Therapeutic levels of Zinc Oxide in Weaner Pig diets

Impact on Copper and Iron Utilisation and the Role of Organic Trace Minerals

Key Points

• Antagonisms between essential trace minerals and dietary components occur within the gut which may adversely affect mineral absorption and utilisation

• Supplying trace minerals in organic form can reduce these antagonisms making them more available for absorption and utilisation

• Research has shown that supplying trace minerals in organic form can improve the mineral status of the pig

• When zinc oxide is supplied in weaner diets at therapeutic levels, the use of organic minerals may help to prevent Cu and Fe deficiencies

Background

Recommendations for trace mineral supplementation are typically based on research identifying the minimum levels needed to overcome a deficiency, and not necessarily the levels required to optimise performance. Diets are therefore usually formulated with an additional insurance factor and higher levels of minerals are supplied. However, increasing the supply of minerals in the diet does not necessarily mean that the animal’s requirements will be adequately met. When minerals are supplied in inorganic form, as is typically the case, interactions and antagonisms between trace minerals occur (Figure 1), as well as mineral precipitation in the small intestine which may lead to reduced absorption. Research has shown that the availability of trace minerals can be improved by binding the trace element to either a mixture of amino acids or small peptides to maintain a consistent bioavailability.

Figure 1: The mineral wheel – the arrows indicate interferences existing between minerals. These antagonisms between minerals can reduce utilisation.

How does the availability of inorganic and organic minerals differ?

Traditionally, inorganic mineral salts such as oxides and sulphates are used in pig diets. However, the bioavailability of these inorganic minerals varies – for example the general consensus is that sulphates have a higher bioavailability than oxides. The absorption coefficient of inorganic trace minerals is low, ranging from 5 up to 20% (NRC Pigs, 2001).

Benefits

Research has confirmed performance benefits from using organic minerals in pig rations. However there is only indirect evidence supporting the theory that organic minerals are absorbed via the amino acid and peptide absorption pathways. This leaves open the hypothesis that organic minerals are absorbed by another method which we are yet to understand.
Efficacy of Optimin Zn in weaned pigs
A trial feeding weaned piglets (age, 34 d; BW, 8.6 kg) demonstrated the benefits to feed conversion efficiency of feeding an organic source of zinc compared with inorganic sulphate. The basal diet fed to all pigs contained 45ppm of zinc which was supplemented with an extra 15ppm of zinc in sulphate, Glycinate or Optimin form.

Figure 2: Feed conversion rate of piglets fed various sources of Zn.

When Optimin Zn was included into the diet the FCR was improved by 8.4% across the trial period (3 weeks) compared with the diet containing zinc in sulphate form. Zn blood plasma levels were also higher in pigs receiving the Optimin Zn diet, indicating a higher bioavailability of Optimin Zn compared to the other Zn sources.

High levels of ZnO: What are the effects on Cu and Fe absorption and utilisation?
Scouring is common in weaned piglets when they change from a predominantly milk based diet to a solid feed. This also may lead to secondary gut health problems such as E.Coli proliferation in the small intestines which is potentially fatal. To overcome this, therapeutic levels of ZnO are often included into piglet diets for up to two weeks post weaning. Although this is an effective method to prevent scours in weaned pigs, there is often no consideration of the potential antagonisms that ZnO has with other trace minerals in the diet. Figures 3 and 4 gives us an indication of these potential antagonistic relationships, demonstrating the impact on plasma Cu and Fe concentrations when therapeutic ZnO is fed in the first 14 days post weaning.

The antagonism between Zn and Cu is primarily mediated through the absorption process. It has been shown that Zn induces high concentrations of metallothionine in the intestinal mucosa which binds to Cu. The Cu bound to metallothionine is therefore not absorbed. As a result of this antagonistic relationship between Zn and Cu when supplied in inorganic forms, Figure 3 shows a negative correlation between plasma concentration of Zn and Cu when ZnO is fed at 3 kg/T. A 3-fold increase in plasma Zn concentration corresponded to a 4-fold decline in plasma Cu concentration.

Figure 3: Plasma concentration of Zn and Cu in post weaning piglets when fed a diet containing 3 kg/T ZnO.

Additionally, the low Cu status may then subsequently negatively impact on Fe utilisation, shown in Figure 4.
Cu is required to synthesise ferroxidase which is used to transport Fe across the intestinal lumen. Therefore if there is insufficient Cu available to synthesise ferroxidase, Fe cannot be absorbed across the intestinal lumen. The pig may then also be at risk of becoming deficient in Fe. Consequently, Fe which is not absorbed is then at risk of accumulating in the small intestines. This can encourage bacterial growth and results in increased susceptibility to infection and disease.

What is the solution?
Nutritional strategies can be taken to overcome the potential risk of Cu and Fe deficiencies when ZnO is included into diets at therapeutic levels. This includes the use of Optimin chelated trace minerals, in this situation specifically Optimin Cu and Fe. The provision of Cu and Fe in a chelated form means that the mineral is not present in the gut lumen in a reactive form, thus avoiding potential interactions between minerals and therefore preventing the potential deficiencies occurring described above.

The structure of Optimin chelated minerals leads to increased integrity and solubility of the chelate structure, even when subjected to varying digestive pH levels. At different pHs simple mineral complexes and weak chelate structures can be hydrolyzed and lose their nutritional value during the gastric passage. Optimin minerals maintain their chelate integrity keeping the organic mineral in its original form throughout digestion. Nutreco trials have concluded Optimin Zn and Cu to be two to three times more bioavailable than inorganic mineral forms.

Further information can be obtained from the Frank Wright Trouw technical department on 01335 341102. Receive these technical publications directly via e-mail link. Contact Sarah Brandrick to register your interest on 01335 341128 or at sarah.brandrick@frankwright.com. You can also access this and past CONTACT and URGENT NEWS publications by registering on our website: www.frankwrighttrouw.com