# Patented process activates copper and zinc to reduce piglet diarrhoeas

Healthy piglets are a cornerstone for high zootechnical performances and success in modern pig production. Post-weaning diarrhoea caused by Escherichia coli (E. coli) is one of the most prevalent diseases in pig production worldwide.

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High, therapeutic doses of zinc oxide (ZnO) and copper oxide (CuO) have been shown to help to prevent diarrhoea in weaned piglets and are therefore a proven tool in starter diets internationally. However, due to several negative side effects to this practice, there is a need for alternative solutions.

The objective of this study was to assess if ZnO and CuO, activated by a patented production process, are an option to replace high dose Zn and Cu supplementation.

For this purpose several in vitro and in vivo experiments were carried out. Results indicate that activated ZnO (aZnO) applied at a dose of 125ppm has a comparable inhibitory effect on the growth of E. coli as standard feed grade ZnO at a dose of 2,000ppm.

In a feeding trial during the first two weeks after weaning, application of activated CuO (aCuO), improved the feed conversion ratio by 5.48% compared to application of Cu sulphate.

The mode of action behind the reduction of post-weaning diarrhoea after application of zinc and copper oxide is still subject to research. However there is evidence that one of the reasons for the positive effect of ZnO and CuO on the incidence of diarrhoea in weaned piglets is the reduction of E. coli. Therefore inclusion rates of up to 3,000ppm ZnO and 300ppm CuO are not unusual in piglet diets worldwide.

However, high dosages of ZnO and CuO are resulting in an increased risk of excretion of heavy metals to the environment, which has led to a ban of high dose dietary ZnO inside the European Union and plans for implementation of more restrictive limits for CuO are in place as well. Further countries might follow this example soon.

For this reason, there is a demand for alternative solutions for the prevention of post-weaning digestive disorders, without the harmful effects to the environment described above.

As a positive side effect, deleting therapeutic dosages, especially of ZnO, from piglet diets would also create space for the addition of other ingredients or additives.

For the present study, in vivo and in vitro experiments were carried out to study the effects of a novel feed grade aZnO and aCuO on the growth

of E. coli and on zootechnical parameters of weaned piglets.

Both materials (ZnO and CuO) were mechanically activated beforehand, through a patented production process using an eccentric vibrating mill, modifying the physiochemical properties of the raw materials, such as particle size, surface area and the amount of internally stored energy inside the oxide molecules.

## Material and methods

An in vitro experiment was conducted to understand whether there are differences in terms of the inhibitory effect of a standard feed grade zinc oxide (ZnO) and the activated zinc oxide against a selected test strain of E. coli.

The different Zn Oxide compounds were brought into suspension at concentrations of 2000, 1000, 500, 250, 125, 62.5 and 31.3mg/l and were incubated with the test strain of E. coli. After an incubation period of 24 hours, the germ count was measured in relation to the negative control.

Subsequently, the effect of adding aZnO and aCuO to piglet pre-starter feed was tested in a feeding trial.

At 25 days of age, 200 weaned piglets (DanAvl x Duroc, mixed sexes) were allocated into a flatdeck with eight pens, containing 25 animals per pen. Pigs were divided into three groups (negative control, positive control and treatment).

The duration of the trial was 14 days, raising the pigs from approximately 6.3kg to 8.5kg of live weight (LW).

Animals of all groups received a piglet pre-starter feed, composed of soy, corn, wheat, rye, barley, mineral feed and highly digestible protein sources (Table 1). During the first five days after arrival at the flatdeck, the amount of feed offered to the animals was limited to 80% of the feeding curve and feed was administered through a mobile metal trough inside the pens.

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**Fig. 1. Density of E. coli germs after 24 hours incubation independent of ZnO source and dosage.**

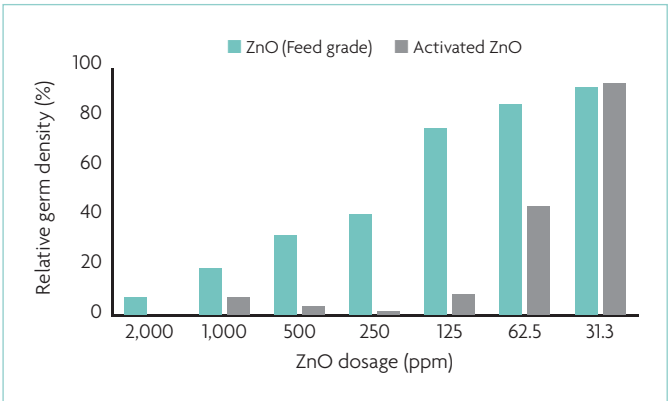
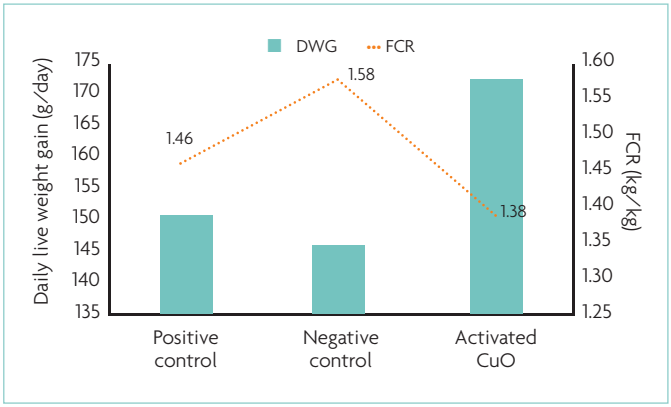



**Fig. 2. Average daily weight gain and feed conversion (FCR) of the three groups during days 1-14 after weaning.**



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To ensure sufficient feed intake, the feed was moistened with warm water. On days six and seven piglets were fed ad-libitum through wet-feeders and the metal trough (limited), while from day eight onwards feed was administered ad-libitum through wetfeeders.

The three groups received complete feeds containing 120ppm aZnO. The negative control was supplemented with 15ppm copper sulphate, while the positive control received 140ppm copper sulphate. Feed of the treatment group was supplemented with 140ppm of aCuO. At the beginning and at the end of the 14 days period, body weight and feed consumption per pen were measured and feed conversion ratio was calculated.

## Results and discussion

Results of the in vitro test are strongly indicating that the mechanical activation process inside the eccentric vibrating mill has improved the inhibitory effect of aZnO against E. coli. At a dosage of 125ppm, aZnO showed better inhibitory effects on the growth of E. coli than the feed grade ZnO at a dosage of 1,000ppm. At a dosage of 125ppm of aZnO, the growth of E. coli bacteria was limited to 8.8% (Fig. 1), relative to the negative control. The improved inhibitory effect might be a consequence of the decreased particle size and increased surface area caused by the activation process. It has also been shown in further experiments with aZnO (data not shown) that the amount of stored internal energy in the ZnO molecule is increased by the activation process.

| | Piglet prestarter (Day 1 – 14) | | |
|---|---|---|---|
| **Trial group** | **Positive control** | **Negative control** | **Treatment group** |
| **Ingredients** | | | |
| Barley (%) | 21.0 | 21.0 | 21.0 |
| Wheat (%) | 16.7 | 16.7 | 16.7 |
| Rye (%) | 16.0 | 16.0 | 16.0 |
| Corn (%) | 11.2 | 11.2 | 11.2 |
| Whey powder (%) | 9.00 | 9.00 | 9.00 |
| Soy protein concentrate (%) | 9.00 | 9.00 | 9.00 |
| Soybean meal (44% CP) (%) | 6.00 | 6.00 | 6.00 |
| Mineral feed (%) | 4.50 | 4.50 | 4.50 |
| Vegetable oils (%) | 4.50 | 4.50 | 4.50 |
| Feed acids (%) | 2.00 | 2.00 | 2.00 |
| Activated ZnO (ppm) | 120 | 120 | 120 |
| Activated CuO (ppm) | – | – | 140 |
| Copper sulphate (ppm) | 140 | 15 | – |
| **Nutrient levels** | | | |
| Energy (ME) (MJ/kg) | | 13.9 | |
| Crude protein (%) | | 17.8 | |
| Lysine (%) | | 1.55 | |
| Calcium (%) | | 0.74 | |
| Phosphorus (%) | | 0.55 | |

**Table 1. Ingredients and nutrient levels of trial diets.**

## Feeding trial

The results of the feeding trial suggest that the supplementation of aCuO to the diet of piglets for the first 14 days after weaning has a beneficial effect on their performance levels.

The average daily gain was increased by 14.0% compared to the positive control and 17.8% when compared to the negative control during the period of the trial (Fig. 2).

For the treatment group, the feed conversion ratio was 5.48% lower compared to the positive control and 12.7% lower when compared with the negative control (Fig. 2).

As the feed intake did not vary considerably (data not shown) between the groups and the feed conversion ratio was improved when aCuO was applied, the differences in daily weight gain between the groups may be associated with an improved utilisation of nutrients from the feed by the treatment group.

As aCuO and aZnO have proven to inhibit the growth of E. coli in several further in vivo trials, the improved zootechnical parameters of the treatment group could potentially be explained by a reduction of E. coli, pathogenic pressure and related post-weaning problems.

## Conclusion

Therapeutic dosages of zinc and copper oxides are a well proven tool for prevention of post-weaning diarrhoea.

However, due to growing environmental awareness there is a clear demand for alternative solutions for the prevention of post-weaning digestive disturbances, especially those that are related to E. coli.

The results of the present study indicate that activated zinc and copper oxide are a viable alternative to therapeutic dosages of Zn and Cu oxide.

The addition of 125ppm aZnO led to a reduction in growth of E. coli by 91.8%, while a dosage of 2,000ppm was needed to achieve the same effect with conventional feed grade ZnO. ■

**References are available from the author on request**