Nutritional and growth-promoting levels of zinc in pigs: effects on performance and on the environment

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Zinc is an essential trace element which plays a major role in many biological functions. Zn content in conventional cereal-soybean meal diets is below pigs' requirement, and Zn has to be added to all pig diets. Loss of appetite, diarrhea, growth retardation and parakeratosis are the main symptoms of zinc deficiency. Zinc requirement of pigs is most often determined according to dose-response curves, with growth performance, Zn contents in plasma, bones or liver, and alkaline phosphatase as response criteria. Most of the studies on Zn requirements have been conducted in growing animals and only few are available for sows. Zn requirement is affected by different diet-related factors that affect its bioavailability. Among them, phytic acid plays the most important role, and the addition of microbial phytase to the diet, which is now a common practice, has been shown to significantly reduce Zn requirement of pigs.

Bioavailability of Zn may differ between sources. As for the requirement it is generally measured according to dose response curves with $ZnSO_4$ used as the reference standard (100% bioavailability).

Used at pharmacological levels in diets for piglets at weaning (i.e. about requirement x 30), zinc oxide is reported to increase feed intake and growth, and reduce the occurrence of diarrhea though different physiological mechanisms, not completely elucidated, involving regulation of feed intake, production of enzymes, changes in the morphology and functioning of intestine, and alteration of the microflora. The use of such high levels of zinc is limited to short periods to avoid the risk of toxicity and the development of resistant bacteria.

Body zinc content of pigs is estimated around 22 mg/kg live weight. With conventional diets (eg 150 mg/kg Zn) Zn excretion amounts 91% to 95% of Zn intake in weaners and fattening pigs, respectively, and up to 98% in weaners fed pharmacological levels of Zn for two weeks. Most of the Zn is excreted in feces, and manure is highly concentrated in this element, which accumulates in top soil after spreading, may cause toxicity to plants and microorganisms, and become an environmental concern in areas of intensive pig farming. With the present EU regulation, Zn content in slurry DM (about 1250 mg/kg DM) is below the maximal concentration allowed in sewage sludge (3000 mg/kg DM), but it exceeds the concentration allowed for organic fertilizers (600 mg/kg DM). When slurry is treated (e.g. by anaerobic digestion) this ratio increases due to the reduction in organic matter.

Zn is thus an essential element for animal metabolism, a heavy metal with possible harmful effects to the environment, and a non-renewable resource. In the context of a global increase of animal production a sustainable use of Zn requires a holistic approach of nutrition, with an optimization of supplies along animal's life to take the best benefit of this important nutrient whilst reducing environmental hazards. This can be achieved through modeling approaches.