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.

Zinc 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, Zinc (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 800ppm 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 on skin (skin lesions or dermatitis) and carcass 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.

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

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<tr>
<th>Zinc Source</th>
<th>RBV Zn (% bone)</th>
<th>RBV Zn (% plasma)</th>
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<tbody>
<tr>
<td>ZnSO4, H2O</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Potentiated ZnO (HiZox)</td>
<td>105</td>
<td>126</td>
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<tr>
<td>ZnO 1</td>
<td>66.1</td>
<td>84.3</td>
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<td>ZnO 2</td>
<td>92.0</td>
<td>83.5</td>
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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 antibacterial than regular zinc oxide products. Its superior effectiveness has been demonstrated on Escherichia coli, Salmonella enteritidis and typhimurium and Clostridium perfringens species in vitro experiments.

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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).

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

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

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

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

References are available from the author on request.