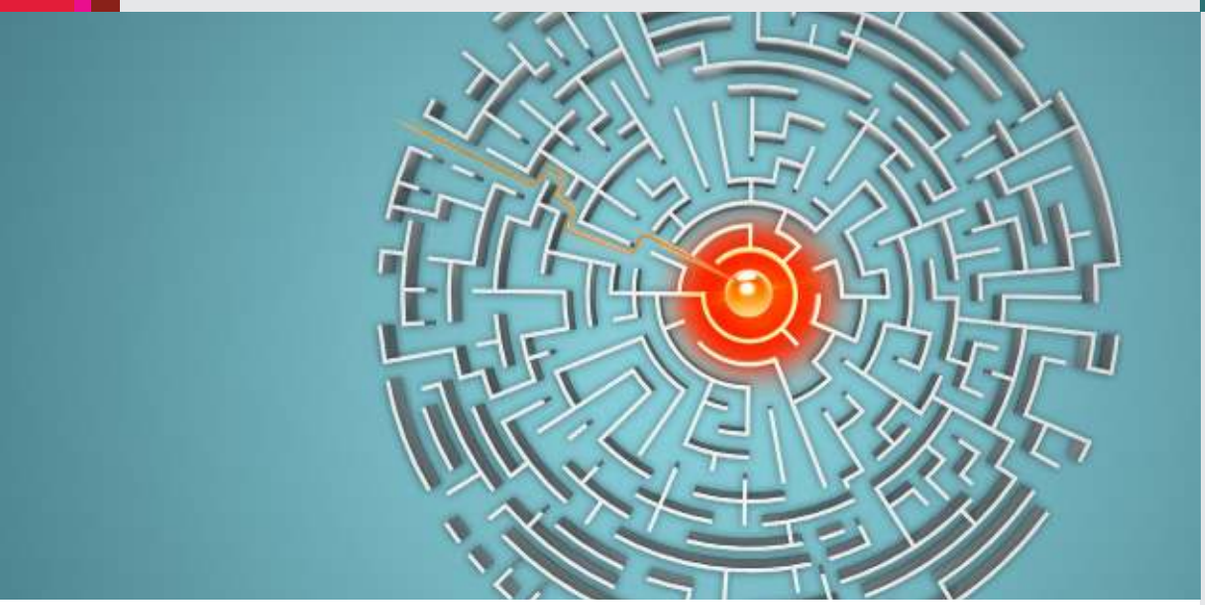
AXTRA® PHY

THE FAST-ACTING PHYTASE THAT HELPS YOU FINISH FIRST

Danisco Animal Nutrition



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Optimising phytase matrix values to maximise performance

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INTRODUCTION

The effective use of phytase matrix values in feed formulation can have a significant positive impact in terms of improving performance, reducing costs and boosting production efficiencies.

The challenge for nutritionists and feed producers is how to ensure maximum commercial return – particularly in view of increasing feed ingredient costs. Diet composition must be taken into account. But most important, is a detailed understanding of the behaviours of different ingredients in combination as well as the highly influential role of full matrix values.

Here we examine the latest research carried out to further explore the issue – with a particular focus on calcium and phosphorous ratio in the presence of phytase - and set out recommendations for achieving the optimal nutritional balance.

THE IMPORTANCE OF THE Ca/P BALANCE

It is well known that calcium (Ca) plays a significant role in the utilisation of phosphorous (P) which is one of the most important minerals in animal nutrition. Getting the Ca/P balance right is vital – not only for the animals' health but also in terms of economic performance and productivity. Phytase is an enzyme commonly used in animal feed to improve phosphorous digestibility – but its interaction with calcium is not yet fully understood.

The issue centres on the fact that calcium chelates with phytate in the small intestine and makes this essential compound less accessible to the animal; potentially leading to phosphorous deficiency and ultimately poor performance.

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Equally important to this delicate interaction is the presence of phytase, which is an enzyme used to breakdown phytate (salt of phytic acid) in the upper gut and release digestible phosphorous before it can bind with calcium. But the rate at which it does so is dependent on a number of factors.

Particle size, solubility and volume of dietary calcium are key considerations, but so is the activity level of the phytase at low pH – particularly in view of recent technical advances in enzyme screening and protein engineering which has led to a new generation of phytase with unique pH profiles and ever greater efficacy.

Realising the full benefits of phytase requires a detailed understanding of the most effective ratios required to achieve the best possible outcome.

DEFINING CALCIUM CONTRIBUTION

The impact of calcium on phytase efficacy is directly related to phytase activity in the upper part of the gastrointestinal tract (GIT). Here the low pH means that phytate is more soluble so a phytase that is highly active in these conditions will break it down more quickly and completely; meaning less phytate remains to be bound by the excess calcium to form the insoluble Ca-phytate complex in the small intestine. As a result, the anti-nutritional effect of phytate on digestion is also reduced. The corresponding increase in calcium availability is an additional benefit.

Given this need for careful alignment, a defined calcium contribution number - or matrix value - is essential in order to maintain the optimum Ca/P balance when phytase is used in the diet. Without it, an imbalance may occur and impair digestion and overall performance.

As each phytase has a unique pH profile, it follows that calcium matrix values need to be defined for each individual type. With this in mind, we carried out a series of studies using a new generation *Buttiauxella* phytase, known as Axtra® PHY, which is known to have a higher activity at low and wider pH range compared to other commercial phytase products.

But to establish an optimal calcium matrix, the million-dollar question must first be answered: How many calcium molecules can be bound by a phytate molecule?

Published studies suggest that one phytate molecule (the principal storage form of phosphrous in plant based ingredients, also called inositol 6 phosphate or IP6) can bind up to 4-5 calcium molecules in the gut of animals. While lesser inositol phosphate esters, such as IP4, IP3 and IP2, have very little or no binding capacity. Based on these findings, it can be assumed that one IP6 binds to 4 calcium molecules and - with supplementation of 1,000 FTU/kg (phytase units/kg) Axtra® PHY - will be broken down to IP2. This will release 4 molecules of calcium and 4 molecules of phosphorous. On a weight basis, the calcium to phosphorous ratio would be approximately 1.3:1; indicating that phytase may contribute to greater calcium matrix values than digestive phosphorous matrix values.

OPTIMISING Ca:dig P MATRIX RATIO

To explore the relationship further, we carried out a study to determine the effect of increasing calcium matrix values on phosphorous digestibility and performance in broilers.

Four treatments were tested: one positive control and three test diets.

- The base diet was formulated using Axtra® PHY full matrix values - specific to digestive P, ME, dig AA and sodium - based on a contribution of 1000 FTU/kg.
- The test diets were supplemented with different levels of limestone calcium to create a low, medium and high calcium downspec (reduced levels).
- Axtra® PHY was added at 1000 FTU/kg to all three test diets.

Analysis showed that average calcium levels were 0.16%, 0.19% and 0.21% lower in the test diets, compared to the positive control, while the digestive phosphorous was 0.16% less. *(See Figure 1)*. A result which suggests increasing the Ca:dig P downspec ratio linearly increases ileal P digestibility.

It was further observed that increasing the calcium matrix also reduced the feed conversion ratio (FCR). *(See Figure 2)*. The treatments with Ca:dig P downspec ratios of 1.2:1 or 1.3:1 significantly improved the feed efficiency compared to the positive control. Viewed in the context of the full matrix values of Axtra® PHY at 1000 FTU, this result confirms that the phytase compensated for the nutrient reduction –

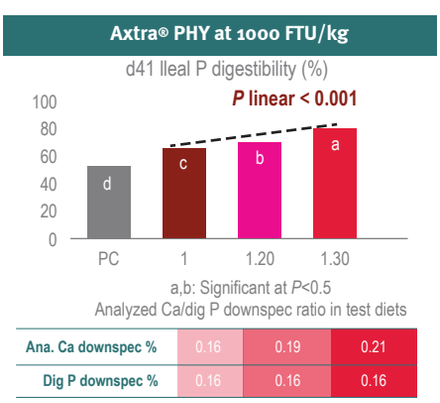

Figure 1

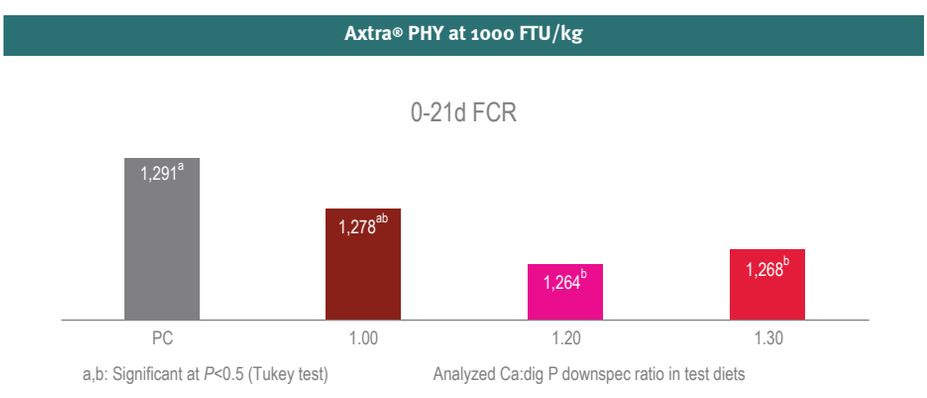

Figure 2

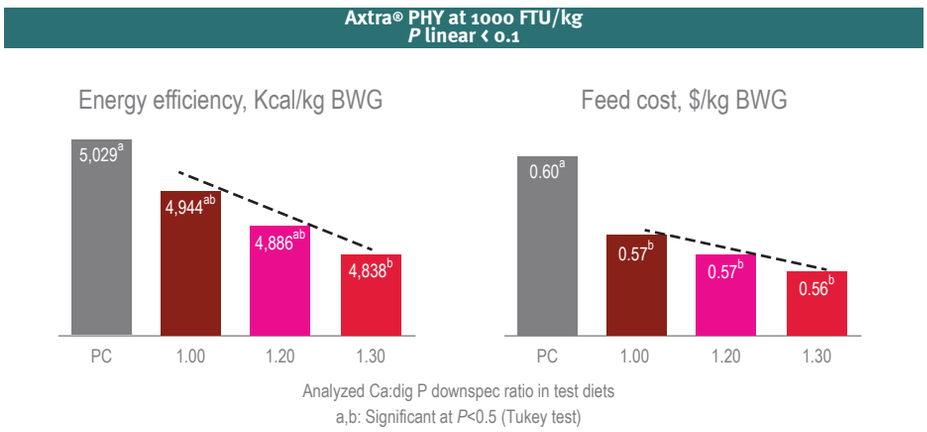

Figure 3

or may even have outperformed the positive control.

In the same study, a tendency of linear response in energy conversion was also identified; indicating that less energy is needed to produce one kg body weight gain (BWG). This implies that increasing calcium downspec reduces the energy costs of maintaining the Ca:P balance. It therefore follows that increasing the calcium matrix also reduces feed costs. *(See Figure 3)*. Both key commercial benefits in broiler production.

It is important to note that during this study, no mortality was seen in starter or growth phases, but high calcium reduction treatment did have a numerically high mortality in the finisher stage. The analysed calcium level was 0.43% at this stage, which may be too low for maintaining bone quality, even though no significant difference was observed on tibia ash. Consequently, a matrix which is too high may increase the risk of calcium deficiency.

CUSTOMISING CALCIUM MATRIX

Despite the growing body of evidence in support of leveraging digestible calcium to formulate diets, many producers still rely on total calcium levels. Although the importance of maintaining an optimal Ca/P ratio is generally recognised, how to fully realise the benefits has not yet been addressed.

But it is important to understand that it is not a question of one size fits all. In other words, more is not always better. In fact, an unrealistically high calcium contribution number (or reduction in Ca level in the diet) may pose a risk of leg weakness, especially when using a source from limestone with poor digestibility. Instead the calcium matrix value for phytase should be a function of dietary composition, age and species of animal, as well as calcium source and levels. This analysis will provide an optimal recommended calcium level.

With this in mind, DuPont is investing in research and innovation to generate species, life stage and diet-specific data that can be applied by nutritionists to create a tailored formulation and achieve the best performance outcome.

THE BENEFITS OF USING FULL MATRIX VALUES

Our ongoing research programme demonstrates the all-round benefits of using full matrix value for Axtra® PHY. When it is applied, this phytase has been shown to maintain performance in a number of important ways, when compared to a positive control.

In laying hens, inclusion of Axtra® PHY at 600 FTU /kg in a nutrient deficient diet:

- Reduces feed costs ($/kg egg) by up to €0.5
- Maintains egg production and egg quality
- Maintains tibia ash
- Increases yolk colour.

In broilers housed in semi commercial conditions, inclusion of Axtra® PHY at 500 and 1000 FTU/kg:

- Reduces relative feed costs* by 3.5% and 3.8%
- Maintains average daily gain
- Maintains final bodyweight
- Maintains and improves carcass yield by 0.8%

[Relative feed cost €/kg liveweight gain based on representative 2017 US feed cost.]*

In nutrient deficient broiler diets, inclusion of Axtra® PHY at 1000 FTU/kg:

- Reduces relative feed cost by 3.7%
- Reduces foot pad dermatitis by 25.3%
- Maintains FCR
- Improves bone strength by 14.0%.

REDUCING FEED COSTS

Although the exact net cost savings of using a phytase matrix will vary according to changeable market prices, the principle can be demonstrated effectively by using a 2017

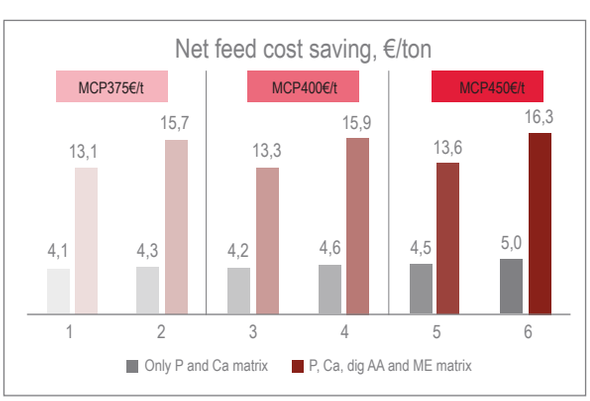

Figure 4: Feed cost saving calculated based on the current EU ingredients prices. (control diets without phytase cost: 233.9, 233.3 and 233 €/t for MCP priced at 450, 400 and 375 €/t respectively, with 0.85% Ca, 0.37% dig P, 19.7% CP and 12.95 MJ/kg ME. Wheat and SBM based diets with calculated phytate P level of 0.26%).

** Figures based on European prices, December 2017.*

snapshot of ingredient values in the EU.

In fact, in terms of overall feed cost savings, the latest calculations present a compelling argument for using the full matrix value for Axtra® PHY *(see Figure 4)*.

CONCLUSION

As we have seen, the importance of maintaining an optimal Ca/P balance in the presence of phytase is clear and widely accepted. But the key to fully realising the benefits is tailoring the ratios according to individual matrix values.

In practical terms this means that while a highly soluble and excessive calcium can have a negative impact on phosphorous digestibility and phytase efficacy - the extent of this impairment will differ depending on the phytase used in the feed formulation.

As a general rule, our recommendation is to maintain calcium level above 0.5% in broiler finisher diets and 0.4% in pig finisher diets. Beyond that, applying full matrix values should always be considered as a highly effective way to achieve considerable production savings.

ABOUT THE AUTHOR

Dr. Yueming Dersjant-Li is a senior scientist with the Global Innovation group within the Danisco Animal Nutrition industry team – which is part of DuPont Industrial Biosciences. At present, her main research area is enzyme application in non-ruminants animals. She obtained her PhD degree at Wageningen University (WUR), and has been working in the animal feed industry for many years. She has published numerous papers in peer-reviewed journals, conference proceedings and commercial magazines.

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