Phytase: Should we be using levels above the double dose?

Summary

- Maximum inclusion level of phytase is determined by the amount of phytate-bound nutrients in the feed
- Phytate can form complexes with calcium and other nutrients, therefore not all phytate phosphorus will become available for release by phytase
- At current practical dietary calcium levels, approximately 50% of the phytate bound phosphorus can be released by phytase
- It is concluded that super dosing of phytase is not effective

Introduction

Phytase has become a standard enzyme in pig and poultry feeds. Initially, only phosphorus was attributed to phytase as a nutrient, but on the basis of additional research data, this was extended to calcium, trace minerals, amino acids and energy. In order to account for the lower efficacy of phytase at high inclusion levels, different matrix values can be applied to phytase at the different dose rates. In diet formulations, the first phytase dose is attributed higher nutrient values than the second dose. For inclusion rates above the second dose, nutrient matrix values are further reduced (for adult birds i.e. laying hens, these steps are applied for each 150 FTU instead of 250 FTU for growing animals). More recently, new generation phytases have been introduced that claim to have a higher efficacy. In order to reduce phosphorus supplementation as much as possible, very high inclusion levels of phytase (1500 – 2500 FTU/kg) are being recommended in practice (super dosing). Based on literature and Nutreco trials, the possibilities and limitations of super dosing of phytase will be explained.

Interaction between dietary calcium level and phytate disappearance

Recent data indicates that the amount of phytate that can be degraded is dependent on the dietary calcium level. Phytate has a negative effect on calcium utilisation (Angel, 2011; Walk and Bradford, 2011). Phytate chelates with calcium and forms insoluble complexes when pH increases. At a pH of 2, no phytate is precipitated, but at a pH of 5, half of the phytate is precipitated and is unavailable for phytase to act upon (Angel, 2011). At a pH of 6, only about 10 % of the phytate is left in solution. Therefore, dietary calcium can have a negative effect on the potential phosphorus releasing capacity of phytase. Work carried out by Nelson et al. demonstrated that the calcium requirement of broiler chickens fed phytate free feeds was only 5 g/kg as compared to 9.5 g/kg for chickens fed diets containing phytate.

Tamim et al. (2005) found that at low dietary calcium (1.8 g/kg) phytate phosphorus (also known as inositol phosphorus, IP) disappearance increased to 76 - 80% with the use phytase (table 1). This indicates that a maximum of 75-80 % phosphorus from IP can be released by phytase. With the current phytase evaluation a maximum phytate degradation of 75 %, approximately 1500 FTU of phytase could be included in the feed to gain maximum benefit. However, at more typical dietary calcium levels (6.8 g/kg), no more than 45-59 % of the IP was degraded meaning the phytase dose to gain maximum phosphorus release is under 1500 FTU.

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Table 1: Effect of added calcium and phytase on phytate phosphorus disappearance (%) in the ileum of 24-day-old broiler chickens (Tamim et al., 2005)

Calcium g/kg	No added phytase	500 FTU/kg Phytase C	500 FYT/kg Phytase D
1.8	69.2[b]	79.5[a]	76.2[ab]
6.8	25.4[e]	58.9[c]	44.9[d]

Effect of including higher inclusion levels of phytase

In phytase dose response studies, the improvement in performance reduces as phytase level increases (see Figure 1).

The maximum inclusion level of phytase is then defined by the economic value of the added phytase and the amount of phytate that is present in the feed.

Tamim et al. (2005) found that the IP disappearance was about 45-59 % in broiler feeds that contained 6.8 g/kg of calcium and 500 units of phytase. Therefore, it can be assumed that a maximum of 50 % phytate bound phosphorus can be released by phytase. For example, when a broiler diet contains 2.5 g/kg IP a maximum 1.25 g/kg (50%) of P can be released from the IP, which corresponds with a phytase dose of 900 FTU. This disappearance indicates that, in terms of P release, super dosing of phytase will not be effective with the current dietary calcium levels used in UK diets.

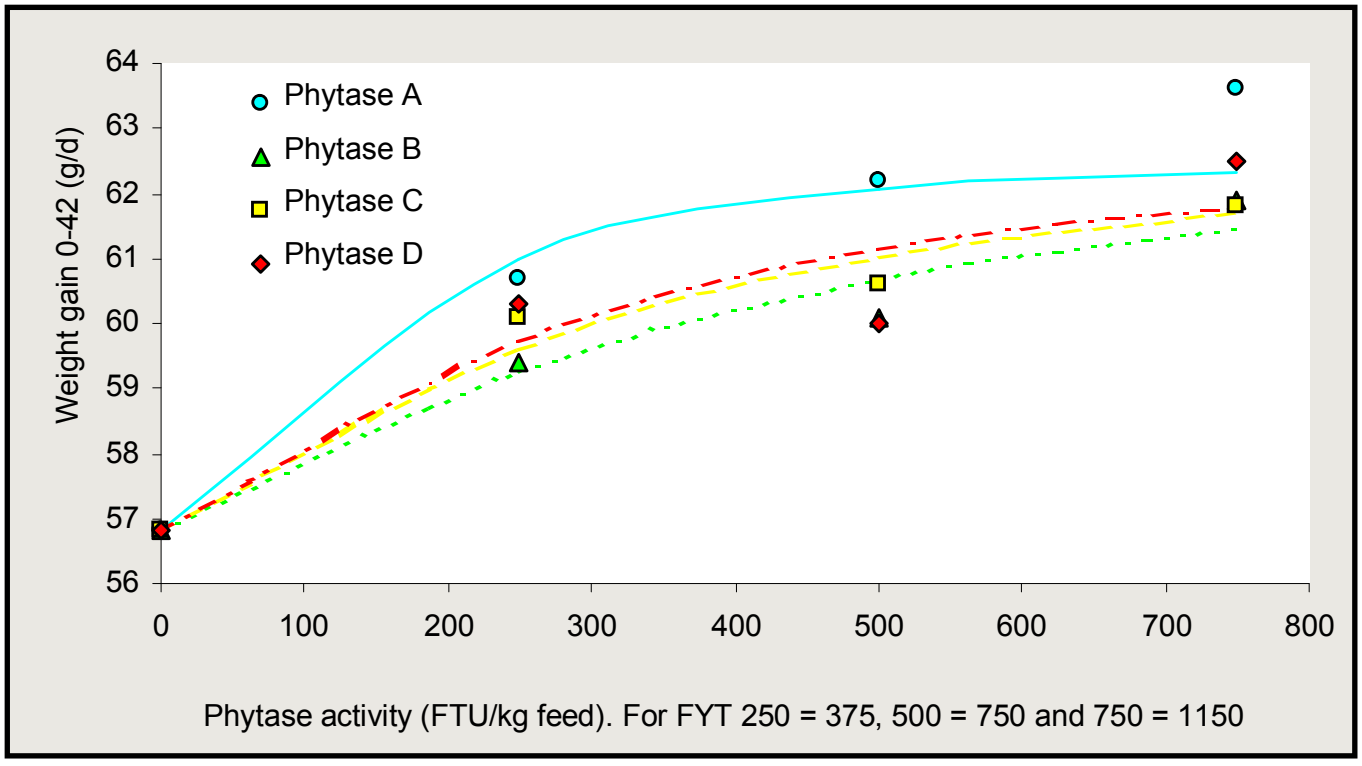

Figure 1: Effect of different dietary phytase levels on broiler performance (PRRC, 2008)

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Conclusions

The maximum inclusion level of phytase is determined by the efficacy as function of the dose used and the amount of IP in the feed. Due to the fact that phytate can form complexes with calcium, not all phytate phosphorus will become available for release by phytase. At current practical dietary calcium levels, about 50 % of the phosphorus can be released by phytase. This means that super dosing of phytase is not effective. The reason that super dosing of phytase has not provided negative effects on performance may be related to the fact that higher phosphorus levels have been applied than the minimum levels currently recommended.

Recommendations

In order to take into account the lower efficacy of phytase at higher inclusion levels, it is recommended to use different nutrient values depending on the inclusion rate.

Nutrient release may vary between the commercially available phytases. Therefore it is advised to use the nutrient matrix values specific to the phytase which is used.

The maximum level of phytase that can be used is half the amount of phosphorus that can be released from IP. Therefore, negative IP values should be attributed to phytase and a minimum of 0 g/kg should be used for IP. This ensures that phytase does not exceed available substrate from IP.

It is advised to use the minimum levels of calcium and phosphorus within the current TNI recommendations when high levels of phytase are used. This seems to be the most cost effective way to use phytase and to reduce dietary phosphorus levels.

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References

Angel, R., 2011. Impact of calcium on phytase efficacy in broilers. Mid Atlantic Nutrition Conference, March 23-24, 2011, Baltimore.

Nelson, S., J. J. McGillivary, T. R. Shieh, R. J. Wodzinski, and J. H. Ware, 1968. Effect of phytate on the calcium requirement of chicks. Poult. Sci. 47:1985-1989.

Tamim, N., R. Angel, and M. Christman, 2005. Influence of dietary calcium and phytase on phytate phosphorus hydrolysis in broiler chickens. Poult. Sci. 83: 1358-1367.

Walk, C.L., and M.R. Bradford, 2011. Calcium solubility and digestibility: The influence of calcium source and phytase. Mid Atlantic Nutrition Conference, March 23-24, 2011, Baltimore.

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