A new dawn in enzymes

In the continuing search to optimise animal performance through nutrition, new enzyme applications based on fibre-degrading enzymes show interesting promise.

By Dr Erik Vanderbeke, Aveve Biochem, Belgium

The solubility of the NSP-fibres differs strongly depending on the feed raw material and the specific tissues of the grain from which they originate.

Grains typically represent about 50% of the feed protein as well as about 50% of the non-starch polysaccharide (NSP)-fibres of animal diets. By-products from grain and oil seeds are major protein sources and they represent the other 50% of total protein and fibre in European animal diets. Fibres influence animal nutrition due to the fact that their soluble and insoluble forms influence nutrient availability, they are partly fermentable and non-fermentable and influence water holding capacity and transit time.

Fibre types in animal feed

NSP analysis of feed raw materials give a 'NSP-sugar-fingerprint' indicating the main fibre types present. Xylans as well as glucans are important in grains like corn, wheat and their by-products. In by-products of oil seeds like soybean meal, additional to glucan and xylan, especially the levels of pectins, composed of monomeric sugars like galactose, arabinose, galacturonic acids and rhamnose is very important.
The solubility of the NSP-fibres differs strongly depending on the feed raw material and the specific tissues of the grain from which they originate. Corn has a similar NSP sugar composition as wheat, but its fibres are much more insoluble due to a higher degree of substitution and esterification. In arabinoxylans (xylans) a higher substitution ratio of arabinose/xylose (A/X) results in a lower solubility.
Wheat and corn by-products contain more insoluble xylans as during processing, the outer layer of the grain with higher A/X ratio are concentrated in the by-product raw materials. Insoluble glucans will represent more cellulose-insoluble-types of fibre. Soybean meal and rapeseed meal additionally contain high levels of the more soluble pectin type of NSP-fibres. Other types of by-products like sunflower meal and DDGS can contain important levels of insoluble glucans like cellulose.

Solubility of fibres and nutrition

Soluble fibres are involved in viscosity development in the small intestine, which is considered anti-nutritional for

animals. It limits efficient absorption of nutrients and feedback mechanisms of nutrient monomers and can lead to the loss of endogenous enzymes due to over-secretion.
Insoluble fibres on the other hand limit the access of endogenous enzymes to the nutrients within the desired time frame and carry away nutrients from the small intestine into the large intestine and caecum. Meanwhile, soluble NSP-fibres are fermented to volatile fatty acids of which some are used by enterocytes, increasing the intestinal villi health and also the nutritional value of the raw material i.e. energy value.
Insoluble fibres influence the gut motility and are mentioned as platforms for gut microbiome association. In general, both soluble and insoluble fibres have an important impact on the gut microbiome and metabolome. The influence of soluble fibres on the microbiome is also stated as prebiotic. The gut microbiome presents a first barrier for pathogenic microorganisms and it interacts with the gut associated lymphoid tissue (GALT) and local immune system. Fibres thus have an important impact on the gut microbiome equilibrium and the GALT system.
Also nutritionally important is the fact that NSP-fibres are connected with dietary proteins through direct linkage or inclusion. They can limit protein hydrolysis in the stomach and the small intestine and hinder efficient absorption of amino-acids in the small intestine which is needed for optimal animal performance. On the other hand, high levels of excess protein in the large intestine lead to energy loss by the animal due to the need to detoxify amino-acid degradation products resulting from microbial fermentation. Also, in general, in broiler nutrition, excess protein is avoided to limit the water intake and to keep wet litter under control.

PHOTO: SHUTTERSTOCK

New horizons in feed formulations

With high costs for protein, reduction of total Nitrogen (N) and digestible amino-acids in diets can realise important economic advantages in feed formulations. Whereas non-starch polysaccharide-degrading enzymes (NSPase) are commonly used to avoid negative effects of soluble fibres, their potential impact on insoluble NSP fibres need more attention in animal nutrition and can open new horizons to optimise feed formulations. The efficacy of NSPase enzymes towards insoluble fibres and related animal performance is dependent on the type of enzyme activities, their level in the enzyme product (concept) and the dosage of this concept into the diet. To obtain sufficient NSP hydrolysis of soluble and insoluble fibres, the addition of minimum threshold levels of well-chosen enzyme activities is needed.
Insoluble fibres like cellulose, will require a higher threshold quantity and a broad composition of enzyme activities to obtain partial hydrolysis. A cooperative action between different enzyme activities targeting different fibres in the insoluble fibre network is important. Also added enzymes have to perform their actions in time at the right gut location within the restricted time frame available. Enzyme combination and concentration are important issues in this context. Only animal trials and performance measurements using well designed feed compositions and well characterised enzyme concepts can indicate if the overall effects on performances are economically interesting for animal production.

'High dosing' NSPase concept

Aveve Biochem has 30 years of experience in designing enzyme concepts, based on more than 300 animal trial set-ups. The company recently developed new NSPase enzyme concepts including demonstrating for the first time that 'high dosing' of NSPase enzymes can be used to reformulate broiler diets to lower total protein and lower minimum digestible amino-acid levels, indicating increased protein digestion.
It proves that high dosing of NSP enzymes opens the fibre structure and improves access of animal proteases to the dietary protein present, increasing protein digestibility. High dosing of NSPase enzyme containing endo-1,4-beta-xylanse and endo-1,3(4)-beta-glucanase to a more economic broiler diet reformulated with -3% reduced total protein and -3% reduced minimum digestible amino-acids (dAA) (NC), restores normal growth and FCR comparable to the positive control feed (PC) (*Figure 1*). High dosing of NSPase allows the equivalent protein reformulation as a mono-component protease. High dosing of NSPase indicated however to be more economic than the use of protease for this feed reformulation purpose.
Another new concept is the use of high pectinase enzyme activity. Here it was demonstrated that the addition of high pectinase activity on top of endo-1,4-beta-xylanase and endo-1,3(4)-beta-glucanase increased growth rate and significantly decreased FCR on top of a standard broiler wheat-soybean meal and corn-wheat-soybean meal diet. As soybean meal is the major source of pectins in the diets tested, it is clear that additional performance increases are related to the action of pectinase on soluble and insoluble soybean meal pectins.
Soybean meal products are standard in broiler diets and the performance effect is not dependent on the grain type in the diets. Piglet diets containing a high level of soybean meal show the same response to added pectinase enzyme activity. High levels of pectinase on top of xylanase and glucanase seem to hold an important potential to further improve broiler as well as piglet performances.

References available on request

Figure 1 – Results of trial of XG high dosing NSPase in -3% protein and -3% dAA protein formulated diet.