Formulating cost effective pig diets with an advanced phytase

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It is universally acknowledged that phytase has the ability to improve dietary phosphorus availability in pig diets and to help reduce manure management costs. As a result, it is the most widely used feed enzyme in the world, with an estimated penetration of over 70% into pig diets and over 90% into poultry formulations.

Today, the most frequent question from nutritionists and pig producers is not 'should I use phytase' but rather, 'how can I best use phytase'? Phytase users want to know about optimum dosing levels and also the extent to which matrix values for phosphorus, calcium, amino acids and energy can be utilised in feed formulation without compromising pig performance. This article explores some new phytase developments and how they can best contribute to maximising value from phytase use.

Anti-nutrient effects

Recent scientific research has shown that the phytate level in nursery diets has a significant negative impact on the growth performance of piglets (Fig. 1).

Similar effects on energy and protein/amino acid digestibility in growing pigs have also been shown in earlier research studies

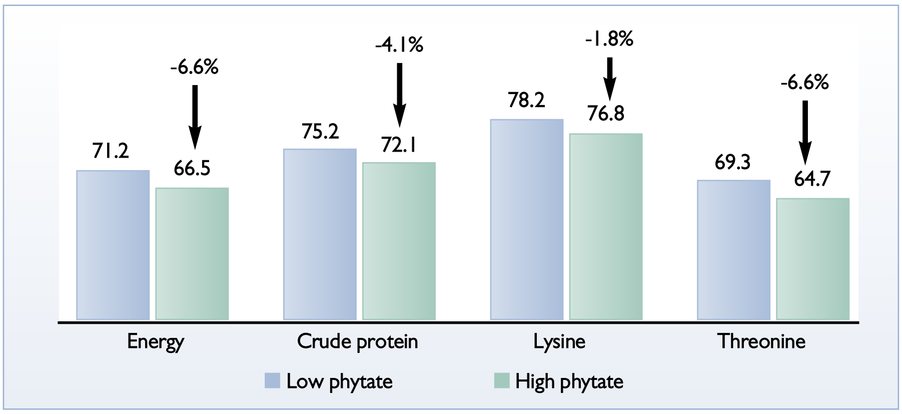


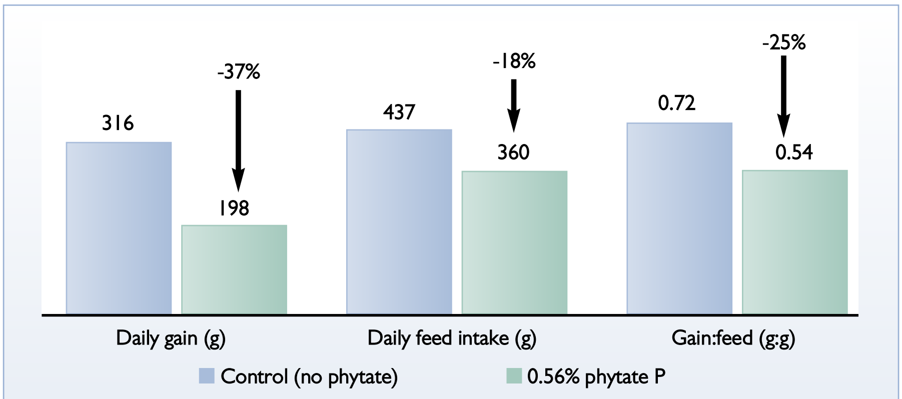
Fig. 2. Increasing dietary phytate levels decrease ileal nutrient digestibility (%) in growing pigs (40.6kg) (Liao et al. 2005). Low phytate P = 0.22%; high phytate P = 0.48%; phytate effect P<0.001.

(Fig. 2). Phytate reduces the availability of nutrients to the animal because it forms complexes with protein, calcium and trace elements in the digestive tract, a process which decreases the nutritional value of diet formulations.

The acidic pH levels (pH<4.5) in the upper part of the digestive tract, where phytate is soluble, are particularly conducive to protein binding. The phytate-protein complex is not a substrate that can be dealt with by the animal's own proteases (for example pepsin) and as a consequence gastric secretions of pepsin and hydrochloric acid are increased as a compensatory mechanism. This leads to higher endogenous losses of protein and further reductions in the efficiency of digestion of protein and energy.

Nutrient contributions arising from the effects of phytase are by no means fixed and will depend upon the initial phytate concentration in the diet, the amount of phytase added to the feed and, most importantly, the rate and extent of phytate hydrolysis by phytase in the upper part of the digestive tract. A good, highly effective phytase needs to work rapidly at low pH to negate the detrimental effects of dietary phytate.

Fig. 1. Phytate as an anti-nutrient decreases weaner pig (7.4kg) performance. Pigs were fed synthetic diets based on casein-corn starch supplemented with and without phytic acid additions (Woyengo et al 2012).



Phosphorus as a pollutant

About 60-70% of the total phosphorus (P) in feedstuffs commonly used in pig diets exists as phytate phosphorus, which is effectively indigestible.

Pigs are unable to use this phosphorus because they cannot break-down the phytate molecule. As a result, a lot of the phosphorus contained in pig feed will end up in manure which can, in turn, pollute fresh water supplies.

Indeed phytase was originally introduced in the late 1980s to help Dutch animal producers avoid a 'phosphorus tax' that was imposed on any operation found to be polluting water with harmful undigested phosphorus.

Today, complying with P based manure regulations can still significantly increase the cost of manure disposal in areas or on farms

	Pos. control	Neg. control	NC + Buttiauxella (FTU/kg) 250	500	1000	NC + E. coli (FTU/kg) 500
Phosphorus digestibility (%)	50.0[d]	40.7[e]	55.5[c]	61.0[b]	64.9[a]	55.0[c]
Calcium digestibility (%)	59.7[d]	49.4[e]	64.8[c]	69.4[ab]	73.1[a]	66.2[bc]

Table 1. Effect of a Buttiauxella spp. phytase (Axtra PHY) on nutrient digestibility in weaner pigs (12-19kg) in comparison to an E. coli phytase (Schothorst Feed Research, The Netherlands).

where there is not sufficient nearby availability of land for manure application.

In the US, switching from nitrogen based livestock manure policies to phosphorus based policies has been shown to increase the cost for compliance, ranging between $0.56 and $21.74 per unit of pig production capacity. For pig producers this represents significantly decreased profitability.

The improvement in bioavailability of naturally occurring phosphorus via the use of phytase means that less inorganic P needs to be added to the feed and less P will be excreted in the manure, reducing both feed costs and the environmental impact of pig production. For example in Canada, adding phytase to pig diets has been shown to increase profitability by up to 14% when manure has to be transported.

Phytase evolution

Our understanding of the role of phytate in animal nutrition has advanced substantially since phytase was first introduced to help animal producers avoid legislative penalties associated with phosphorus excretion.

Benefits from the improved absorption of phosphorus, a vital mineral for skeletal growth, and a reduced reliance on relatively expensive inorganic phosphorus sources helped improve animal performance and save costs throughout the 1990s.

The first E. coli phytase on the market was launched in 2003, offering a 20% improvement in bio-efficacy and associated feed cost savings compared to traditional fungal phytases available at that time.

This was followed in 2007 by unique developments in Thermo Protection Technology (TPT) of dry phytase, offering the customer more confidence in use through the steam conditioning and pelleting process.

Recent research has demonstrated that there are significant differences even between E. coli phytases in terms of their bio-efficacy and consequent ability to reduce the anti-nutrient effects of phytate in diets.

More advanced phytase sources, such as the one based on a Buttiauxella spp. that was first launched in the US early last year, can also further increase the availability of phosphorus, calcium, energy and amino acids to the animal.

Commercial trials have shown that this novel phytase offers even higher activity under low pH conditions, ensuring more efficient breakdown of the phytate molecule early in the digestive process. Table 1 shows the results of a digestibility trial in weaner pigs with diets reduced in available phosphorus by 0.20%, calcium by 0.14% and a dietary phytate P level of 0.21%.

The Buttiauxella phytase in this particular trial was as effective as the E. coli phytase at half the dose in terms of phosphorus and calcium digestibility.

A much bigger dataset of 14 digestibility trials (>550 data points) involving both weaner and grower-finisher pigs has recently concluded that the new Buttiauxella phytase, at typical inclusions of 500 FTU/kg feed, offers a 34% bio-efficacy benefit over a comparable E. coli phytase in terms of phosphorus and calcium release.

This, coupled with digestible energy improvements of ~35 kcal/kg feed (0.15 MJ) with the new product, translates into an economic advantage of around $1.00-1.30/tonne versus using a comparable E. coli phytase.

Profiting from phytase use

Customers seeking to achieve the substantial economic benefits that the latest phytase technologies can offer should be particularly vigilant with regard to the basis of the matrix recommendations that are supplied with those products.

Extrapolating work from broilers to pigs is unacceptable, given their differing digestive physiology, so particular attention should be given to source information.

Similarly, thermo-stability rightly remains a major customer concern when using dry phytase products and demands extensive mill testing and regular quality control.

Recovery of a dry phytase in feed should always be assessed versus mash samples collected pre-conditioning; only in this way can products be satisfactorily compared.

Paying attention to some of these key aspects when faced with new phytase choices will ensure that phytase continues to be one of the most valuable feed additives currently available to the global animal feed industry, offering excellent return on investment. ■