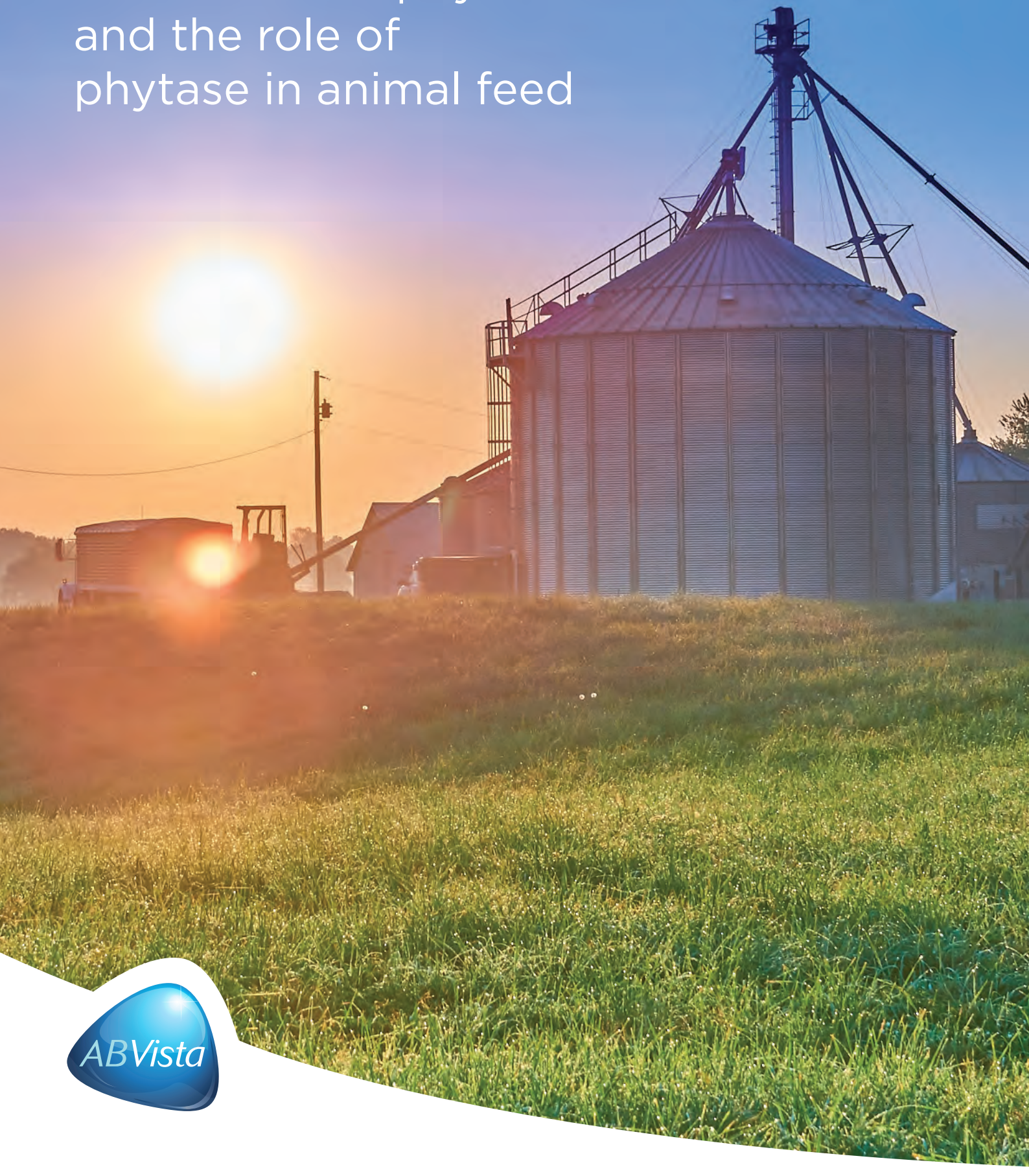
WHITE PAPER

Understanding the value chain of phytate and the role of phytase in animal feed



ABVista

The animal feed industry

The feed industry has evolved rapidly, with science and innovation driving greater understanding of animal biology, feed composition, and nutrition. Approaches to diet and nutrition that may have been seen as best in class ten years ago are now outdated. This evolution must continue, as complex external factors drive a re-evaluation of nutrition strategies.

As the industry has learnt more about phytate and its interactions in the animal, we have come to understand it as a source of valuable nutrients. Feed efficiency, animal welfare and ultimately profitability are all affected by phytate. So when looking to achieve precision nutrition and efficient animal diets, the role of phytate cannot be ignored.

This white paper highlights some areas of research and innovation that are bringing new understanding, greater precision, and more efficiency and profitability to the feed and nutrition sector.

CONTENTS

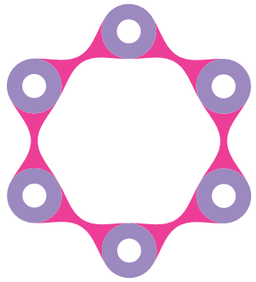
The value chain of phytate

Phytate (phytic acid) is present in all feedstuffs and is an important source of phosphorus (P) for poultry and swine as well as essential nutrients such as protein and minerals.

Whilst phytate is a valuable store of nutrients and protein, these remain unavailable to the animal if a phytase isn't used to release them.

Currently phytase saves the global monogastric industry around $3 billion per year in feed costs.

Phytases have traditionally been thought of as a means to provide phosphorus from IP6, attacking IP6 and making from it IP5 — a new substrate that phytases continue to attack. This continues down to IP1.



No phytase breaks down IP1, but fortunately the alkaline phosphatase in the gut is a very rapid enzyme and it will digest IP1 producing inositol.

That is how people have traditionally thought of using phytases; most people are looking at removing approximately 50% of the phosphorus from phytic acid, so there is still a considerable amount of IP6, 5, 4, and 3, left in the gut of the animal undigested.

If the focus remains only on removing IP6, a considerable amount of IP6, 5, 4, and 3, is left in the gut under-exploited and is an expensive waste of valuable nutrients.

PHYTASE

Many end-users are now using higher phytase doses in feed to transform the expensive waste of phytate. This has been proven to give additional animal performance benefits beyond standard phytase doses.

When we think about phytases, we should think about them as enzymes to effectively break down IP5, IP4, and IP3, as well as IP6. We want phytases not only to release the phosphorus we need but to release all the essential minerals and protein that enable the animal to grow more efficiently.

Not all phytases are created equal

Commercial phytases differ significantly in their ability to break down phytate and the lower esters IP5, IP4, IP3, even when fed at high levels. For producers to see a greater return from their phytase programme, they need to select an effective phytase, such as Quantum Blue which, when applied at high levels, can break down IP6 to IP1, even at low concentrations of phytate.

SUPERDOSING CHECKLIST

KEY PHYTASE REQUIREMENTS

EFFICACY AT LOW PH

SUSTAINED GASTRIC PERFORMANCE

SUSTAINED ACTIVITY EVEN AT LOW PHYTATE CONCENTRATIONS

THERMOSTABILITY

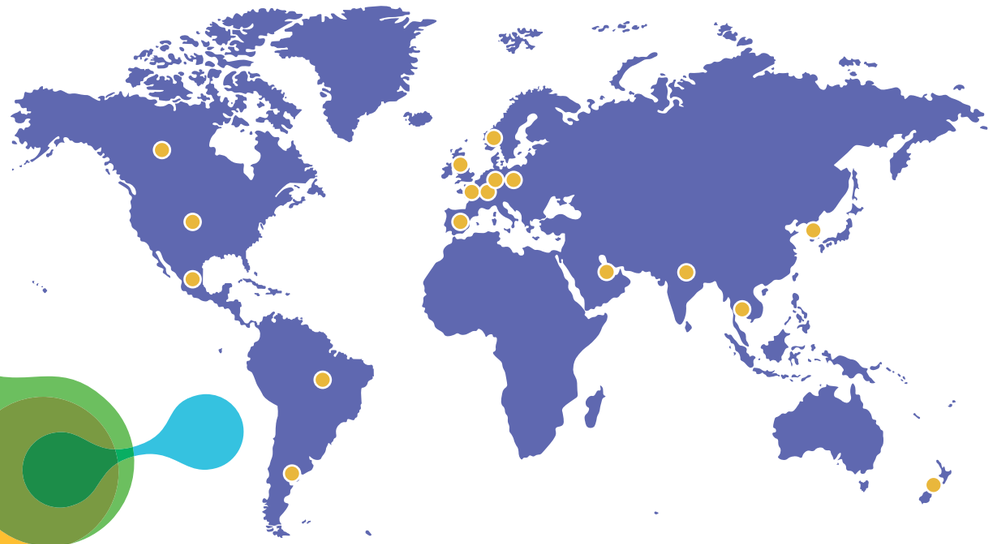
IPS3: Innovation in collaboration

International Phytate Summit

The International Phytate Summit (IPS3), a global congress held in November 2016, was an important step in re-evaluating industry nutrition strategies.

The summit brought together leading researchers, academics and industry innovators to collaborate on the current understanding of phytate. The event sought to identify corresponding nutrition strategies that will help the food production industry to remain profitable in today's market, and meet the needs of consumers without compromising animal welfare.

Attendees included researchers from universities and academic institutes, as well as pig and poultry producers. Delegates attended from countries around the world — as shown below.



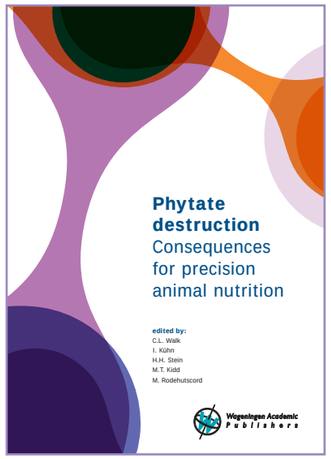
International PHYTATE SUMMIT

Focus areas

The event focused on research and practical approaches to transforming phytate, and how that can improve feed efficiency, nutrient utilisation, sustainability and ultimately profitability:

- Session One highlighted the most recent research into phytate, including a presentation on what the industry is doing to transform dietary phytate.
- Session Two covered the role of phytate in formulating diets for trace minerals, including reviewing the role minerals play in the poultry industry in respect of meat quality, welfare, and as replacements for antibiotics.
- Session Three examined mechanistic effects of phytate, including phytase effects on protein, and investigating the role of amino acids in diet formulation.

"I now have a heightened understanding of the importance of the other hydrolysis products such as IP5, 4, 3, and 2. IPS3 also revealed new insight into chelation of minerals and amino acids by IPs." — IPS3 academic delegate



IPS3 proceedings — Phytate destruction: Consequences for precision animal nutrition. Available to buy in print and e-copy from Wageningen Academic Publishers

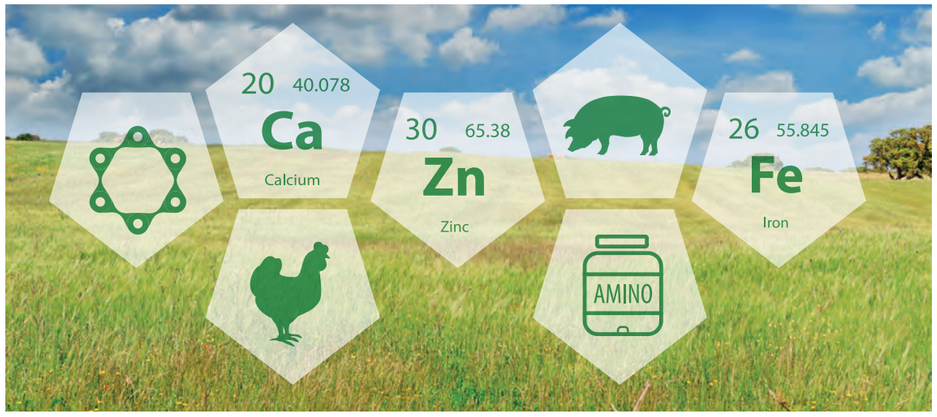
The value chain of phytate: consequences for precision animal nutrition

A CHANGING LANDSCAPE

Despite profit margins across the industry remaining slim, precision nutrition promises to deliver benefits across the production chain. Through improved data collection and assessment, coupled with an ever-improving understanding of digestion and nutrition, greater gains are waiting to be had.

There are several areas where research is delivering insights into potential improvements, including:

- Inositol production
- Calcium digestibility
- Amino acids
- Trace minerals
- Near infrared reflectance (NIR) technology



INOSITOL PRODUCTION

The benefits of inositol

Inositol is produced when all six of the phosphate ions contained within phytate have been stripped away by the combined action of phytase and endogenous phosphatases.

The resulting inositol appears critical to successful superdosing, and its production relies heavily on achieving greater than 85% breakdown of both phytate and its lower esters (IP5 through to IP1).

The growth-enhancing effects of inositol in chicks have been recognised since the 1940s — due to its important metabolic roles, such as in fat metabolism and cell function, as well as being combined with phosphorus at a cellular level to recreate phytate, which is a potent antioxidant.

What current research is demonstrating is that inositol accounts for around 30% of the improvement in feed conversion ratio (FCR) seen in broilers when superdosing. Targeting the necessary level of phytate breakdown, and subsequent inositol production, is therefore vital.

Inositol is also reported to have some antioxidant capacity — and there is continuing research into this area.

"Until now, my thoughts about phytate were as a potential source of phosphorus for the animal. However, inositol as a functional compound opens new insights for animal production and health."
— IPS3 delegate

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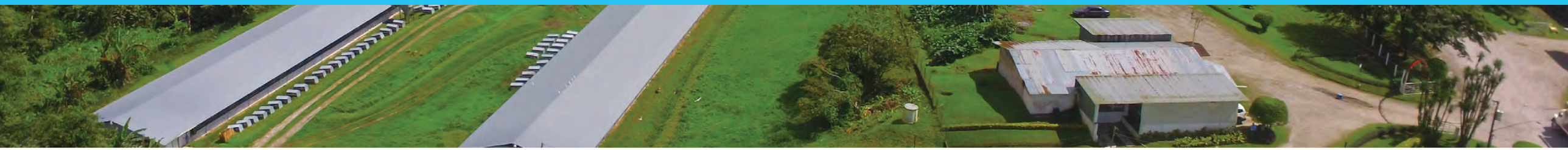


CALCIUM DIGESTIBILITY

Increasing calcium digestibility through superdosing

AB Vista is collaborating with Dr Hans Stein and the University of Illinois to develop the foundation of a working digestible calcium (Ca) system for use in commercial pig diet formulations.

Unlike for phosphorus, there is currently no system to allow pig nutritionists to accurately formulate for digestible or available Ca. Being presently limited to just total Ca values tends to result in oversupply to avoid deficiency, a situation compounded by the relatively low cost of Ca and the often unaccounted for use of limestone as a flow agent in soya bean meal.

This research is likely to bring benefits across the industry. By measuring standard total tract digestibility for Ca in pigs, it has been possible to develop a better understanding for the Ca requirements, as well as values for Ca availability, content and variation in common feed ingredients.

These are the early stages of a continuing research effort designed to lead to the development of a working digestible Ca system for pig diet formulation.

Ultimately, it will enable more precise nutrient supply, resulting in improved phosphorus, amino acid and Ca digestibility, and subsequently have a major positive influence on growth performance, skeletal integrity and feed efficiency.

Dr Hans Stein from the University of Illinois presenting digestible calcium research at the IPS3 meeting.

AMINO ACIDS

The role of phytase and amino acid digestibility

Over-supply of amino acids can significantly impact animal performance and increase secretion of nitrogen into the environment. Conversely, under-supply can impact animal performance, immune function, and meat yield. With research suggesting that phytase influences amino acid digestibility, understanding the underlying mechanisms is important to make the most of these compounds.

As superdosing continues to gain traction in both broiler and pig production systems, more research focused on improving amino acid utilisation with higher phytase doses is being conducted to understand the maximum opportunity for phytase application.

Mike Kidd from the University of Arkansas presented current and future amino acid formulation trends at IPS3.

26 55.845 Fe Iron

30 65.38 Zn Zinc

29 63.546 Cu Copper

TRACE MINERALS

Making the most of minerals in pig feed

Environmental concerns remain a priority — as they do in markets around the world. With increasing mineral limits in animal feed imposed, the industry must find a way to maintain efficient and high-quality animal production. The release of essential nutrients with phytase superdosing could play an important role in diets where producers are looking to comply with any new legislation, whilst maintaining production efficiencies.

AB Vista research has shown that in the presence of superdosing phytase, the level of zinc from zinc oxide (ZnO) can be reduced from 2500 mg/kg to 1750 mg/kg. This can be achieved without having a negative effect on performance as measured by gain and FCR.

Furthermore the data has shown that superdosing phytase lowers the level of post-wean diarrhoea which is attributed to the increased effectiveness of ZnO due to the lower levels of dietary phytate attained with the use of superdosing phytase.

Lifetime nutrition

It is well established in swine production that maximising early growth with a better start often leads to a better finish, with pigs at 1 kg extra gain at the end of the nursery resulting in 2 to 3 kg of gain at slaughter. Often post-weaning pigs are limited in nutrient intake due to the low post-wean feed intake associated with weaning. Hence improving nutrient utilisation is key and it has been shown that even small amounts of dietary phytate (increase of 0.04%) can reduce performance. Hence, using superdosing phytase to release essential nutrients from phytate can be a benefit in terms of improving post-weaning performance.

"By superdosing phytase, you probably have an increased efficiency in degrading phytate — and the more you degrade phytate the more you release the naturally present zinc, linked to phytate, and so you will increase zinc bioavailability. This could help the industry when it comes to further reducing levels of supplementary zinc."

Dr Patrick Schlegel, Swiss Federal Research Station — Agroscope, presenting at IPS3

Optimising aqua feed

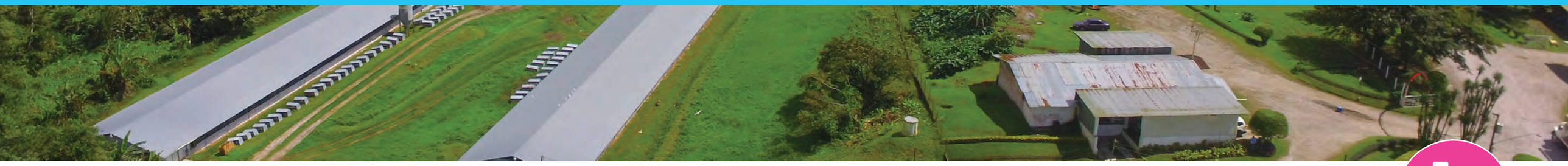
With the use of fishmeal in aquaculture diets reducing, many producers are turning to more plant-based protein sources. These plant-based materials have an impact on the level of phytate in the diet and therefore part of the transition process involves addressing with enzymes some of the indigestible portions of the diet.

The potential benefits of phytase superdosing extend beyond the cost savings attributable to liberation from phytate, to include:

- Improved growth rates & FCR
- Reduced water pollution
- Improved oxygen capacity / haematocrit levels that contribute to a reduction in anaemia and improved overall fish health
- Improved feed intake and growth yield by 25% and reduced mortality associated with bacterial aeromonas infections

"Phytase use can play a significant role in sustainable aquaculture production. Research has demonstrated that superdoses of phytase supplied in a plant-based diet for rainbow trout increased dietary phosphorus retention from 36 to 67 per cent and reduced the excretion of nitrogen into the environment by seven per cent."

Dr Gabriel Morales, University of Buenos Aires, presenting at IPS3



Combatting woody breast

In markets where demand for white breast meat is high, such as in the US, being able to maintain the increase in growth rate and breast meat yield without negatively impacting muscle tissue development is important.

The exact cause of woody breast, a muscle abnormality affecting the texture and colour of chicken breast meat, is currently unknown — although some researchers point to selection for increased growth rates and meat yield.

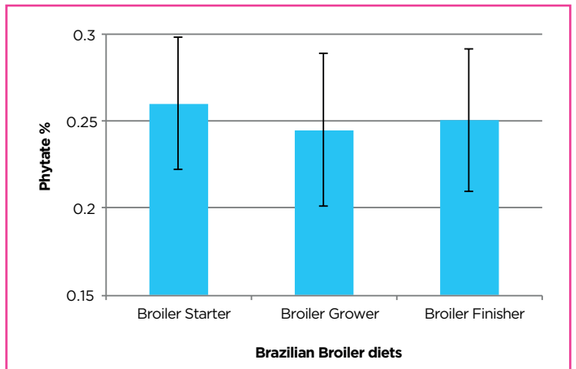
New research suggests when superdosing high levels of phytase is combined with other factors that support the antioxidants system, such as organic zinc, there is some success in reducing the severity of woody breast.

The University of Arkansas developed a scoring system to identify the varying degrees of severity of woody breast; 0 to 3. 0 is good quality breast meat whereas 3 is essentially like a board, and that is where the word 'woodiness' comes from.

NIR | ANALYSING AND OPTIMISING FEED

Analysis beyond proximates

Near infrared reflectance (NIR) is shedding new light on optimising animal feed and nutrition. Whilst previous NIR equations were limited to predicting proximate values of raw materials, recent advancements offer a more in-depth analysis of raw materials, making it possible to predict a wider range of parameters. The ability to understand and predict levels of phytate, energy and reactive lysine in feed could help improve enzyme application and feed formulation.



With feed costs accounting for up to 80% of the total variable costs, it is one of the most critical factors driving profitability.

Least-cost feed formulation software allows nutritionists to construct a diet that meets the requirements of the animal and considers feed ingredient cost and nutrient content — but there is considerable variation within an ingredient.

Combatting feed ingredient variation

Several factors including cultivar, soil quality and growing, harvesting and post-harvesting conditions can result in significant variation, which is a challenge for feed manufacturers and producers. A recent trial measuring phytate levels in different Brazilian broiler diets (Starter, Grower and Finisher), showed a wide variation between feeds — not just between different feedstuffs, but within a single raw material.

NIR technology can analyse this phytate content, giving the nutritionist confidence that there is sufficient substrate on which a phytase enzyme can act. Where higher levels of phytate are detected, producers can use higher doses of efficient phytases in order to increase phosphate availability.

The last word

Professor Merlin Lindemann of the University of Kentucky said new developments in the industry's understanding of nutrition could have a significant impact on feed formulation.

"When one realises the benefits of superdosing phytase to destroy the anti-nutrient phytate actually go beyond calcium and phosphorus release to amino acid release, trace mineral release and whole body energetics improvement, one wonders what other unanticipated benefits may there be?"

For more information visit **www.abvista.com** or contact your local AB Vista representative.