Zinc oxide and post-weaning challenges in pig production

The process of weaning, which generally occurs 21-28 days after birth, is one of the most stressful events in the pig's life, as it entails dramatic changes in both nutrition and environment.

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The animals experience stresses due to physiological, environmental and social challenges when weaned from the sow, which in turn may contribute to intestinal and immune dysfunctions.

These stressors have a strong impact on the piglet's health, as they often lead to post-weaning diarrhea (PWD).

As it results in either piglet death or poor weight gain in surviving piglets, but also poor performance in the long term throughout the rearing and fattening phases, PWD is a major cause of economic losses for the pig industry and producers.

Zinc oxide supplementation

Supplementation at pharmacological doses of dietary zinc in the form of zinc oxide (ZnO; 2,000-3,000ppm) is a consolidated practice that allows efficient control of PWD in post-weaning piglets. Although the precise mechanism of action of ZnO against PWD remains elusive, many studies have hypothesized and demonstrated its positive effects, exerted in a multifactorial manner.

The main mechanism of action of ZnO appears to be linked to a substantial enhancement in nutrient absorption and intestinal morphology. Specifically, it has been shown that ZnO increases nutrient digestibility and the activity of digestive enzymes.

Several other beneficial effects of ZnO have been hypothesised on different targets, such as the immune system, digestive secretion and intestinal architecture.

Moreover, the positive effects of zinc oxide on internal mucosa can also be linked to its antioxidant properties.

However, despite a potential antioxidant mechanism, the actual effect of ZnO on the bacterium Escherichia coli F4 (K88), the main causative agent of PWD, is moderate; it is thus believed that the action of ZnO on bacterial infection is different from direct antimicrobial activity.

Concerns over the use of zinc oxide for pigs

Despite the beneficial effects of zinc oxide on the reduction of PWD in piglets, its substantial and prolonged use at pharmacological levels in pig production has raised several concerns, such as the potential onset of toxic effects due to the

accumulation of ZnO in the tissues (kidney, liver, pancreas) of the animals.

Besides this toxicity to the pigs, the extensive use of zinc oxide raises several other issues. One of these issues concerns the considerable risks to the environment, following pollution arising from the application of zinc-rich manure on fields. Several studies have also shown that ZnO supplementation in piglets might contribute to an acceleration of antibiotic resistance gene spread, an increase in heavy metal tolerance gene spread, and possibly a modification of the microbiota via a modification of the bacterial population composition. Although zinc is an essential nutrient and can have positive effects on pig health and growth, the increasing concerns regarding the severe hazards for the environment and the antimicrobial-resistance threats led the European Medicines Agency (EMA) to mandate a free from pharmacological levels of ZnO since June 2022. This decision had been supported by European Commission.

As ZnO is only usable as a feed additive with a legal limit of 150ppm of total Zn in complete feed, and as this dose is unlikely to exert the same effects as pharmacological levels of ZnO, non-traditional approaches for combating PWD are needed. Following the European Commission's decision to eliminate ZnO at pharmacological doses, important swine production markets such as China have followed the same trend.

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Fig. 1. Average daily gain performance of piglets from 21-70 days of age.

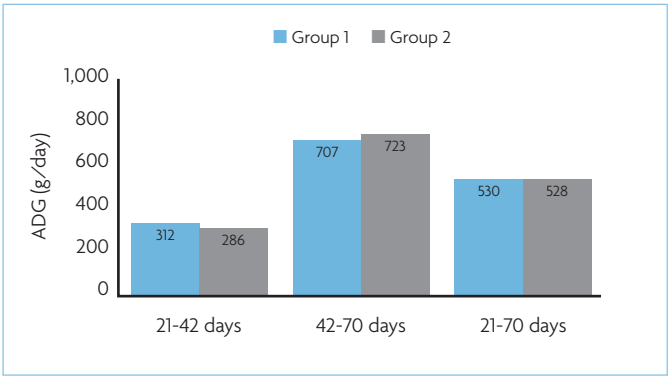
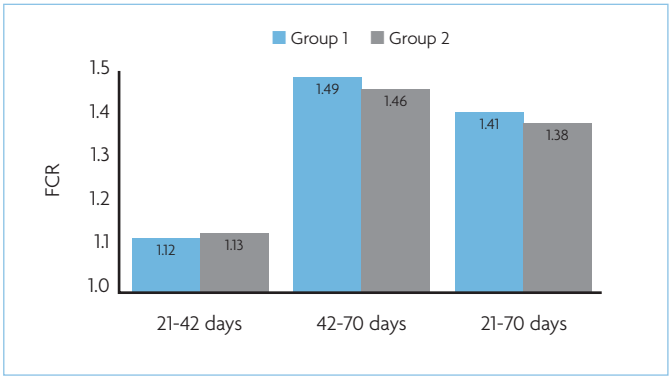


Fig. 2. Feed conversion ratio of piglets from 21-70 days of age.



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Alternatives to zinc oxide

Poor environmental conditions are considered to be noteworthy factors to PWD onset; specifically, poor housing hygiene triggers a background inflammation status that may intensify other stressors. Careful running of post-weaning facilities, heating, ventilation, etc is therefore essential, with a focus on preventive actions and management.

The complexity of the supposed multi-factorial and multi-target action of zinc oxide makes it difficult to find innovative alternatives for this compound.

Management of the weaning phase for piglets will require a combination of strategies and tools, in order to develop a novel approach against PWD involving environmentally friendly molecules in a context of biosafety and animal welfare.

Under this context, ADM Premix and Services business, has developed a unique concept named Partner For Life (P4L), which promotes a holistic approach to support the removal of pharmacological dosage of zinc oxide in piglet diets.

The P4L program aims to combine digital application and nutritional solutions, including a complete line of starter diets and feed additives.

The digital application is normally the first tool to be applied. By asking several questions about the farm conditions as farm health status, hygiene, water quality, farrowing management and housing/post weaning conditions, the software indicates the farms' strengths and suggests recommendations for improvement. The result of this questionnaire is presented in a graphic format for easy interpretation and fast action. To consolidate the P4L program, ADM Premix & Services business has also focused on a combination of 4 innovative & complementary solutions to address medication reduction. Those solutions, developed thanks to the network of 13 R&D centres, are:

- A patented combination of low level of copper ions with synthetic zeolite aiming to control pathogenic microbiota,
- POWERJET, a blend of plant extracts aiming to reduce intestinal inflammation & oxidative stress,
- FITACTIF, a blend of organic acids aiming to increase digestibility & control pathogenic microbiota,
- BTRAXIM 2C Zn, an organic source of Zinc ensuring improved bioavailability.

	Prestarter (21-42 days)*	Starter (42-70 days)**
Group 1	Basal diet + ZnO (2,500ppm)	Basal diet + Organic Acids (3kg/ton)
Group 2	Basal diet + Copper Exchanged Clay CeC (800g/ton) + POWERJET (200g/ton) + FITACTIF (5kg/ton) + BTRAXIM 2C Zn (40g of Zn/ton)	Basal diet + CeC (400g/ton) + POWERJET (200g/ton) + Organic Acids (3kg/ton)

*Crude protein: 20.0% - Fat: 6% - Lys: 1.35%
** Crude protein: 17.4% - Fat: 2% - Lys: 1.19%

Table 1. Diet description.

Trial results and conclusions

In an internal trial aiming at comparing those 4 feed additives to a diet containing ZnO at pharmacological dosage, 144 piglets, weaned at 21 days, were separated in two groups of 72 animals and tested from 21 to 70 days of age. Each group were allocated in 12 pens of six piglets per pen (12 repetitions per treatment). The animals were allocated under challenge conditions (room not disinfected, not pre-heated and dampened floor and wall at the animals' arrival). The diets had similar levels of nutrients and additives as described in Table 1.

As expressed by Figs. 1 and 2, both growth performance and feed conversion ration have been numerically similar to the group treated with pharmacological dose of zinc oxide.

Under the trial conditions, the combination of ADM Premix & Services business feed additives demonstrated to be an efficient alternative for the zinc oxide replacement. This experiment illustrates that it is possible to obtain similar performance to pharmacological dosage of zinc oxide by using this combination of synergistic feed additives due to their complementary mode of action. ■

References are available from the authors on request