INSPIRING BEST PRACTICE

Dr Gustavo Cordero, AB Vista Swine Technical Manager for EMEA

Understanding enzyme characteristics; the solution to reliable xylanase performance

Xylanase feed enzymes vary greatly, not only in their source, but also in terms of the key characteristics that determine efficacy in the pig. Even similar enzymes from the same family of xylanases can differ significantly, so it should be no surprise that the broad range of xylanase products currently available often perform very differently under commercial conditions.

Key xylanase characteristics

Being able to withstand the high temperatures of pelleting, yet at the same time be highly active at the body temperature of the target animal, is critical. So too is a high level of activity at the point of action, namely in the animal gut, along with ease of assay in the manufactured feed to ensure enzyme survival and dose accuracy.

All are characteristics that should be on any checklist for assessing potential xylanase purchases if return on investment is to be maximised.

Substrate specificity matters

There are also substantial differences in the way xylanases interact with the target substrates found in corn- and wheat-based diets. Critically, these specific non-starch polysaccharides (NSP), predominantly xylans, can differ widely, even within a diet.

For example, the chain length of the xylan present varies depending on the number of xylose sugars that make up the 'backbone' of the molecule, whilst differing numbers and placement of arabinose and other side-chains create a multitude of potential structures. Both the backbone length and side-chain structure have a substantial effect not just on the impact within the pig – for example, long-chain, soluble xylans are responsible for increased gut content viscosity – but also on the type of xylanase needed to degrade them.

> *"Know your processes, know your animals and know your enzymes."*
>
> Dr Christophe Courtin, Inspire Forum UK, 2014

Maximising performance response

Just as importantly, it is the specific oligosaccharide end products, produced from the xylan with the use of a xylanase, that have been linked to performance response in the animal. In fact, according to the latest research, it appears that performance benefits are maximised only when those end-products include specific short-chain arabinoxylo-oligosaccharides (AXOS) that have the potential to act as prebiotics in the animal gut.

The net result is most often an improvement in overall digestion efficiency, leading to an increase in the digestibility of the whole diet, not just the NSP fraction. It also explains the strong performance response to Econase XT xylanase seen in pigs fed corn-based diets, where increased digesta viscosity isn't an issue, as well as in wheat-based diets where it is.

Effective xylanase selection

The target for xylanase use should therefore never be complete xylan degradation, and any over-dosing or inclusion of additional NSP enzyme activities risks destroying these important prebiotic AXOS. A clearer understanding of how xylanases overcome the limitations xylans place on nutrient utilisation and pig performance should also mean it's no surprise that when it comes to raising standards and delivering the most consistent and reliable results, the solution is the highly targeted, dose-optimised, single enzyme xylanase Econase XT.

Watch experts discuss the varying characteristics of xylanases

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Xavière Rousseau, AB Vista Swine
Technical Manager for EMEA

Substrate knowledge the key to correct enzyme targeting and success

Despite the negative impact of non-starch polysaccharides (NSP) on pig performance being widely recognised, the complexities, structures and properties of those NSPs remain much less well understood. Yet such characteristics have a direct influence, not only on any anti-nutritional effects within the pig, but also on the efficacy of NSP-degrading enzymes.

If NSP-degrading enzymes are to be used to greatest effect, it is therefore essential that a good understanding of the primary NSPs is developed. It's easy to see why the proliferation of feed enzyme products containing multiple NSP enzyme activities has produced more confusion in end-users than it has success in the pig if the substrate being targeted is not clearly defined in the first place!

Xylans – the dominant NSPs

Of the NSPs present within plant hemicellulose, xylans are the most abundant, making up 30-35% of the cell wall material in cereals. However, these xylans are a very diverse and heterogeneous group of substances, with structures that differ widely in terms of branching, substitution (arabinose side chains) and the length of the xylose 'backbone'.

Just as importantly, these structures and their resulting properties can vary significantly between plants, varieties, parts of the plant and even from one growing year and location to the next. Differences between growing sites have in some cases been shown to exceed varietal variations.

> *"The xylans…are a very diverse and heterogeneous group of substances."*
>
> Dr Kim Langfelder, Inspire Forum UK, 2014

Important structural differences

Such structural differences are hugely important. The level of soluble arabinoxylan can dictate digesta viscosity effects, for example, whilst the location of any side-chains will affect how and where xylanases can act to break down these long-chain molecules.

Since end products of xylan hydrolysis are also influenced by xylan structure and xylanase action, both directly affect production of the prebiotic arabinoxylo-oligosaccharides (AXOS) that appear critical to pig performance response to xylanase addition, particularly in less viscous corn-based diets.

Consistent xylan targeting

The key to the success of an enzyme such as Econase XT xylanase is its ability to target the dominant xylans consistently across all corn-, wheat- and rye-based diets, regardless of any differences in diet formulation, feed ingredient batch or growing season.

In fact, the single xylanase Econase XT generally outperforms those products containing multiple NSP enzymes – matching enzyme characteristics to the dominant xylan substrate and the desired end-products is far more important than including additional enzyme activities!

So take the time to understand which of the NSPs in pig diets are most important, and choose a xylanase such as Econase XT developed specifically for that target. The result will be better pig performance, a greater return on the investment made in feed enzymes and a consistency that has all too often been missing within the NSP-degrading feed enzyme sector.

Visit the Inspire website to watch a video about The Substrate Story

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Dr Gustavo Cordero,
AB Vista Technical Manager

Thermostability and ease of assay essential for xylanase success

Knowing whether a feed enzyme has survived feed processing to reach the site of action within the pig in a still-active state, and at the target dose rate, is essential.

However, the enzyme characteristics and development that allow this to be achieved vary considerably between different enzyme products. Remember that xylanases differ not only in the way they work within the pig, but also in terms of thermostability, how they survive pelleting and the methodology required for assay.

Improved quality control

As a result, it's highly unlikely that all xylanases will achieve the same levels of efficacy, or be as easily monitored for quality control and assurance purposes. The 'QuickStix' enzyme-linked immuno-sorbent assay (ELISA) developed specifically for Econase XT, for example, is capable of detecting the presence or absence of active enzyme in as little as individual feed pellets within just five minutes of feed manufacture!

This makes it a unique quality control tool for feed manufacturers, particularly if combined with the matching 'QuantiPlate' micro-titre ELISA. This test kit can accurately quantify enzyme activity over the range normally found in commercial feeds in less than three hours, and can be set up as a lower cost solution to a traditional lab and does not require highly trained staff.

> ***"There are many xylanases…they all differ in their abilities to survive these processes and these rigours."***
>
> Dr Mike Bedford, Inspire Forum UK, 2014

Confirming enzyme survival

In the case of Econase XT xylanase, such assays make it extremely easy to confirm the typical 90-110% recovery rates found post pelleting when compared to levels in the unprocessed mash. Just as importantly, Econase XT can withstand temperatures of up to 90-95°C (194-203°F) under normal pelleting conditions without the need for coating technologies. This allows Econase XT to be added prior to heat treatment either as a standard dry product or as a liquid into the mixer which potentially is more cost-effective and can also improve mill efficiency.

Uniformity of distribution

Applying Econase XT as a dilute liquid into the batch mixer, for example, has been shown to improve uniformity of distribution within the feed and produce coefficients of variation (CV) as low as 5% in both pellets and mash. In addition, the extra liquid applied was found to reduce pelleting power consumption by up to 4%. Production trials have also shown Econase XT to be capable of both significantly improving pig performance, while returning a greater overall return on investment.

Together, such attributes represent a significant step forward in terms of simplified xylanase application, increased dosing consistency, improved quality control and greater efficacy in the pig. These factors are important in enabling Econase XT to both survive the manufacturing process and be active within the pig. This provides the end user with the confidence that the pig is getting the product at a consistent dose from batch to batch of feed production.

Visit the Inspire website to watch a video on examining enzyme solutions

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Svetlana Peganova, AB Vista Technical Manager

Xylanase specificity critical to pig performance response

In order to evaluate the potential efficacy of any xylanase feed enzyme, it's essential that we know not only the exact type of enzyme we're dealing with, but also what kind of non-starch polysaccharides (NSP) are being targeted. In fact, it is only by fully understanding the characteristics and subsequent interactions between these two components that xylanase performance in pig diets can be optimised.

Consistent pig performance

Since optimised performance in the pig – as opposed to within the laboratory – is the key to consistent and reliable returns on any investment made in feed enzymes, getting to grips with the specifics of the NSP enzyme-substrate interaction is critical.

Yet despite 25 years of the industry working to resolve the issues surrounding the negative impact of NSP in pig diets, the detail of these interactions and xylanase mode of action is still not fully understood.

> ***"The most important thing is to understand or define the mechanism of action."***
>
> Dr Usama Aftab, Inspire Forum UK, 2014

Inspiring greater understanding

It's a challenge that was at the heart of the decision by AB Vista to host the first international forum on NSPs, with INSPIRE Forum 2014 bringing together expertise from across the industry to discuss progress to date, current best practice and possible directions for future research.

What became clear is that the pig's gut is an extremely complex environment, with an enormous number of interactions taking place at any one time. The predominant NSPs in pig diets, mainly xylans, also differ widely, both in terms of their physical structure and chemical characteristics.

For example, the number of xylose sugars that make up the 'backbone' of a xylan molecule can vary substantially, as can the number and placement of arabinose side-chains. The result is a multitude of potential structures that affects not just the impact within the pig, but also on the type of xylanase needed to degrade them.

Beneficial xylanase action

The xylanases used to break down such NSPs are equally variable. Endo-acting xylanases like Econase XT attack the xylose backbone mid-chain, rapidly degrading the long-chain, soluble xylans responsible for increased gut content viscosity.

Just as importantly, it now appears that certain of the short-chain oligosaccharides produced may potentially exert an indirect prebiotic effect on the pig.

In contrast, exo-acting xylanases cleave single monosaccharides from the 'edges' of NSP molecules, so don't affect gut content viscosity as effectively or produce the same level of short- chain oligosaccharides. There is also data to suggest that the resulting free xylose and arabinose monosaccharides may be detrimental to growth.

Importance of specificity

The net result of all these interactions, and the potentially differing outcomes, is to put the spotlight firmly on xylanase specificity. Therefore, choosing the right xylanase such as Econase XT that has these key enzyme characteristics is important in optimizing on farm pig performance.

Visit the Inspire website to learn more about xylanases

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Xavière Rousseau, AB Vista Technical Manager for EMEA

INSPIRE – driving progress on NSP research

It was the desire to bring together leading experts from the scientific and animal feed communities that was at the heart of the decision by AB Vista to host the original international INSPIRE non-starch polysaccharides (NSPs) Forum in 2014.

Broad topic mix

Covering a broad spread of topics, from plant science to baking, and from animal physiology to enzyme technology, the speakers at INSPIRE represented a great mix between established names and those less familiar to the audience. The net result was a far greater understanding of the key NSPs characteristics, their impact on nutrient digestibility and how to optimise response to NSP-degrading enzymes in pigs.

One presentation, in particular, outlined the multitude of factors that interact to explain the indirect effect that NSP-degrading enzymes can have on providing beneficial gut conditions and improving pig performance. It was clear that correctly identifying the predominant substrate, defining its critical characteristics and selecting the right type and dose of enzyme to target it were all critical to success.

> *"It's good to do science, it's even better to do science that has application."*
>
> Prof. Hank Classen, INSPIRE Forum UK, 2014

Breakthrough mode of action

In swine production, the positive effects of NSP-degrading enzyme use have been seen across wheat-, corn- and barley-based diets, including those containing a variety of fibrous feed materials.

This has been shown to be the case when using a single xylanase product such as Econase XT, which works both with soluble and insoluble fibre in diets. In diets with insoluble fibre, where viscosity is not an issue, the positive performance responses with a single xylanase are believed to be partly associated with a newly proposed mechanism.

Put simply, the target for NSP-degrading enzyme use is not, as previously believed by some, the complete breakdown of every possible NSP substrate. Instead, it appears that the response in a monogastric comes in part from production of specific NSP breakdown products which stimulate beneficial gut microflora, leading to improved overall digestive efficiency.

Proven xylanase success

Research to date has also demonstrated that in nearly all diets there is sufficient xylan substrate – the predominant NSP in plant-based feed materials – for this effect to be reliably achieved using only a single xylanase product, such as Econase XT.

The work to disseminate this new understanding, much of which was consolidated at the INSPIRE Forum, continues across all the major continents. For pig producers, their advisors, researchers and the feed industry as a whole, it is crucial information.

There are other factors that can interact to affect NSP-degrading enzyme performance in commercial swine production systems. However, it is by understanding an enzyme's primary mode of action that such factors can be put into context.

Thanks to initiatives like the INSPIRE Forum, that understanding is now better than it's ever been, and the net result is even greater optimisation of both NSP-degrading enzyme efficacy and pig performance.

Visit the Inspire website to learn more about xylanases

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