Inherent thermostability is the key to maximising xylanase benefits

by Dr Rob ten Doeschate, Technical Director, AB Vista EMEA.

High temperature processing of poultry feeds has long posed a challenge for xylanase feed enzyme manufacturers, particularly since feed mills have been increasing heat levels and conditioning times over the years to improve feed hygiene. As the xylanases typically included in commercial products are insufficiently thermostable to withstand such conditions, their application during feed manufacturing has until now been compromised.

Advances in xylanase thermostability are therefore critically important, with application of xylanase feed enzymes prior to heat treatment or pelleting both more efficient and more effective. As such, the introduction of Econase XT, a new generation of xylanase that is intrinsically thermostable without the need for coating, represents a major breakthrough in terms of simplified application, improved consistency in feed, higher recovery rates and greater efficacy in the bird.

Early developments

When xylanase feed enzymes were first introduced, they were initially only available as dry products added to the batch mixer. Although the generally lower processing temperatures employed at the time meant the enzymes did produce clear benefits, it soon became clear there were weaknesses in both thermostability and ease of assay.

This led to the development of equipment for spray application of feed enzymes after pelleting, side-stepping any inherent thermostability weaknesses and producing much better recovery and performance results.

The past two decades have seen feed mills around the world make substantial investment in post-pelleting liquid application (PPLA) equipment, with the best systems now offering a degree of flexibility in terms of both dose rate and the number of products that can be applied simultaneously.

However, even the most advanced PPLA equipment can typically only achieve coefficients of variation (CV) of around 10%, with older systems being closer to 20%. There are few other feed ingredients for which a poultry nutritionist would be content with such a high level of variability!

Yet despite this compromise and the increased running costs associated with the regular maintenance and calibration of these complex systems, PPLA of xylanases was still a significant step forward at the time. However, investments in PPLA equipment in the past do not mean it will continue to deliver acceptable performance in the future, nor should it preclude a switch to better, more cost effective alternatives as they become available.

Improving thermostability

The search for solutions to the xylanase thermostability problem has therefore continued, with the aim of enabling xylanase application into the batch mixer pre-pelleting, but without the associated loss in enzyme activity and performance suffered in the past. To date, the different approaches taken have generally fallen into three categories, coating, enzyme engineering and discovering new inherently stable enzyme candidates. Although the first two have been successful to varying degrees, both incur additional compromises that once again limit the potential gains to be made from xylanase use.

The application of a coating to the enzyme limits water penetration, thereby increasing thermostability, and has the added advantage of significantly reducing the dustiness of the product. In terms of thermostability, the best coatings can achieve close to 100% enzyme recovery after commercial feed pelleting, but coatings can also have a significant negative impact on subsequent availability.

The coatings themselves can reduce the dissolution rate of the enzyme in the bird

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Fig. 1. Thermostability of Econase XT in comparison to competitor xylanases (Kolding Technology Institute, 2006-7).

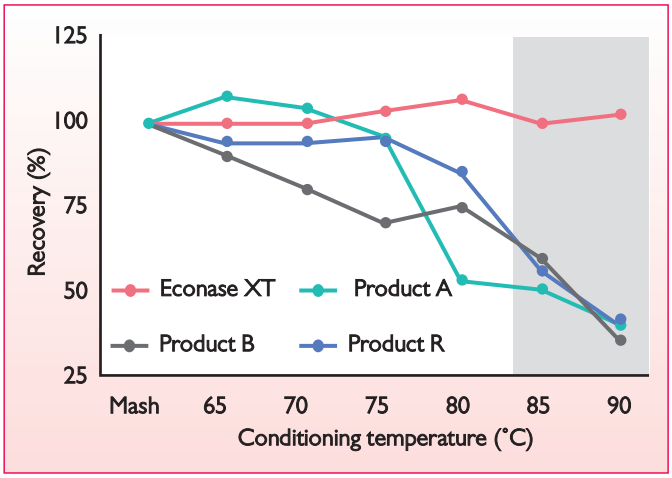
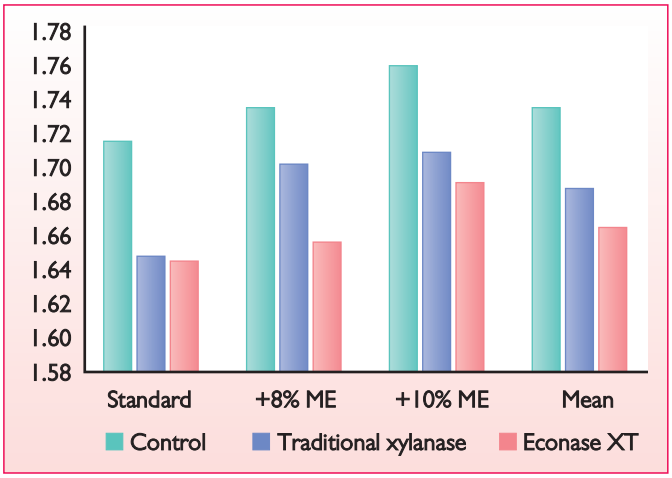


Fig. 2. Feed conversion efficiency in 42 day old broilers fed wheat-based diets (AB Vista, unpublished).



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gut, leading to slower xylanase release and a potential reduction in the time available to act on the target substrate, in this case the non-starch polysaccharides (NSPs) responsible for increased gut viscosity.

The second approach has been to 'engineer' existing xylanases to alter the amino acid structure of the enzyme. This can result in the enzyme being more hydrophobic (water repellent) or more tightly structured and stable, thus increasing thermostability without the need for coatings.

It is a technology that has been successfully used to produce several commercial xylanase products, though care must be taken to ensure any changes do not alter the active site on the enzyme, as this could reduce efficacy.

The third and final option involves the screening of micro-organisms found in warm environments, such as hot springs and deep-sea fissures, for naturally thermostable xylanases. When the genes for these xylanases are transferred to a standard producing organism for large scale fermentation, highly efficacious intrinsically thermostable xylanases can be produced.

More importantly, the end result is a new generation of intrinsically thermostable commercial xylanase products that require no coatings and no amino acid manipulation. Econase XT, the first such xylanase to enter the market, is sufficiently thermostable to allow application as a liquid into the batch mixer, as well as more conventional application as a dry product through the premix or directly at the mill.

In fact, independent testing has found Econase XT to be thermostable at up to 95°C (203°F) under normal pelleting conditions, which in this case included 30 seconds of steam conditioning followed by pelleting through a 3.0mm die (see Fig. 1). In addition, stability tests performed using various conditioning and pelleting processes in a range of commercial feed mills across Europe have demonstrated typical recovery rates for Econase XT of 90-110% of the level observed in the mash.

Numerous production trials have also shown this new generation xylanase capable of improving bird performance in both wheat- and maize-based diets. In one such trial, comparing Econase XT with a previous generation xylanase in wheat-based diets fed to male broilers, performance was assessed in a standard diet, plus in test diets reformulated assuming either an 8% or 10% wheat energy uplift.

There was no difference in 42 day liveweight, but addition of a xylanase significantly improved ($p<0.01$) feed conversion ratio (FCR, 0-42 days), with the level of improvement markedly greater with Econase XT. Even when the FCR deteriorated as the assumed wheat energy uplift was increased, Econase XT still produced the best performance (see Fig. 2).

Liquid benefits

The possibility to apply Econase XT as a liquid into the batch mixer brings additional benefits. Diluted with water prior to application, the larger volume is more uniformly distributed into the feed during post-application mixing, making CVs of 5% achievable in both mash and pellets. It has also been shown, in several pelleting trials, that dilute liquid Econase XT addition can reduce power consumption during pelleting by up to 4%.

Further cost savings come from the simplified mixer liquid application (MLA) technology developed by AB Vista to apply Econase XT to the batch mixer, eliminating the need for complex and expensive PPLA systems installed on every press line.

Quality assurance procedures are also more straightforward and robust thanks to an ease of assay not previously seen in the xylanase market.

Econase XT is a new generation of intrinsically thermostable product that raises the standards for xylanase feed enzymes, offering a unique opportunity to review enzyme application methods and policy, plus the potential to both improve bird performance and reduce costs. Put simply, the compromises that have long been a part of feed enzyme use in poultry diets, whether in terms of feed manufacture or bird growth, need no longer be accepted. ■