New preventive approach to bacterial infection to ensure healthy piglets

Weaning causes nutritional, psychological, social and environmental stress for piglets. During this period, piglets are separated from the sows and moved to a new environment. Feed is changed from milk to solid feed, and piglets have to live with unfamiliar piglets from different sows.

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In addition, diarrhoea may occur frequently due to a decrease in function or a decrease in immunity due to the immaturity of the digestive system. Piglet diarrhoea is a gastrointestinal disease in pigs that can be caused by various species of bacteria such as Escherichia coli, Salmonella typhimurium, Salmonella enteritidis, and clostridium right after weaning.

This could lead to diarrhoea, dehydration, poor growth performance, and even death, which can cause great economic loss to farms. Therefore, the livestock industry has made many efforts to control these pathogenic bacteria, and antibiotics have been widely used to inhibit these.

However, broad-spectrum antibiotic abuse can exacerbate the problem by causing antibiotic resistance to both pathogenic and non-pathogenic bacteria. Studies have reported that 35% of E. coli from pigs in several countries are already resistant to antibiotics.

Ban the use of AGPs

In this situation, scientific and medical groups have been insisting on the banning of antibiotics use to promote animal growth for decades because an antibiotic-resistant bacteria, known as the 'Superbug' is threatening the world. Since the European Union first banned the use of AGPs in 2006, regulations on the use of antibiotics for growth promotion are being banned in many countries.

In 2017, the US Food and Drug Administration (FDA) proposed new guidelines to ban AGPs, and allow only those antibiotics prescribed by veterinarians for disease treatment considering animal welfare and health.

However, the ban on AGP increased piglet diarrhoea and resulted in impaired growth performance and high mortality. Therefore, it is necessary to reduce the use of antibiotics or to control post-weaning diarrhoea in piglets in response to antibiotic-resistant bacteria.

Bacteriophages: the next alternative to antibiotics

Bacteriophages are potential alternatives to antibiotics. Bacteriophages are bacteria-eating viruses that only kill the targeted bacteria without any negative effects on human or animal cells. They have the largest number of particles (10^{31}) on the planet and can exist in various environments such as seawater, freshwater, soil, and food.

Bacteriophages attach to the bacterial cell membrane and inject their genetic information into the bacterial host to infect the bacteria, leading to the lysis of the bacteria. In this action, the bacteria are killed by the bacteriophage.

Safe and sustainable bacteriophages

A lytic bacteriophage is a micro-organism that selectively kills bacteria in a species-specific manner, without causing any genetic mutation. The US FDA has approved this bacteriophage as a GRAS (Generally Recognized As Safe) substance.

The effectiveness of bacteriophages

Since bacteriophages can exhibit their effects on bacteria that have acquired resistance to antibiotics, they may have a superior antibacterial effect to antibiotics.

Fig. 1 shows the growth of E. coli when colistin-resistant E. coli bacterium is treated with a bacteriophage and colistin.

Colistin treatment did not completely inhibit the growth of bacterium which is already resistant to antibiotics, whereas the bacteriophage showed complete control over this bacterium.

This result indicates that it could be the best answer as an alternative to antibiotics.

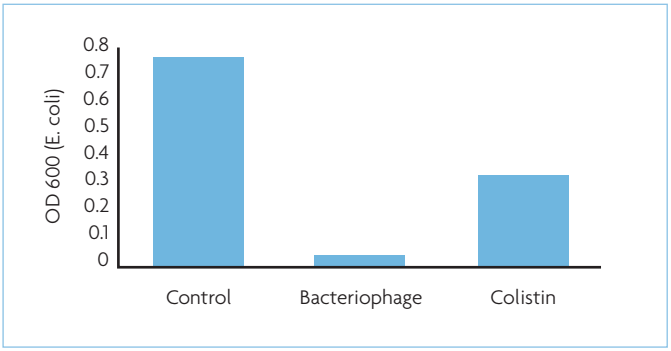
The effect of dietary supplementation

In 2015, a trial was conducted to evaluate the effect of dietary supplementation of bacteriophages in piglet diets on a commercial farm in Korea. The trial was performed on 1,300 sow farms and bacteriophages were added to piglet diets at the inclusion level of 0.1% from the beginning of June.

After starting bacteriophage feeding on this farm, where the mortality rate was rapidly increased by E. coli, the mortality rate of piglets steadily decreased and improved post-weaning diarrhoea. (Fig. 2)

Continued on page 12

Fig. 1. The effect of bacteriophage on the antibiotic-resistant bacterium.



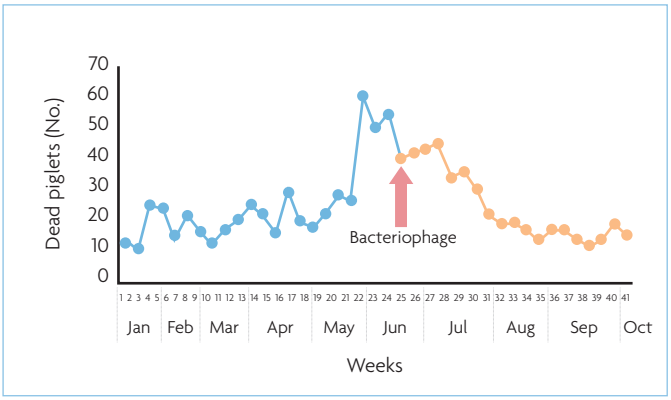


Fig. 2. Piglet mortality on a commercial farm.

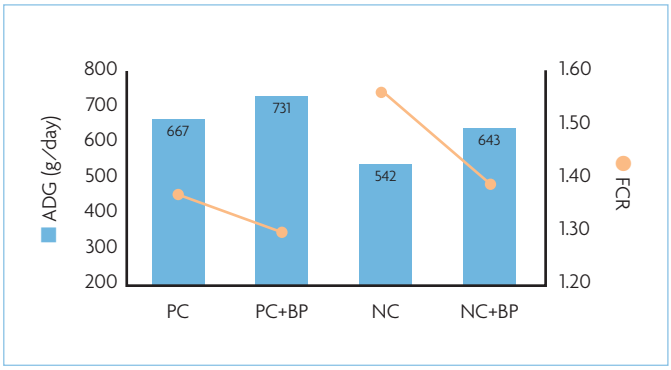


Fig. 3. The effect of dietary supplementation of bacteriophage on growth performance in piglets challenged with S. typhimurium.

Continued from page 11

Salmonella challenge trial

A total of 48 weaning pigs were given a basal diet for three days for adaptation.

Following the adaptation period, piglets were allotted to a completely randomised design in 2×2 factorial arrangement treatment, with a bacteriophage product (ProBe-Bac SE: 0 and 0.1%) in Pathway Intermediates and Salmonella typhimurium challenge (either challenged or not) serving as the two factors.

Treatments included PC (basal diet), PC+BP (basal diet + 0.1% bacteriophage), NC (basal diet + Salmonella typhimurium challenge) and NC+BP (basal diet + Salmonella typhimurium challenge + 0.1% bacteriophage).

A total of four pens per treatment were used with three pigs per pen. Salmonella typhimurium was orally administered at the level of 1.5×10^{11} CFU/20ml.

Salmonella challenge significantly compromised ADG and FCR, while bacteriophage supplementation increased ADG and significantly decreased FCR (Fig. 3).

During the six days after the salmonella challenge, the faecal concentration of salmonella and bacteriophage were measured.

Since day three of post-challenge, NC+BP treatment significantly reduced faecal salmonella counts compared to NC treatment.

Also, since day one of post-challenge, NC+BP treatment showed significantly higher faecal bacteriophage counts compared to PC+BP treatment.

This study indicates that bacteriophage supplementation can effectively control or prevent Salmonella typhimurium infection in weanling pigs suggesting bacteriophages as a proper antibiotic alternative.

Conclusion

Bacteriophages settle in the intestines of animals and regulate the population balance of the gut microbiota by reducing the number of specific pathogenic micro-organisms, improving animal growth and feed efficiency.

The powerful combination of bacteriophages selected against E. coli, salmonella, and clostridium allows various diseases that are prevalent in swine to be inhibited, such as oedema, septicaemia as well as diarrhoea. Bacteriophages could be the safest and most reliable alternative to antibiotics. ■