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Zinc supplementation to cover nutritional requirements: FOCUS ON BONE ZINC

"Zinc (Zn) is one of the major trace minerals supplemented in animal feed diets. Zinc oxide (ZnO) is a form commonly supplemented and is sometimes wrongly considered to have a lower bioavailability than sulfates. In a recent trial, published in the British Poultry Science journal, researchers investigated the correlation between the physicochemical properties of different ZnO sources and their bioavailability in broilers."

Sulfates sources of trace minerals are often assumed to have 100% bioavailability due to their high solubility in water. However, when referring to trace minerals, solubility and bioavailability are not always directly related.

Indeed, it is important that a trace mineral source can solubilize so its free ions can be taken up by the intestinal cell. Nevertheless, if this solubilization happens too early in the upper part of the gastrointestinal tract, the release of those ions will interact with other feed compounds (e.g: acid phytic and calcium) forming insoluble complexes and becoming unavailable for animal absorption.

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First, an *in vitro* trial was carried out to evaluate the properties of feed-grade ZnO sources and their dissolution kinetic behavior. Then, an *in vivo* trial was performed at INRAE (France) to evaluate the bioavailability of these sources in broiler chickens. The objective was to assess the dose response of Zn supplementation. Treatments consisted of a con-

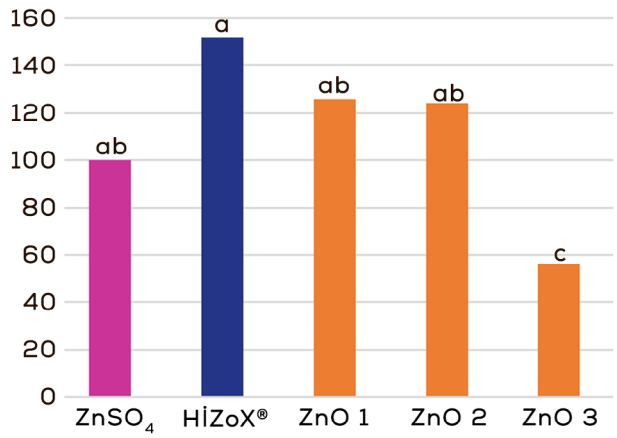

Figure 1. *Relative biological values of different sources of ZnO compared to $ZnSO_4$, considered to have a 100% of bioavailability ($P < 0.05$).*

trol diet (containing 23 ppm of native Zn) and Zn supplemented at 6 or 12 ppm, either from $ZnSO_4$, a potentiated source of ZnO (Hizox®, Animine, France), or 3 ZnO sources. In the last day, the right tibia of birds was collected to assess the relative bioavailability of bone Zn (Figure 1).

The experiment demonstrated that sources with a quick dissolution kinetic in acidic condition like gastric pH (similar to the $ZnSO_4$ ones), have similar bioavailability to the sulfate reference (ZnO 1 and 2). In the opposite, ZnO sources with an inert dissolution kinetic showed the lowest bioavailability values (ZnO 3). Finally, in between, the study demonstrated the specific properties of HiZox®: a source with small aggregates and agglomerated particles. Hizox® showed the highest bioavailability, compared not only to the other ZnO sources, but also to $ZnSO_4$.

The bioavailability of HiZox®, which proved to be superior to the $ZnSO_4$, can be considered at least the same as the best chelates in the market. Two recent trials performed by Animine compared the concentration of Zn in bone (the best biomarker of the zinc bioavailability in farm animals) from broilers fed HiZox® versus other chelated sources. The first trial compared HiZox® to a methionine hydroxy analog (MHA) source of Zn in European conditions. Levels tested were 70 or 35 ppm of Zn. Native Zn concentration was 34 mg/kg and the animals were slaughtered at 35d (Figure 2, Trial 1). The second trial compared HiZox® to an amino acid source of Zn in North American conditions. Levels tested were according to genetic lines recommendation (100 ppm of Zn). Native Zn concentration was 29 mg/kg and the animals were slaughtered at 28d.

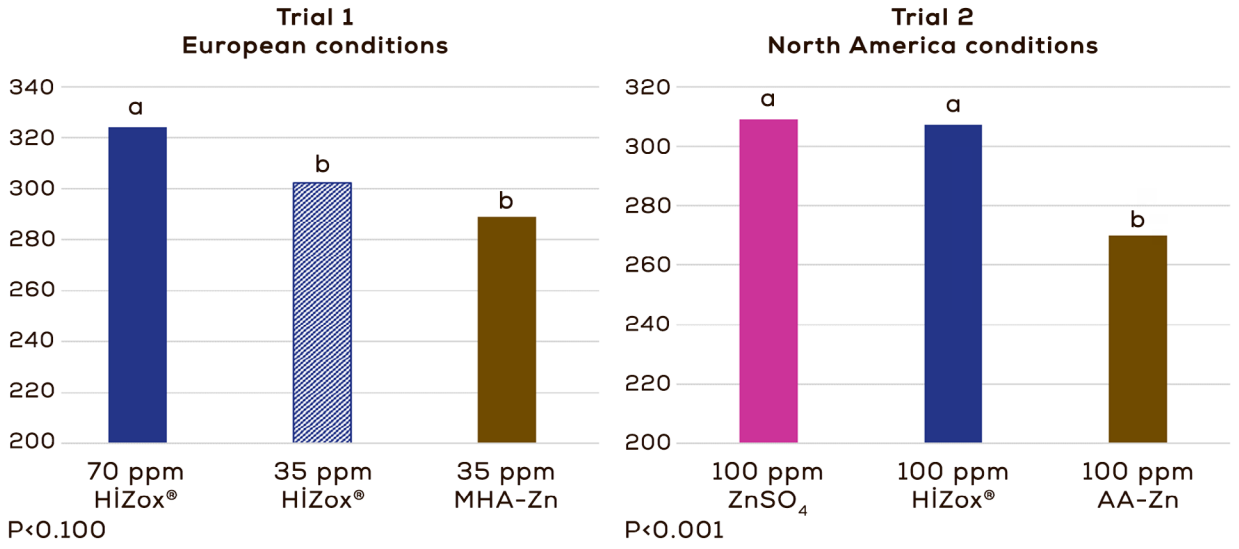

Figure 2. *Tibia zinc concentration (mg/kg ash) for different sources of zinc in broilers.*

Although these two trials were not designed to evaluate bioavailability, by tibia Zn results we can see that HiZox® provide at least the same or better Zn deposition than the Zn-chelate. Regarding performance parameters, HiZox® provided the same values as chelates: in trial 1 no differences on average daily gain (ADG) were observed (60.5 g/d on average); in trial 2, a tendency for a better ADG and FCR for HiZox® (61 g/d, and 1.39 g/g) in comparison to sulfate (58 g/d, 1.41 g/g) and chelates (57 g/d, 1.42 g/g) was observed.

What happened? The unique physicochemical properties of HiZox® led to slow dissolution kinetics behavior under the acid conditions of the gizzard and proventriculus. This slow release of ions allowed this source to dissociate later and to be better absorbed by the enterocytes in the small intestine. The delay on its dissolution also avoided interactions with other feed compounds, specially phytate and calcium.

CONCLUSION

Zinc sulfates, although considered to be the reference source, can suffer a compromised bioavailability due to its fast solubilization and to interactions with feed compounds.

Zinc oxide sources can have very different bioavailability values according to their physicochemical properties and dissolution kinetics behavior.

HiZox®, a potentiated source of zinc oxide with small aggregates and agglomerated particles, has proven data on high bioavailability, not only compared with other oxides and sulfates, but also with the more known chelates in the market.

About Dr. Alessandra Monteiro

Dr. Alessandra Monteiro is an animal scientist graduated in Brazil. In 2014 she started her PhD degree in Animal Production in partnership between the State University of Maringá (Brazil) and INRAe (France). In 2017, she worked as a Postdoctoral Research Associate at INRAe. Alessandra joined Animine in 2018 and have been working with the research and development group since then. Since 2023, Dr Alessandra Monteiro became the new R&D Director of Animine.

About Axel Minetto

He is an agronomic engineer and worked for the past 8 years in Valorex (France) where he gained solid monogastric and international skills to push nutritional solutions. His particulars skills are trace minerals, essential fatty acids, omega 3 enrichment, feed formulations, protein sources evaluations, nutritional matrix development and applications.