The effect of zinc on the intestinal health of poultry

Zinc requirement of poultry is defined according to specific criteria, related to growth, bone composition, or immune function and could vary according to the criteria considered.

Supplementation with inorganic salts or the chelated form aims to satisfy the animal's need on top of the zinc contained in feedstuffs.

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While little is to be expected in animal health from the usual sources of zinc added on top of requirement, the use of potentiated zinc oxide has shown positive effects on gut microbes and intestinal health parameters. Data obtained in necrotic enteritis (NE) challenge conditions with a potentiated zinc oxide have demonstrated a source-related effect on growth, mortality and intestinal lesion score.

These results support the use of this novel zinc oxide form to improve intestinal health and to manage NE in poultry.

Zinc requirements of poultry

Zinc (Zn) is an essential nutrient in poultry for gene expression, cellular replication, stabilisation of proteins, and hormone structures. It is also crucial for bone growth through alkaline phosphatase and collagenase.

It plays a major role in the body as a constituent or a cofactor of 300 enzymes involved in the synthesis or degradations of lipids, proteins and nucleic acids. Zn is also essential for immune function.

Zn naturally occurs in plants used in poultry nutrition, but its concentration is very variable, even within the same species. The amount of zinc in raw materials is often too low to satisfy the animal's requirements and some anti-nutritional factors like phytate can decrease its bioavailability. Therefore, Zn is usually supplemented in the premix to reach total dietary levels of between 60-150ppm.

As requirements from different institutes vary from 40 to 80ppm Zn added on top of plant-born Zn (evaluated between 20 to 40ppm Zn), feed levels often exceed the animal's needs and avoid zinc deficiency.

Zinc levels and sources for optimal body function

Despite adequate levels being fed to poultry, some publications and practices are reporting benefits to skin (skin lesions or dermatitis) and carcase quality when using non-commodity zinc sources at slaughter. Considering the usual zinc levels in feeds, these effects can be explained by a low bioavailability of native zinc and/or added zinc.

It is also hypothesised that the animal requirement can be increased in case of environmental challenge as heat stress or disease challenge. We might then expect that zinc sources with high bioavailability would better serve the animal demand in such cases.

The development of a new potentiated zinc oxide (HiZox) resulted in a product with superior physico-chemical properties. When compared with other zinc oxide sources and zinc sulphate, this new form of zinc showed significant higher Relative Biological Values (RBV) in a state-of-the art experiment conducted at INRA.

This experiment highlighted the huge variation on RBV values of zinc oxide, ranging from 66% for the lowest and 105% for HiZox on tibia Zn concentration (Table 1).

Feeding animals such a source of highly bioavailable zinc would result in higher Zn supply to the animal and optimise body function related to zinc status.

	RBV Zn (% bone)	RBV Zn (% plasma)
ZnSO4, H2O	100^{b}	100^{a}
Potentiated ZnO (HiZox)	105^{a}	126^{a}
ZnO 1	66.1^{c}	84.1^{b}
ZnO 2	92.0^{b}	83.5^{b}

Table 1. Relative Biological Value (RBV) of four zinc sources (Narcy et al.)

Source-specific effect of zinc on intestinal health

The antibacterial effect of the pharmacological dosage of zinc oxide is well known by pig nutritionists but not by poultry nutritionists, because of the toxicity it will induce to avian species at levels above 500-1000ppm in the feed.

The concept of potentiated zinc oxide, with an increased surface area, has proven to be more anti-bacterial than regular zinc oxide products. Its superior effectiveness has been demonstrated on Escherichia coli, Salmonella enteritidis and typhimurium and Clostridium perfringens species in in vitro experiments.

Considering the effect of potentiated zinc oxide on Clostridium perfringens, the effect

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Fig. 1. Necrotic enteritis lesion score of challenged broilers

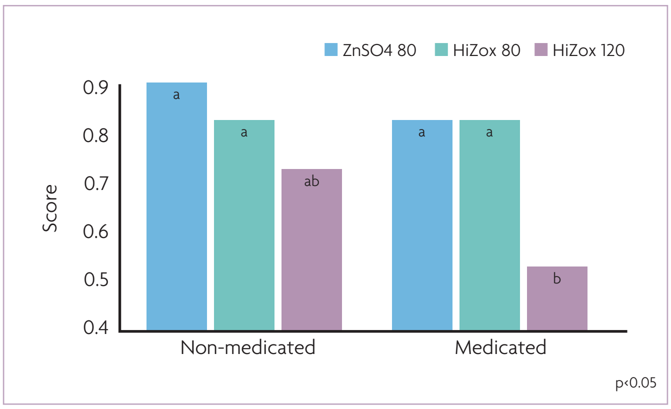
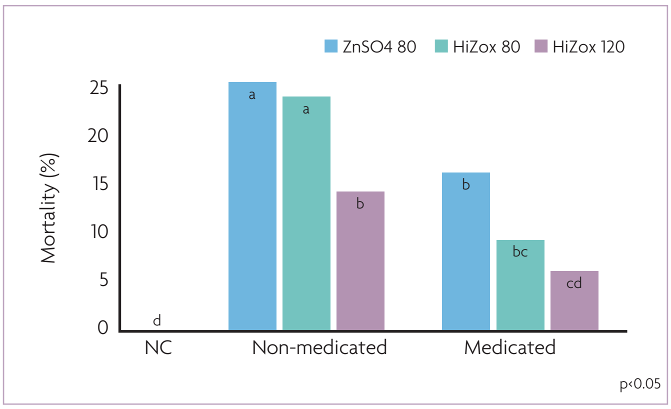


Fig. 2. Mortality of necrotic enteritis challenged broilers.



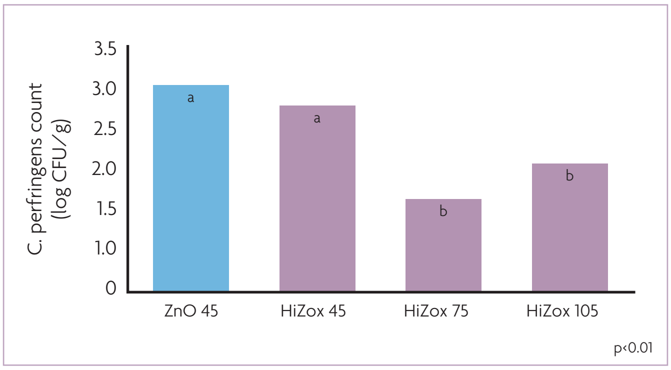


Fig. 3. C. perfringens intestinal count of challenged broilers.

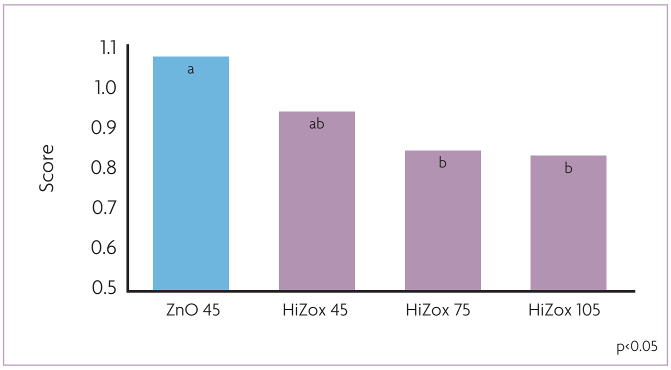


Fig. 4. Necrotic enteritis lesion score of challenged broilers.

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on NE was investigated in a broiler challenge experiment at Southern Poultry Research in the USA.

The trial consisted of 72 cages starting with eight chicks each. They were divided into three groups of 24 cages: one group fed with 80ppm of Zn from zinc sulphate (ZnSO4) and the others with Zn from potentiated zinc oxide (ZnO) source (HiZox), at 80ppm or at 120ppm.

Each group was then subdivided into three groups of eight cages: non-challenged birds, challenged birds with non-medicated feed and challenged birds with virginiamycin at 20ppm.

On day of trial (DOT) 14, all the broilers were orally inoculated with ~5,000 oocysts of E. maxima.

On DOTs 19, 20 and 21, animals of challenged groups were given a broth culture of C. perfringens ~10^8cfu/mL. Growth performance per cage was recorded on DOT 0, 14, 21 and 28.

On DOT 21, three birds from each cage were sacrificed and examined for the degree of presence of necrotic enteritis lesions, from zero (normal) to three (sloughed and blood small intestine mucosa).

Concerning the growth performance, the differences were essentially related to challenge and to medicated feed: on DOT 28, non-challenged birds and challenged birds fed virginiamycin had the highest bodyweight and the lowest feed conversion ratio, compared to challenged birds with non-medicated feed.

For the necrotic enteritis intestinal scoring, challenged broilers fed 120ppm of Zn from HiZox was numerically (non-medicated feed, 0.7 vs 0.8-0.9) or significantly (medicated feed, 0.5 vs 0.8) lower.

Mortality decreased in groups fed HiZox, numerically (80ppm of Zn) or significantly (120ppm of Zn), compared to groups fed ZnSO4 (see Figs. 1 and 2).

In another experiment in Thailand, using coccidial and C. perfringens challenge as well, potentiated zinc oxide was compared with standard zinc oxide in broilers.

Some 45ppm added Zn from standard ZnO was compared to the same Zn level added or 75 and 105ppm from potentiated zinc oxide (HiZox).

The use of HiZox improved numerically (at same dose) or significantly (at higher dose) the lesion score. The bacterial count was significantly lower with 75ppm and 105ppm of HiZox compared to the other treatments (see Figs. 3 and 4).

These two experiments tended to indicate a zinc source and a zinc level effect on the severity of NE lesions as well as on the NE consequences on broiler performances.

Recent field investigations on an E. coli outbreak in laying hens showing a reduction in bird mortality, confirms the potential of such a novel zinc source to attenuate bacterial challenges in poultry.

Another experiment conducted in Iran at Tehran University looked at the effect of this innovative zinc oxide source in heat stressed broilers. Basal corn-soybean meal diets were formulated and supplemented with 100ppm of zinc from standard ZnO or with a potentiated ZnO source (HiZox), at 75ppm, 100 or 125ppm.

The potentiated ZnO tended to reduce the number of dead birds (2.5% to 3% depending on treatment) in comparison with the standard ZnO. The skin resistance was also improved in groups fed the potentiated ZnO, as shown in Fig. 5.

The effect of the potentiated zinc oxide has also been investigated in a high density challenge at the University of Putra Malaysia. In this study, experimental diets were supplemented with 60ppm of zinc from ZnSO4 and three doses of zinc from the potentiated zinc source (HiZox: 60, 90 and 120ppm).

The potentiated ZnO at 60ppm significantly improved feed conversion ratios and weight gains of broilers raised in high density during the starter period (day 1-21), compared to ZnSO4 at the same dosage (Fig. 6).

In addition, increasing the supplementation level of the potentiated ZnO numerically increased growth performance.

Conclusion

Despite some discrepancies in zinc poultry requirements throughout reference publications, the practical levels used by the industry seem to be well over animal needs, thus avoiding deficiencies. The quality of the zinc sources used might be questioned as it is well established now that all sources do not have the same bioavailability.

The arrival on the market of an innovative potentiated zinc oxide, HiZox, is a way to secure zinc supply in poultry. For the first time in the feed industry, the zinc oxide source in HiZox has shown unique anti-bacterial properties.

Studies in poultry revealed an interesting potential to alleviate the consequences of necrotic enteritis as well as management and environmental challenges, like heat stress or high stocking density.

The use of this new zinc source will advantageously replace any zinc source in the feed, while also improving animal conditions under challenge. ■

References are available from the author on request

Fig. 5. Skin resistance of broilers under heat stress.

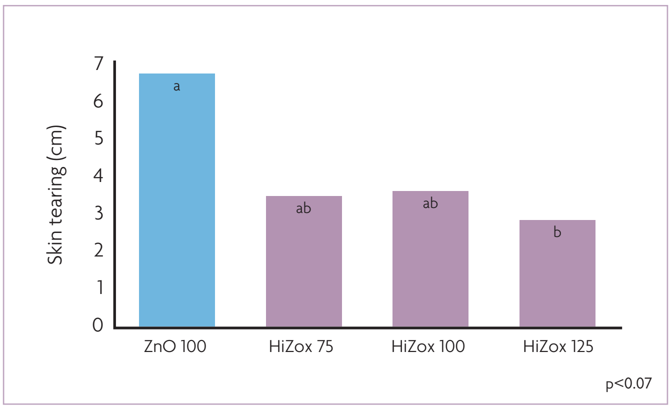

Fig. 6. Weight gain of broilers raised in high density (1-21 days).