Boost starter pig performance with phytase superdosing

by Dr Pete Wilcock, AB Vista Global Technical Manager.

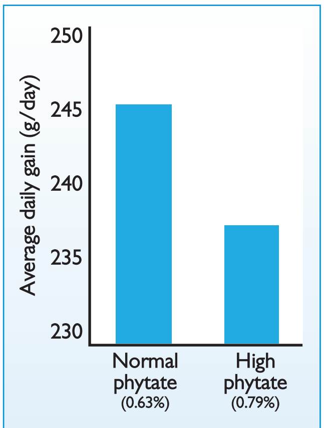
The use of a standard dose (500 FTU/kg or less) of phytase for phosphorus (P) release has to date been minimal in piglet starter diets fed for 21 days post-weaning. This is due primarily to the low dietary phytate levels that result when animal and milk proteins predominate, rather than plant proteins. In addition, the inclusion of zinc oxide at pharmacological levels to control post-weaning scours can bind phytate thereby reducing phosphorus release.

However, the application of new generation phytases at high doses – superdosing – to eliminate the anti-nutrient effects of phytate, rather than simply improve mineral supply, offers a fresh opportunity for starter pigs to benefit from phytase use.

Phytate impact

The full anti-nutrient effects of dietary phytate have become increasingly well defined in recent years, with phytate now known to have a significant negative impact on amino acid, energy and mineral utilisation. The net result is that even a small 0.16% increase in dietary phytate concentration has been shown to reduce average daily gain (ADG) by 3% during the starter period (Fig. 1), for example.

Fig. 1. Performance of piglets fed typical starter feeds with (high phytate) and without (low phytate) 2.5% rice bran from weaning to 21 days post-weaning (Walk et al., 2014).



Such increases in dietary phytate content are commonplace in starter diets, especially with recent moves to increase the use of plant-based protein sources in place of animal-based proteins. Even the natural variation in phytate content within commonly used raw materials such as corn, wheat, soybean meal and soy protein concentrates can elevate dietary phytate levels to where performance is impaired.

Anti-nutrient effects

There are several modes of action by which phytate has this negative impact, though all act to reduce digestibility and utilisation of important nutrients supplied in the diet. Key amongst these is the ability of the negatively charged phytate molecule to bind with positively charged minerals (such as calcium, zinc, iron and copper) and feed proteins (positively charged at low pH), rendering them less available.

In addition, the presence of phytate has been shown to reduce activation of the stomach enzyme pepsin, which is responsible for protein digestion. Combined with lower protein solubility due to phytate binding, the subsequent reduction in protein breakdown in the stomach can be significant. The resulting rise in undigested protein reaching the small intestine also increases endogenous losses by triggering production of additional hydrochloric acid and pepsinogen (the precursor to pepsin) in the stomach. Further losses come from greater secretion of mucus to protect the gut wall from the irritant effect of this acid, and sodium bicarbonate to neutralise the extra acid.

The overall effect is therefore not just a reduction in nutrient digestibility and utilisation, but also a substantial increase in overall maintenance energy requirements. The presence of phytate can also negatively affect the mechanism by which amino acids are absorbed from the small intestine. Interest in the elimination of phytate anti-nutrient effects and the development of low phytate nutrition programmes for starter pigs has therefore risen sharply since the concept of phytase superdosing was first introduced. Recent uptake has also increased following the introduction of new generation phytases, such as Quantum Blue, which can consistently target up to 90% phytate elimination when sufficiently high doses are applied.

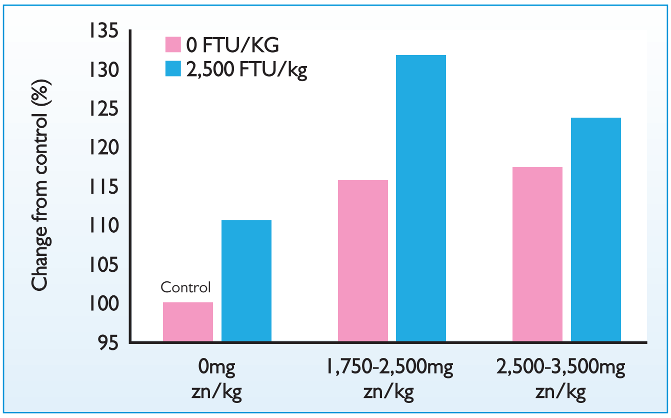


Fig. 2. Influence of zinc level (from zinc oxide) on growth rate response to phytase superdosing with Quantum Blue in starter pig (average of five trials) up to 21 days post-weaning (AB Vista, 2014).

Superdosing benefits

Such phytase superdosing typically requires the application of three to four times the standard dose, and involves the use of a highly efficient phytase developed specifically to target near complete phytate destruction.

Critically, no mineral matrix is applied during diet formulation when superdosing for the first 21 days post-weaning. This is due to the types of diet fed during this time traditionally being low in dietary phytate and including pharmacological levels of zinc oxide, both of which can reduce the amount of P released.

In 42 comparisons investigating the performance of piglets fed diets with or without Quantum Blue superdosing (no mineral matrix applied), the average response was an 8% increase in ADG and a five point improvement in FCR. Further research has demonstrated that superdosing works irrespective of the level of zinc inclusion, but with the response appearing to be optimised at between 1750-2500ppm for both ADG (Fig. 2) and feed conversion ratio (FCR).

This potential to lower dietary zinc levels results from the improvement in zinc availability when phytate-zinc binding within the gastro-intestinal tract is reduced by superdosing, as indicated by the clear rise in zinc serum levels seen during the research. Although 1750-2500ppm still represents a pharmacological level of dietary zinc, in many cases it is a reduction of between 500-1000ppm compared to the standard level of inclusion, and so offers the opportunity to reduce feed cost as well as optimising starter pig performance.

Inositol impact

However, to achieve this level of success when superdosing, it is critical that the phytate (which is inositol hexaphosphate, IP6) is degraded to a point where only its lower, less

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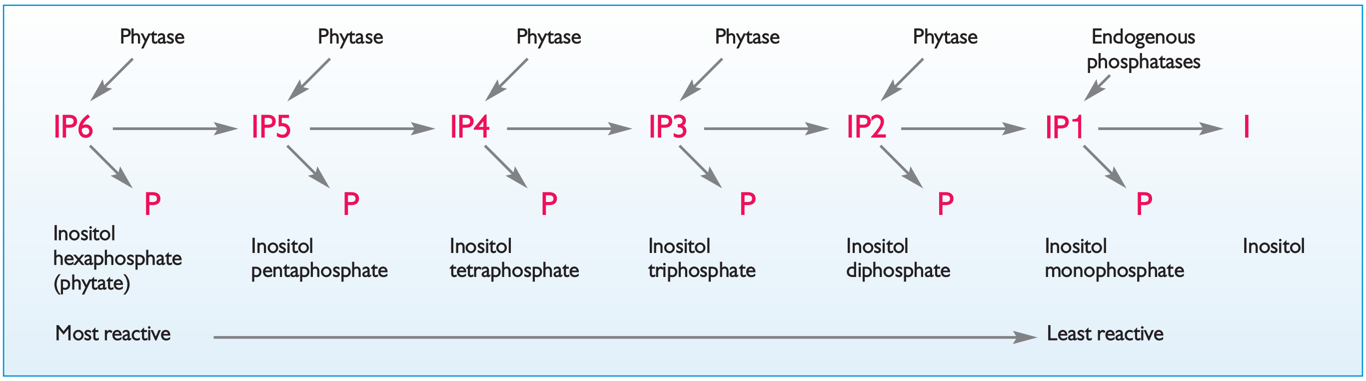

Fig. 3. Breakdown of phytate to inositol and phosphorus through the action of phytase superdosing.

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reactive esters (<IP3) remain, as these have limited anti-nutritive effects (see Fig. 3).

In addition, it appears that the inositol produced following the removal of P from phytate by phytase action is also potentially beneficial to the piglet.

Inositol is known to have important metabolic roles, such as in fat metabolism and cell function, and is also combined with P at a cellular level to recreate phytate (which acts as a potent anti-oxidant within the cell) and certain lower phytate esters (IP3 and IP4 are important to cell function).

Although little research has yet been carried out specifically targeting the impact of inositol in pigs, the latest research suggests that up to 30% of the benefits of phytase superdosing in broilers are likely associated with inositol release.

Phytase performance

The key to success when implementing a superdosing strategy is therefore to both minimise anti-nutrient effects and maximise inositol release by targeting as near complete degradation of phytate as possible.

The challenge for end-users is that the ability of phytases to achieve this level of phytate degradation, particularly to below IP4, differs considerably, and so does their subsequent suitability for superdosing.

The most suitable phytase products therefore exhibit a high rate and extent of phytate breakdown, being able to act fast enough to prevent anti-nutrient effects taking place and then continue even at low concentrations to drive towards complete phytate elimination.

Furthermore, such products must be effective in continuing to degrade phytate to below IP3 to prevent the accumulation of lower esters that also exhibit anti-nutrient effects, particularly IP5, IP4 and IP3.

In addition, good gastric tolerance and stability is needed to resist breakdown by the piglet's own digestive enzymes, whilst phytase activity should be optimised at the low pH of the stomach (pH 2-3).

Standard practice

As a result, achieving the full growth and feed efficiency benefits from phytase superdosing depends as much on making the right choices and buying decisions as it does on correct dosage and application.

Selecting a phytase that is capable of efficient and extensive phytate destruction, such as Quantum Blue, is therefore vital, and it should be no surprise that phytase superdosing is already well on the way to becoming standard practice for starter pigs in many regions of the world. ■