A protein value for a phytase – some critical remarks

The main reason for using an exogenous added phytase in feed is to liberate phosphorous (P), bound as phytate, in raw materials. This not only leads to a lower feed cost by reducing the amount of added inorganic P, but also exerts a positive effect on performance by degradation of phytate, which is a known anti-nutritional factor in feed.

by Dr Lode Nollet,
Global Product Manager Enzymes,
Huvepharma NV, Belgium.
www.huvepharma.com

Due to the latter action, protein bound to phytate might become more available for digestion, so protein and amino-acid saving properties (matrix values) are also being attributed to a phytase.

Phytate and protein digestion

Phytate, being a myo-inositol ring substituted with six phosphate groups which are negatively charged, will bind in the intestine positively charged molecules, hindering their absorption and therefore digestion (Fig. 1). Protein (amino acids) can also be bound to the phytate molecule, either by its ammonia group (NH_4^+) or by the formation of Ca bridges with the carboxyl group (-COOH).

The first mostly occurs in the first part of the intestine, where pH is low, whereas the second is mainly formed in the small intestine, where pH is higher.

Phytate can also reduce activity of pepsin, a key protease active in the gizzard, and so additionally hinder the digestion of protein.

	Feed	E. coli phytase by T. reesii	Buttiauxella phytase	C. braakii phytase	Hybrid 6-phytase by A. niger	OptiPhos
dig. Meth + Cys/lys (%)	73	229	86	60	26	133
dig. Threo/lys (%)	62	194	81	60	108	108
dig. Tryp/lys (%)	20	112	24	17	25	25

Table 2. Amino acid ratios vs lysine ratios of feed and of amino acids matrix values claimed by different phytase suppliers.

This impaired digestion of protein results in a stimulation of hydrochloric acid (HCl) and pepsinogen production in the gizzard.

These actions represent not only a loss of endogenous protein (pepsinogen) but also have an impact on mucus destruction through excess acid production, requiring a higher usage of feed protein for mucus regeneration.

Also, more sodium bicarbonate is required to neutralise the acidic pH in the duodenum, leading to a higher loss of Na, potentially disturbing the electrolyte balance at gut level.

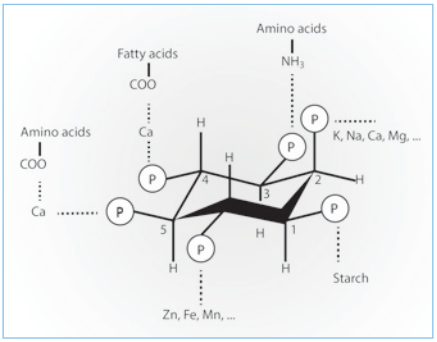

Fig. 1. Phytate as an anti-nutritional factor.

Table 1. Saving on P and protein/amino acids in feed formulation for different phytases dosed at their recommended single dose in broilers (€/T).

	On phosphorous	On protein/amino acids
E. coli phytase by T. reesii	2.8	6.5
Buttiauxella phytase	2.8	2.9
C. braakii phytase	2.8	1.1
6-phytase by A. niger	2.5	1.8
OptiPhos	2.7	2.0

As phytate levels in feed mainly originate from protein source (soybean, rapeseed and sunflower seed meal) and protein levels are highest in poultry starter diets, an early destruction by a fast acting phytase is beneficial in order to counteract this anti-nutritional effect of phytate.

The protein value of a phytase must be linked to its P value

In practice, each supplier proposes a protein value for its phytase, not only for total protein savings, but also for each individual amino acid.

Different commercially available phytases put forward a variety of protein and amino acid matrix values, which are sometimes quite different from each other.

The protein saving of a phytase is completely dependent on its ability to degrade phytate fast (as described above), releasing complexed protein (amino acids) and reducing the loss of endogenous protein.

Phytases are not proteases, so they will not aid the hydrolysis of protein to amino acids but merely make the proteins more available for endogenous protease to digest.

Following this idea, the protein savings need to be linked to the ability of the phytase to degrade phytate; so this means it should be linked to the P matrix value of a phytase.

However, formulating broiler diets with the matrix values of protein (including amino acids) as claimed by different phytase producers leads to savings on protein which are not in balance with savings on P.

Table 1 shows a very high variation in protein savings of different phytases, which is not in line with the savings on P (which is more equal over the different phytases).

Continued on page 25

Continued from page 23

Amino acid values of a phytase and amino acid profile pattern of feed

Feed and feed ingredients have a certain amino acid profile pattern. As phytases are not proteases, they will not selectively hydrolyse protein and not release selectively some specific amino acids like endogenous and exogenous added proteases do. Despite the fact that some free amino acids can bind more easily to phytate in the gizzard, and that mucus has, for instance, a higher threonine to lysine level than in any other tissue, this means that the amino acid matrix values of a phytase should also follow more or less the amino acid profile of the feed. The amino acid ratio of the major amino acids like methionine+cysteine, threonine and tryptophan expressed on lysine as suggested by the phytase supplier should thereby follow roughly the same pattern as in these feedstuffs. As can be seen from Table 2, this is not always the case. For instance, an E. coli phytase produced by T. reesei seems to selectively liberate (according to its claimed matrix values) more tryptophan than lysine (112% vs 100% lysine, while the feed only contains ±19% tryptophan versus 100% lysine). In contrast, a 6-phytase product by A. niger seems to be selectively incapable of releasing methionine+cysteine (only 26% versus 100% lysine), while the ratio in feed is ±73% methionine+cysteine vs 100% lysine respectively.

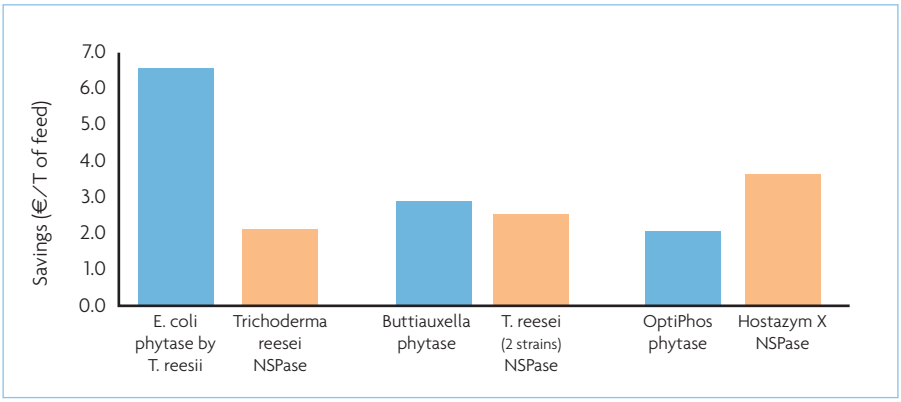

Fig. 2. Saving on protein/amino acids in feed formulation for different phytases and NSPase dosed at their recommended single dose in broilers (€/T).

Comparing the protein matrix values of phytase to NSPs

Enzymes breaking down Non-Starch Polysaccharides (NSPases) increase protein digestibility through reducing viscosity in the intestine, and by release of protein trapped by insoluble fibre (the so called 'cage effect'). An inquiry at nutritionist levels shows that ›90% of them expect an NSPase to improve the protein digestion more than a phytase, due to these two modes of actions.

However, looking at Fig. 2, where the savings on protein by a phytase (as indicated in Table 1) is plotted next to savings on protein by commercially available NSPases (grouped by enzyme producer), it seems that this logic is not always followed.

This means that the claimed protein matrix values for some phytases might be quite overestimated, or the claimed protein values of the NSPases could be underestimated.

Conclusion

It can be concluded that protein matrix values of a phytase are linked to the speed of phytate degradation, and thereby linked to the P matrix value of a phytase. So, phytase with similar proven P matrix values should have very similar protein matrix values. ■