siMMin™ : on line software tool to simulate zinc balance in feeding programs of growing pigs

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Abstract
Copper and zinc are essential nutrients that usually have to be supplemented to pig diets so that animal requirements are fulfilled, but they are also utilised at high levels for growth promoting effects. As a result, Zn and Cu concentrations in animal wastes may be high, which poses a risk of soil accumulation when pig manure is spread on arable land. Moreover, technological treatments of pig slurry concentrate zinc in the solid fraction and this by-product may exceed maximal authorised Zn value when used as organic fertiliser. Some scientific methods to measure zinc balance in pig farms have been proposed by INRA to regulatory authorities and can be more widely communicated to the international pig industry. The software siMMin™ is on line since January 2013 at www.animine.eu/simmin/ and can be utilised by all stakeholders involved in pig production.

Introduction

Copper and zinc are essential nutrients that usually have to be supplemented to pig diets so that animal requirements are fulfilled. A very small proportion of ingested Zn is retained in the body [1]. Excess levels of these metals are supplied in practice either to secure sufficient safety margins, or because they can have beneficial effects at pharmacological dosage on gut health and growth performance. There is a linear relationship between dietary Zn and Cu contents and their respective levels in pig manure [2]. As a result, high Zn and Cu concentrations are found in animal wastes [3]. Without strict public regulation, zinc concentrations in pig manure can be elevated due to its growth promoting effect. In the European Union, the Commission Regulation (EC) 1334/2003 had further reduced the maximal authorised levels of trace minerals in animal feeds [4]. In Member States where no Zn containing medicated premix is authorised in piglet diets, it reinforced the limitation of Zn contents in pig wastes [5]. In major swine producing countries like China, Zn concentration in pig manure has increased from an average of 137 mg/kg dry weight in the 1990's up to 843 mg/kg in 2003 [6]. It is estimated that manure from livestock production contributes to 51% on the total Zn input on agricultural soils in China. In areas of intensive animal production, it poses a risk of metal accumulation in the soils and waters when pig manure is spread on arable land [7;8]. Moreover, technological treatments of pig slurry concentrate zinc in the solid fraction and this by-product may exceed maximal authorised Zn value when used as organic fertiliser [9;10]. Some scientific methods to measure zinc balance in pig farms have been proposed by INRA to regulatory authorities and can be more widely communicated to the international pig industry.

Material and Methods

In 2003 the first national references for the excretion of nutrients (N, P, K) and heavy metals (Cu, Zn) from pig production were agreed by French scientific and regulatory authorities [11]. Zinc body retention was calculated as :

Zn (mg) = 21.8 x Body Weight (kg)

The effects of age, gender and pig breed on mineral accretion have been assessed [12]. When the minerals are expressed on a per kilogram of body component basis, Zn composition of loin and ham is similar for different genetic lines and sexes [13]. Dietary manipulation can affect Zn concentration in some organs [14] but should not markedly affect total carcass content. Zn bioavailability measured by accumulation in storage tissues can be affected by mineral source [15]. However, zinc source does not

modify Zn balance [16;17] and Zn concentration in the pig carcass [18]. More recently, the mass balance approach has been updated from latest literature data [19]:

Zn_{body} = 20.6 x Empty Body Weight (EBW)
EBW = 0.96 x Body Weight

Thus, homeostatic regulation of Zn metabolism minimizes the effect of animal and diet in the assessment of the environmental balance in standard pig husbandry practices. As zinc retention in growing pig can be calculated based on the difference in mineral body content between the beginning and the end of a defined period, mineral excretion can be deduced by the difference between Zn intake and Zn retention.
siMMin™ has been developed with the support of INRA with the objective that it should be easily utilised whatever the local conditions. For example, the feeding program in the fattening phase can be simplified to one single diet or phased with three diets (early grower, grower and finisher feeds). The same is possible for the post-weaning phase. It should be intuitive and user-friendly so that nutritionists and pig producers can get access and understand it. Users can insert their own data including animal performance (FCR, feed consumptions, initial and final body weights), and zinc dietary concentrations in each feed. The software enables to simulate changes in each variable compared to the existing situation, and to measure the rate of improvement in the total reduction of zinc in the life of the growing pig. siMMin™ also calculates the Zn concentration in pig waste. This calculator tool benchmarks any situation to existing EU regulation.

Results
siMMin™ appears on one single web page, which makes it user friendly:

Mineral balance can be assessed by the analysis of excreta [20] but the sampling of manure is labour intensive and results may not be representative [21]. Therefore, siMMin™ facilitates decision making without any need for animal experiments. As many pig producers do not know the trace mineral concentration in pig diets, this software favours the need for mentioning Zn contents on labels of feed bags in countries where this is not compulsory by local legislation. siMMin™ focuses on the pig growing life, from the weaning until slaughter; in order to be adapted to farrowing-fattening farms where significant volumes of manure also come from breeding pigs, it should also include results from sows.

The first version of siMMin™ is in English language and, depending on the level of interest expressed locally, should be later available in national languages for major pig producing countries.

Conclusion and perspectives

The high supplementation dosage of zinc in pig diets may result in excessive levels in soils and waters in areas of intensive animal production. In order to reduce safety margins, a better knowledge of the factors that affect Cu and Zn bioavailability are needed in parallel with a more precise evaluation of the animal requirements. With siMMin™, all stakeholders in the pig production chain now have a user friendly tool to mitigate the environmental footprint towards more sustainable practices.

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