Understanding how potentiated ZnO works against post-weaning diarrhoea



Pig producers worldwide are looking for effective ways to control post-weaning diarrhoea while reducing the use of zinc. This raises an important question: can a zinc source be designed to support diarrhea control at substantially lower inclusion levels? And how does its mode of action differ from conventional zinc sources?

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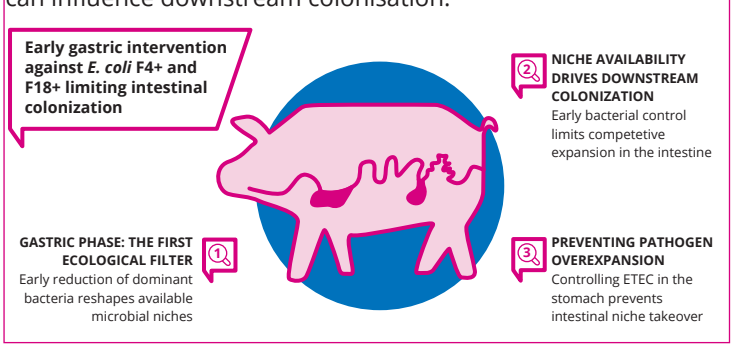
Post-weaning diarrhoea (PWD) remains one of the most important health and performance challenges in pig production worldwide. The condition is mainly associated with enterotoxigenic *Escherichia coli* (ETEC), in particular the F4 and F18 strains, which can proliferate rapidly after weaning and disrupt intestinal integrity, nutrient absorption and animal performance.

The importance of controlling bacteria early

The immediate post-weaning period creates ideal conditions for bacterial proliferation. Reduced feed intake, abrupt dietary changes, immature digestive function and stress collectively destabilise the gut ecosystem. At the same time, gastric acidification capacity is still limited in young piglets, leading to higher stomach pH values than in mature pigs.

This point is critical because the stomach acts as the first ecological filter protecting against pathogenic bacteria. Under normal conditions, gastric acidity limits bacterial survival before microorganisms reach the intestine. However, when stomach pH increases after weaning, this barrier becomes less effective, allowing larger bacterial populations (including ETEC) to enter the small intestine alive. This "niche concept" helps explain why controlling bacterial pressure upstream, at the stomach level, is fundamental for reducing intestinal colonisation later in the digestive tract (F*igure 1*).

Figure 1 – Niche concept: early bacterial control in the stomach can influence downstream colonisation.



The scientific literature consistently demonstrates that pharmacological doses of ZnO have antibacterial properties. However, not all zinc sources behave similarly within the gastrointestinal tract when used at lower inclusion levels. Their efficacy depends largely on their physicochemical characteristics, particularly solubility (which should be neither too fast nor too slow) and surface reactivity (specific surface area). Importantly, the antibacterial effect of ZnO should not be understood as zinc ion release alone. For ZnO sources, antibacterial activity is



A young piglet in the post-weaning period. Photo: **Animine**

linked to both controlled Zn^{2+} release and particle-related properties, including surface interaction and contact with bacterial cells. A potentiated source of ZnO (HiZox) was developed to combine these characteristics through enhanced surface reactivity and controlled dissolution, promoting antibacterial activity in the stomach while supporting beneficial effects throughout the small intestine (*Figure 2*).

Working beyond the stomach

While stomach activity is essential, effective PWD control also requires sustained action throughout the intestine. As digesta moves toward the small intestine, pH progressively increases, and the bacterial environment changes considerably. ETEC adhesion, enterotoxin production and intestinal disruption mainly occur in this region. Through its controlled dissolution, HiZox initiates antibacterial activity in the stomach and maintains its effects into the small intestine, sustaining antibacterial pressure where ETEC proliferation becomes most problematic (*Figure 2*).

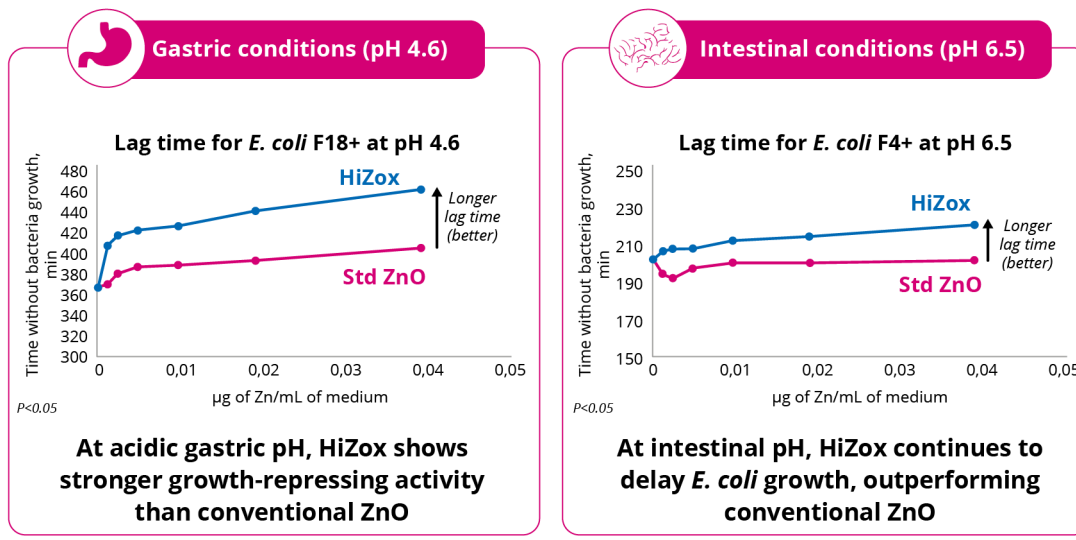
Additionally, the source of ZnO has also been shown to improve intestinal integrity. Peer-reviewed studies have reported increased transepithelial electrical resistance, enhanced intestinal alkaline phosphatase activity, improved villus morphology, and better preservation of tight junctions. Excessive bacterial proliferation disrupts these protective mechanisms, leading to poorer nutrient absorption while increasing the risk of diarrhoea. By helping control bacterial populations, it contributes to maintaining digestive efficiency during one of the most critical physiological stages in pig production.

From gut health to animal performance

The biological effects observed at the gastrointestinal level ultimately translate into productive performance. Several experimental studies evaluating the potentiated source of ZnO under different conditions have reported improvements in diarrhoea control, average daily gain and/or feed efficiency compared with control groups. Importantly, these responses were achieved at zinc inclusion levels substantially below those used in traditional pharmacological ZnO programmes.

In an ETEC challenge study conducted at the University of Bologna, piglets receiving HiZox showed improved faecal consistency and maintained growth performance despite *E. coli* challenge (*Figure 3)*. These results support the hypothesis

Figure 2 – Enhanced gastric and intestinal antibacterial activity of HiZox against *E. coli* compared to standard ZnO.



that efficient bacterial modulation can significantly reduce the physiological consequences of post-weaning stress. Beyond individual studies, a broader analysis of available data further reinforces the consistency of the response. Across 45 trials versus pharmacological ZnO, conducted on four continents and involving more than 9,000 piglets, the product demonstrated positive return-on-investment responses in approximately 80% of evaluated conditions, with most of the remaining studies showing neutral response depending on farm context and nutritional programme. Considering only peer-reviewed studies conducted with HiZox®, the product provided comparable diarrhoea control to pharmacological ZnO at substantially lower inclusion levels (Figure 3B). This consistency across studies supports the reliability of the response despite differences in health status, farm conditions and nutritional programmes.

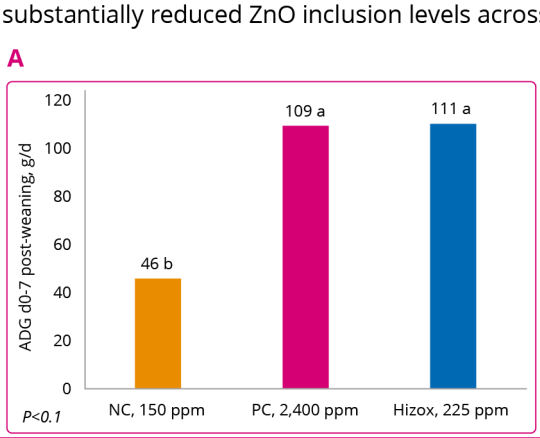
Take home message

Post-weaning diarrhoea remains a multifactorial challenge strongly linked to bacterial pressure and gastrointestinal instability after weaning. HiZox's mode of action combines early bacterial control in the stomach with sustained activity in the intestine. This effect is linked not only to Zn^{2+} release, but also to the specific physicochemical properties of the product, including controlled dissolution and high specific surface area.

For producers, the practical value lies in using zinc more efficiently: targeting bacterial pressure early, maintaining activity through the intestine and supporting performance with lower zinc input. This makes the product relevant not only where pharmacological ZnO is restricted, but also where producers are preparing for more sustainable and future-ready post-weaning programmes.

References available upon request

Figure 3 – *In vivo* performance under *E. coli* challenge **(A)** and consistent diarrhoea control at substantially reduced ZnO inclusion levels across peer-reviewed studies with HiZox (**B**).



B

STUDY	DOSE OF ZnO	DOSE OF HiZox
1 Vahjen *et al.*, 2016	3 kg	~ 20x lower
2 Wang *et al.*, 2018	3 kg	~ 27x lower
3 Pen *et al.*, 2019	3 kg	~ 15x lower
4 Moita *et al.*, 2022	3 kg	~ 6x lower
5 Riedmüller *et al.*, 2026	3 kg	~ 20x lower
6 Ming *et al.*, 2024	2 kg	~ 4x lower
7 Nielsen *et al.*, 2022	1 kg	~ 10x lower