Use of phytase enzymes to optimise feed costs and performance of pigs

by Ulrich Altemueller and Donnie Campbell, DSM Nutritional Products.

Phytase is now well established in all swine diets to utilise the phytate bound phosphorous in raw materials of plant origin such as cereal grains, oil seed meals and their by-products. Phytate is the primary storage form of phosphorous in plants. In typical plant based feed ingredients the phytate bound phosphorous often exceeds two thirds of the total phosphorous (P) content (see Fig. 1).

Due to the lack of endogenous phytase, pigs cannot utilise the phytate bound phosphorous and this valuable source of phosphorous is excreted into the environment where it can pose a problem, especially in areas with intensive agriculture.

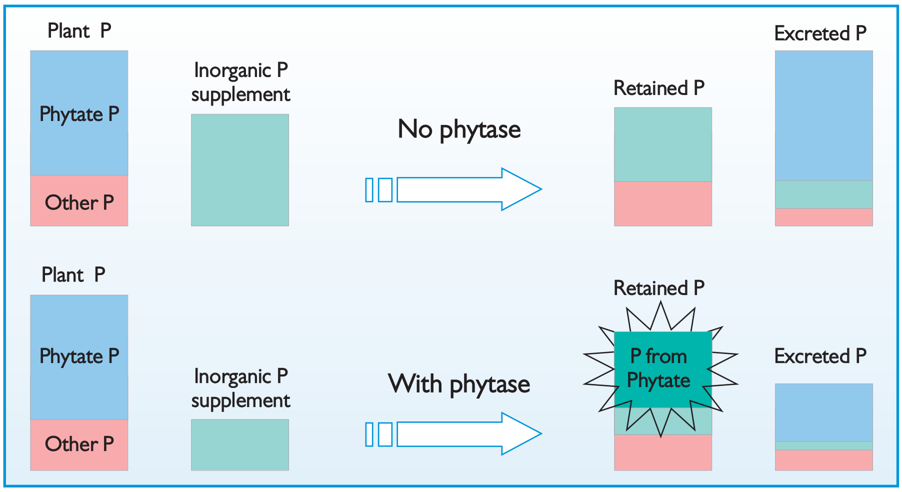


Fig. 2. The principle of phytase addition.

Meeting daily requirements

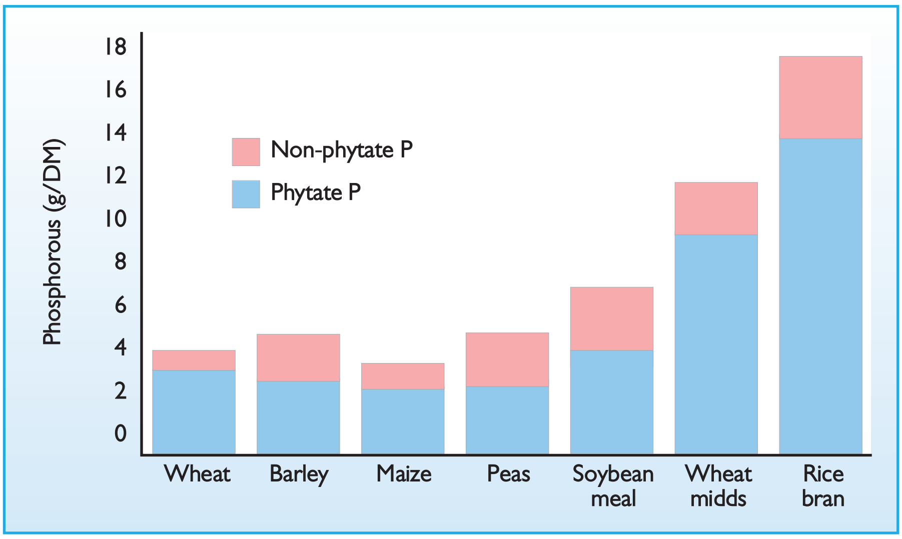
To meet the daily phosphorous requirements for swine, the addition of inorganic phosphorous sources such as mono or dicalcium phosphate or P-rich feedstuffs as meat and bone meal is needed. Added phytase can hydrolyse the phytate bound phosphorous which then can be utilised by the animal.

Thus, the dietary addition of inorganic phosphorous sources can be reduced or, in some cases, may not even be necessary. As a consequence, feeding costs are lowered and the amount of phosphorous excreted is minimised by approximately 30%. The principle of phytase addition to feed is illustrated in Fig. 2.

The hydrolysis of phytate P by phytase does not only release phosphorous, it also has the potential to release minerals and amino acids that may be chelated or associated with the negatively charged phosphate ions. The energy of the diet may also be increased.

Matrix values of phytase for least-cost feed formulations demonstrate the economic advantage of phytase during the feed formulation process and enable a more flexible dosing.

Fig. 1. Phosphorous content of selected raw materials used in feed.



Widespread in nature

Phytases are widespread in nature and can be found in a variety of sources such as fungi, bacteria, yeasts, plants and even in ani-

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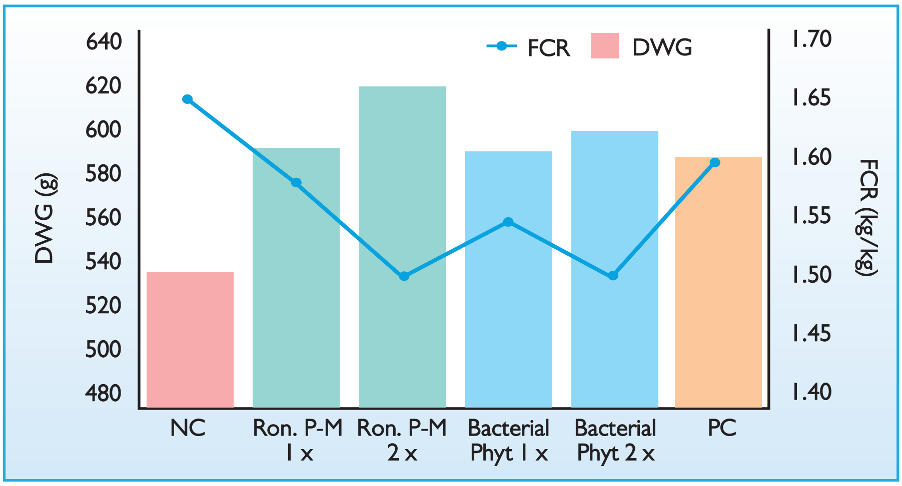

Fig. 3. Effects on performance of starter pigs receiving diets with different levels of available phosphorous and the addition of 1 x and 2 x recommended levels of a fungal and a bacterial phytase (DSM field study, 2009).

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mal tissues. The most relevant forms of phytases used today are derived from fungal or bacterial origin.

Additional description of phytases is the 3- and 6-phytase terminology – indicating the preferred first site of attack – the universal classification of 'fungal' and 'bacterial' provides no information on efficacy and utility. Instead, differences in various biochemical and biophysical traits are phytase-specific.

Furthermore, selective molecular modification may launch a complete set of new characteristics.

Often in vitro data are used to characterise the potential functionality of phytases in the animal feed. As the conditions in the gastric tract vary, additional challenging conditions in terms of endogenous proteolytic enzymes and minerals of dietary origin occur, only animal trials will show the real benefits.

Comparison study

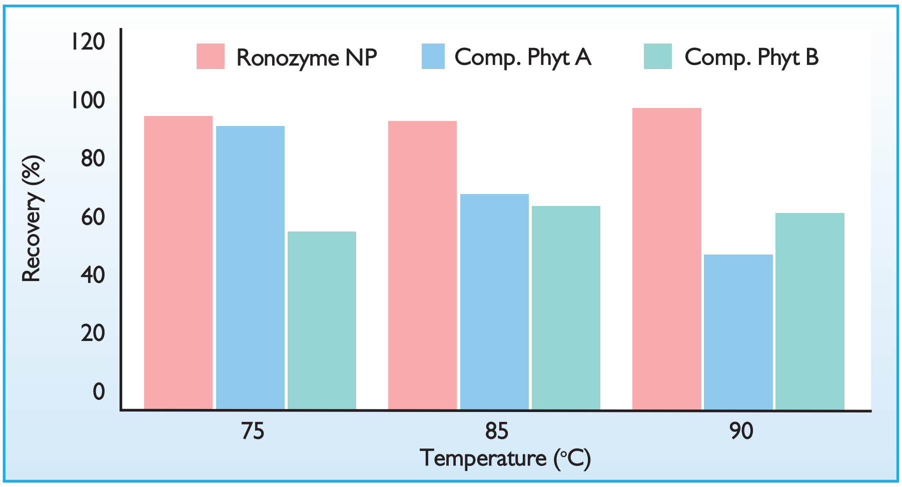
In a recent field study in the USA the usages of different phytases (bacterial vs fungal) were compared against a low-P basal (NC) diet (0.15% available P) and a positive control (PC) diet with added P from dicalcium phosphate (0.29% available P).

In the relevant parameters of daily weight gain (DWG) and feed conversion ratio (FCR) both phytases showed an improvement in performance compared to the low-P basal diet even outperforming the positive control.

No differences were observed between the performances of diets containing either phytases. Using twice the recommendation to replace 0.1% available P (1 x) showed further improvement (Fig. 3).

In certain countries a common feeding strategy to prevent post-weaning disorders in piglets is the reduction of total phosphorous and calcium content in weaner diets.

Fig. 4. Recovery of different phytases after pelleting at various temperatures (TI, Kolding, Denmark, 2009).



Disorders at this development stage often cause severe health problems in piglets. Poor performance or losses is a result of ill-prepared and unbalanced diets during this critical period.

In order to overcome the effect of insufficient production of hydrochloric acid in young piglets, especially shortly after weaning, carefully selected feed ingredients may help to decrease the acid binding capacity of feed for piglets and enhance the digestion of protein in the stomach.

The use of phytase reduces the total amount of inorganic calcium and phosphorous sources such as limestone and dicalcium phosphate. These two feed ingredients have high acid binding capacity values and, therefore, a reduction of these ingredients is crucial to optimise protein digestion in the stomach and prevent intestinal disorders.

In addition to the mode of action described above, phytases like other added feed enzymes need additional properties to fulfill the criteria needed for today's feed processing. Easy and safe handling during the mixing process of feed, homogenous distribution after mixing and stability of the phytase to withstand the harsh conditions of feed processing is a must.

Phytases are proteins that have specific and complex structures. This structure is essential for the activity of the enzyme and its stability to survive the conditions of feed processing (for example pelleting) and guarantee the full potential of the added enzyme in the feed.

Specific developed coating technologies are needed to maintain the potential of the embedded enzyme and to ensure its availability in the intestinal tract. Differences between the products on the market are often obvious just by looking at their physical appearance.

The ability to withstand the harsh conditions during the process of feed production often needs internal investigations to find out whether the desired products fulfill the criteria needed (see Fig. 4).

Conclusion

Phytase is currently a common additive in feeds for piglets, growing-finishing pigs and sows.

The special functionality of phytase enables feed producers throughout the world to optimise feed costs in a very efficient way.

The negative impact of intensive swine production on the environment is reduced.

Although declared activities of enzymes seem to be very similar, their properties in handling, mixing and stability are different.

The efficacies of bacterial phytases have no advantage over fungal phytases in animal performance when added at manufacturers' recommendations. ■