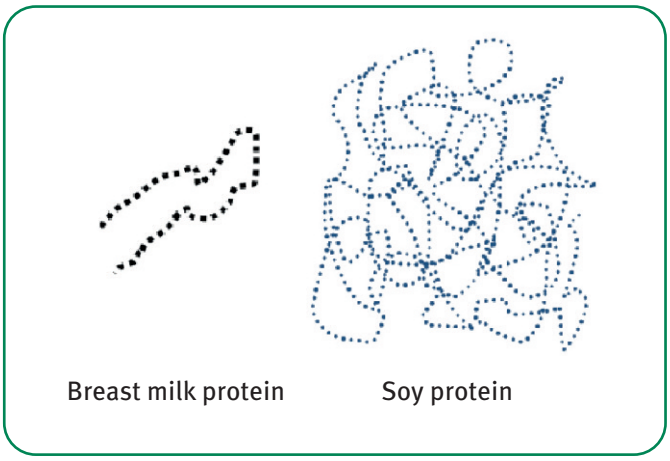

Figure 2. Structure of breast milk and soy protein

2.3 Abnormal Fermentation in the Gastrointestinal Tract

Abnormal fermentation in the intestine occurs when the undigested soy protein complex passes into the large intestine, and produces large amount of noxious gas. This may cause intestinal abnormality and lead to diarrhea. Consequently, protein indigestion is a common cause of diarrhea in swine farming.

3. Nutritional Strategy for Gastrointestinal Health

3.1 Active Substance Produced by Gastro-intestinal Bacteria

Plant isoflavones may positively affect the health status of the animal and consequently its growth performance. Previous studies have shown that intestinal microflora are able to transfer plant isoflavones into equol, which can be absorbed by gastric mucosa, and are able to modulate the physiological function of animals. Results of growth trials using flavonoids in poultry and swine have shown significant improvement in production performance, and it has been suggested that this effect is associated with gastro-intestinal microflora. The clinical effect of flavonoids appears to depend on whether it can be converted into equol. Equol can only be transferred by bacterial in the intestine, and cannot be synthesized by humans or mice. Therefore, the intestinal microflora plays an important role in the effectiveness of isoflavones. For example, an infant is not able to produce enough equol because their microflora is not fully established, and some people do not possess the bacterial species necessary to transfer flavonoids. In these cases, isoflavone products are not always effective in every person. Similarly, the effects of isoflavones in pigs are not always consistent due to different gastrointestinal environments, indicating that isoflavone may also not always effective for every pig. In addition, our previous studies have demonstrated that Chinese pigs may have a greater ability to produce equol than the imported ones, which confirms the importance of intestinal microbial populations in the effectiveness of isoflavones.

3.2 Improvement in Uniformity by Probiotics

Lactobacillus is an inherent component of the intestinal flora. It plays an important role in immunity of the intestinal mucosa, and the physical protection and the absorption function of the intestine, as it adheres directly to the intestinal wall. Therefore, we may find a good colonization effect in the intestinal tract by introducing a probiotic strain which has been isolated from the intestine of nursery pigs. An increase in *Lactobacilli* and a decrease in *Streptococcus* numbers in the intestine were seen when probiotics were given to the animal, making *Streptococcus* no longer the predominant bacteria. Results from experiments conducted in farms located in Zhejiang, Jiangsu, and Shanghai, R.P. China showed that even if the feeding of probiotics to nursery pigs did not affect growth performance, it improved the uniformity of whole group (Figure 3). The reason may have been that the probiotic generally keeps the pigs healthier, leading to a reduced incidence of diarrhea in the weaker pigs.

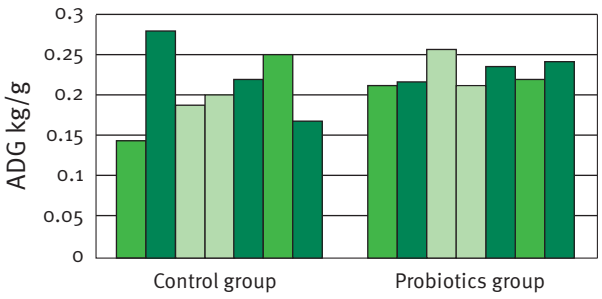

Figure 3. The effect of probiotics on body weigt uniformity of nursery pigs

4. Conclusion

With the development of the modern feed industry and increasing challenges within the swine industry, attempts have been made to improve the gut health of the animal for a long time, with products such as acidifiers, probiotics, essential oil etc. However, it should be noted that results are not always consistent, which may be due to the different conditions found in each experiment. As the mechanism of action on the intestinal ecology are different, a combination of several proven and effective additives may give a better return on investment in practical swine production.