Superdosing phytases in pigs: a revolution in feed performance

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Phytate is a significant anti-nutrient in plant-derived feed ingredients. Phytate increases endogenous secretions of mucin and protein, binds to and reduces mineral availability, reduces amino acid digestibility and inhibits endogenous enzyme activity.

This article discusses how superdosing (using higher levels of phytase to ensure almost total destruction of phytic acid) with a novel E. coli phytase can alleviate the anti-nutritional properties associated with phytate.

Anti-nutritional effects

Phytate chelates with minerals such as zinc, copper, iron and calcium, and prevents the digestion of protein and amino acids.

Phytate hinders endogenous enzyme activity and stimulates endogenous secretions within the gastrointestinal tract. This may increase the maintenance requirements of the pig and negatively impact feed efficiency.

The phytate present in rice-bran has been shown to reduce apparent energy metabolism and crude protein digestibility in 40kg pigs (Fig. 1).

Piglet body weight gain and feed efficiency were also reduced when a purified diet was supplemented with synthetic phytate (see Fig. 2).

A better understanding of these anti-nutritional effects of phytate and the performance benefits of phytate destruction by feeding high levels of phytase will ensure greater value for the pig producer.

The concept

Superdosing is defined as the use of a phytase to degrade the majority of phytate without fully taking into account the expected nutrient matrix, such that performance is enhanced to a greater extent than would be expected by the nutrient release alone.

This is not simply releasing more nutrients by adding more phytase, but almost totally removing and thus reducing the anti-nutritional effect of phytate. This gives a performance boost instead of a diet cost saving.

Phytase is an enzyme which hydrolyses phytate and thereby improves mineral and amino acid availability in pigs.

Commercially available phytases have evolved to be more intrinsically thermostable, pepsin resistant and active in the stomach where phytate is soluble and more easily hydrolysed.

However, the benefits of phytase supplementation with regards to phytate destruction rather than phosphorus release are highly dependent on the phytate level of the diet, the enzymological properties of the phytase source, and the phytase dose employed.

Novel E. coli phytase

Dietary supplementation with a novel, intrinsically thermostable E. coli phytase (Quantum Blue, AB Vista) beyond the typical 500 FTU/kg will result in extensive phytate hydrolysis.

The use of such superdoses (1,000-2,500 FTU/kg) of this novel E. coli phytase improved average daily gain (ADG) by 7% and feed efficiency (gain:feed) by 4% in growing pigs compared with a nutritionally adequately control diet (Fig. 3).

The success rate in 19 superdosing trials was approximately 84 for ADG and 74% for feed:gain. The control diets were

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Fig. 1. Apparent faecal digestibility (%) of 40kg pigs fed high or low phytate diets (from Liao et al., 2005).

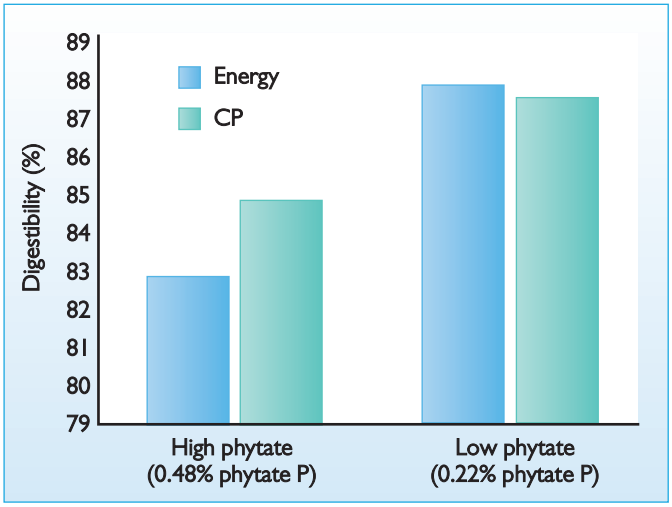
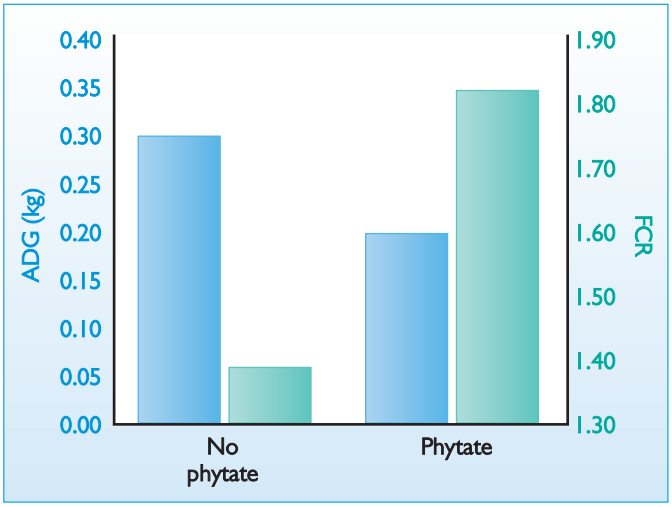


Fig. 2. Growth performance of piglets (7-13kg) fed casein-corn starch-based diet (from Woyengo et al., 2011).



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formulated to be nutritionally adequate, including calcium and phosphorus (1.0; red line).

Therefore, the improvements in performance with phytase application are presumably through the removal of the anti-nutrient influence of phytate rather than the provision of phosphorus.

Extra phosphoric effects

There are two more possible benefits seen when superdosing phytase:

- Balancing the calcium/phosphorus ratio:

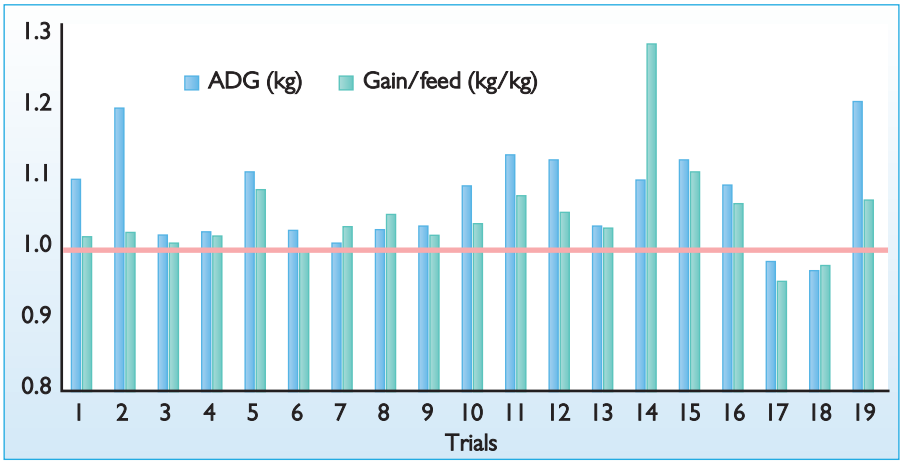

Fig. 3. Influence of superdoses of a novel E. coli phytase on pig relative average daily gain (ADG) and feed efficiency (gain/feed) compared to pigs fed the respective control diet adequate in all nutrients (1.0; red line).

when very low doses of phytases are applied, relatively more calcium is released than phosphorus. When superdosing a novel E. coli phytase, the result is nearly complete phytase destruction and proportionately more phosphorus is released than calcium, effectively balancing the digestibility calcium to phosphorus ratio.

- Production of inositol: phytate destruction results in the production of inositol which can be a growth promoting nutrient and may also be re-phosphorylated to intracellular phytate, an important antioxidant.

Conclusions

Phytate is an anti-nutrient through several mechanisms; it increases the endogeneous secretions of mucin and protein, binds to and reduces mineral availability, reduces amino acid digestibility and inhibits endogenous enzyme activity. As a result, the animal performance and feed efficiency is reduced.

Superdosing is the addition of sufficient phytase to quickly destroy essentially all phytate present in the diet.

As phytate is an anti-nutrient, this will lead to performance improvements in swine greater than those expected from the simple release of nutrients due to added phytase.

Superdosing with a novel E. coli phytase with intrinsic thermostability and high affinity for phytate results in alleviation of the anti-nutrient properties of phytate and may provide further benefits such as production of inositol and balance of the calcium/phosphorus ratio.

This method of phytase use moves away from the application of a dose dependent matrix to reduce diet costs and focuses more on optimising animal performance. ■