Combined products for post weaning diarrhoea – are they worth a look?

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The main goal of animal production is to achieve the best performance while avoiding any possible threats that may endanger the animal. As many factors contribute to the outbreak of post-weaning diarrhoea, it is difficult to avoid its occurrence completely.

Even though much effort has gone into making pig units more economically efficient by shifting towards earlier weaning in the last decade, weaning at four weeks of age remains a common practice in most countries.

Active immunity

At four weeks of age, the piglet has just begun developing an active immunity, which makes them vulnerable. Moreover, the changes that newly weaned pigs are exposed to, such as an abrupt diet change, separation from the sow, new environment, mixing with other litters, etc, represent severe sources of stress.

In the early days post-weaning, piglets may show signs of non-infectious diarrhoea, such as increased excretion of fatty acids and carbohydrates in faeces, watery stools and negative changes in the villi of the small intestine. During this time when the immune system has not yet fully developed, the stresses that piglets encounter due to changes in their environment and diet makes them extremely susceptible to the presence of pathogenic bacteria and non-infectious diarrhoea.

This increases the risk of post-weaning diarrhoea syndrome, which is caused mainly by enterotoxigenic E. coli or salmonella.

In general, between 20-50% of all weaned piglets may be affected, resulting in high economic losses for the producer due to the poor condition of the animals.

Organic acids

Studies have shown that the use of organic acids can have positive effects on the control of post-weaning diarrhoea by reducing not only the incidence but also the severity of diarrhoea.

In general, organic acids act against bacteria in two different ways.

The inclusion of organic acids to a diet results in a reduction in gastric pH, creating unfavourable conditions for pathogenic bacteria which cannot survive in acidic environments. However, in their non-dissociated form, organic acids are also able to penetrate the bacterial cell, which leads to a reduction of the intracellular pH and a disruption of the DNA and protein synthesis.

As a consequence, the bacterial cell is not able to replicate.

Even though single acids have positive effects on the inhibition of pathogenic bacteria and are able to control post-weaning diarrhoea, it has been shown that acid blends are even more effective than single acids in inhibiting pathogenic bacteria, due to their broader spectrum of activity compared to single acids.

However, it was hypothesised that combining acid blends with phytochemicals, which are in general defined as active-health compounds found in plants, could increase the effects of organic acids on the growth inhibition of pathogenic bacteria.

Cinnamaldehyde, a phytochemical occurring naturally in the bark of cinnamon trees, is known to be a strong antimicrobial as it targets the FtsZ protein which plays a major role in the cell division of potentially harmful bacteria.

In the presence of cinnamaldehyde, the cell division is inhibited, resulting in a reduced bacterial load. It was shown in studies done in vitro that combining cinnamaldehyde with a blend of organic acids enhances the inhibition effects on the growth of pathogenic bacteria from 2.3 to 30%.

Inherent resistance

Even though organic acids and phytochemicals have antimicrobial effects that can combat possibly harmful bacteria more effectively, the structural differences between Gram-positive and Gram-negative bacteria have to be taken into account.

The cytoplasm of the cell is surrounded by the cytoplasmic membrane, which is covered by a thick cell wall layer. This layer is significantly thinner in Gram-negative bacteria than in Gram-positive bacteria. Gram-negative bacteria are surrounded by an additional outer membrane.

This outer membrane provides the bacteria with an inherent resistance to antimicrobial substances.

Even if the outer membrane of the Gram-negative cell acts as a protective barrier for external agents, it is possible to weaken this

Table 1. The effect on growth performance parameters, diarrhoea index and jejunal morphology.

<table>
<thead>
<tr>
<th></th>
<th>Negative control</th>
<th>Positive control</th>
<th>Bioticron Top3 (1kg/ton of feed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of animals</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Initial bodyweight day 3 (kg)</td>
<td>10.0</td>
<td>10.9</td>
<td>10.7</td>
</tr>
<tr>
<td>Final bodyweight day 91 (kg)</td>
<td>42.5</td>
<td>43.2</td>
<td>48.1</td>
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<tr>
<td>Feed intake (g/animal/day)</td>
<td>1092</td>
<td>1112</td>
<td>1269</td>
</tr>
<tr>
<td>Daily weight gain (g)</td>
<td>580</td>
<td>578</td>
<td>668</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>1.88</td>
<td>1.92</td>
<td>1.90</td>
</tr>
<tr>
<td>Mortality (No. of animals)</td>
<td>1</td>
<td>2</td>
<td>/</td>
</tr>
<tr>
<td>Diarrhoea index</td>
<td>1.90</td>
<td>1.89</td>
<td>1.24</td>
</tr>
<tr>
<td>Villus height (µm)</td>
<td>418.33</td>
<td>448.63</td>
<td>456.18</td>
</tr>
<tr>
<td>Crypt depth (µ)</td>
<td>192.37</td>
<td>188.77</td>
<td>187.15</td>
</tr>
</tbody>
</table>

* * Means with different superscripts differ at P<0.05.

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barrier by using agents commonly characterised as permeabilisers.

Permeabilising substances act quite differently one from the other. Some remove stabilising cations from the outer membrane, while others bind to the outer membrane, resulting in the loss of barrier function, etc. However, they all weaken the outer membrane of Gram-negative bacteria. This may increase the efficacy of other antimicrobials as it is easier for them to enter the cell and inhibit or destroy vital cellular functions. This means that when a permeabilising substance is added to a mixture of organic acids and a phytochemical, the effects on the inhibition of pathogenic bacteria by an organic acid-phytochemical might be enhanced by 10-70%, depending on the bacteria strain.

The effect of combining organic acids (OA), phytochemical cinnamaldehyde (CA) and permeabilising substance (PS) on the growth performance, diarrhoea index and intestinal morphology was evaluated in a trial carried out at the Research Center of Hunan Agricultural University, Changsha, Hunan, China, using 96 weaning pigs. Pigs were assigned to three treatments (BW 10.5 kg; 35 days) and fed commercial pig diets.

The negative control (NC) group diet contained no feed additives, while the positive control (PC) group was supplemented with antibiotics (100g/t colistin and 100g/t chlortetracycline). The diet of the trial group with a natural growth promoter (NGP) consisted of a blend of OA, CA and PS (Biotronic Top3, Biom in, Austria) at an inclusion rate of 1.0kg/t feed. The duration of the trial was 56 days. The weight and feed intake of the pigs was recorded and feed conversion calculated. Mortality and clinical symptoms for diarrhoea were observed daily. The severity of diarrhoea was assessed from 1 to 3 (soft faeces, fluid faeces and severe diarrhoea). The samples of jejunum were taken and analysed for villus length and crypt depth. The results are presented in Table 1.

**Growth performance**

The study results showed that the growth performance was improved by using antibiotic and natural growth promoters. The body weight, feed intake and daily weight gain was improved in the NGP group by 11, 14 and 16% respectively, compared with the PC group.

Diarrhoea index was lowest in the NGP group followed by the PC group, indicating the firmer faeces by dietary supplementation with the blend of OA, CA and PS.

The results of jejunum morphology showed that NGP had a positive influence on villi development, increasing villi length and shortening crypt depth. Longer villi have a greater absorption area, which improves nutrient absorption and enhances growth performance. In vitro studies have shown that combining NGP products could bring real benefits to the end user.

The combination of different natural substances leads to a synergistic effect in terms of antimicrobial efficacy and enhancement of animal growth performance. This also leads to a reduction in the inclusion level, resulting in maximised benefit.

The positive effects were not only shown on the inhibition of pathogenic bacteria in vitro. In vivo studies also showed positive effects of NGP on growth performance, partly related to the improved nutrient absorption area due to the longer villi.

The in vivo studies showed that supplementation with the NGP reduced the severity of diarrhoea, which might be related to the reduction of pathogens in the gastro-intestinal tract. Thus, a mixture of a high amount of free organic acids, together with phytochemical and permeabilising substances (Biotronic Top3) can be seen as one management tool that improves animal growth performance and controls the growth of pathogenic bacteria such as E. coli and salmonella, the main culprits of post-weaning diarrhoea.

However, while the use of NGPs may control post-weaning diarrhoea, it cannot completely eliminate it as several other factors such as management and diet also contribute to the occurrence of the disease.