A new perspective on maximising the potential of dietary fibre, xylanase and gut health

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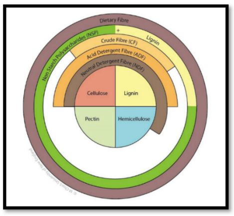
The total dietary fibre concept

Physiologically, fibre is defined as carbohydrates that are not digested and absorbed in the upper part of the intestinal tract, reaching the colon or ceca intact. Thus, the *Codex Alimentarius* in 2005 defined dietary fibre as "carbohydrate polymers with a degree of polymerization of not less than 3, which are not digested and / or absorbed in the small intestine".



In the context of animal nutrition, though, the use of the word fibre is broad, confusing, and chemically ill-defined (Choct, 2015). As an example, crude fibre (the main fibre reference used until today in labels and for the registration of feeds) represents only a very small proportion of around 20% of the dietary fibre of ingredients and feeds.

According to Choct (2015), the definition of dietary fibre causes huge controversy, because there have also been numerous, sometimes confusing, definitions over the years; including definitions based on physiological effects and methods of determination. Of direct relevance to the nutrition of monogastrics, the author recommends defining dietary fibre as "the sum of the content of total non-starch polysaccharides (NSP) and lignin".

In order to embrace this total dietary fibre concept, new nutrient matrices should be developed to consider all the carbohydrates present in the ingredients, including especially the amounts and types of NSP, in addition to having a greater knowledge of their soluble and insoluble fractions and correlating it with gastrointestinal behaviour in animals.

Such an approach leads to a more directed step such as the definition of fibre and its NSP components, and to understand better how the fibre composition and characteristics can impact gut development, lower gut fermentation and consequently animal performance. Also, a better understanding of the fibre characteristics of different ingredients allows one to understand the possible impact of tools available in the market (acids, grinding process, pelleting, different ingredients, carbohydrases, etc) could have on these fibre characteristics.

NIR as a tool to characterize total dietary fibre

NIR technology uses near infra-red light to quickly and easily predict the nutritional quality of ingredients and feeds. Traditionally NIR technology has been used for routine proximate parameters including moisture, protein and crude fibre. These results can be used to e.g. positively accept/release ingredients and feeds and identify trends in raw material quality to help update the formulation ensuring consistent feed quality. Recent advances in NIR calibration technology now enable companies to predict additional parameters such as soybean meal reactive and total lysine, cereal metabolizable energy and phytate-P.

In order to better understand total dietary fibre in different feedstuffs AB Vista has collected approximately 1,700 ingredient samples from 24 different countries over 5 years (Gomes et al., 2020). These samples were analysed according to the method proposed by Englyst et al. (1994), and ground and scanned using a benchtop NIR machine (FOSS DS2500) monochromator spectrometer (FOSS A/S Hillerød, Denmark).

As a result, AB Vista has developed a suite of NIR calibrations that can be used to predict parameters linked to total dietary fibre including:

- ✓ Insoluble and total NSP
- ✓ Insoluble and total arabinose + xylose
- ✓ The ratio of arabinose to xylose in both the total and insoluble arabinose +xylose fractions.
- ✓ Insoluble and total glucose as part of NSP.
- ✓ Also, based on the composition above, other NSP composition such as soluble portions of each group can be quickly and easily calculated

The NIR calibrations can be used to predict these parameters in feed ingredients with very good accuracy. Figure 1 shows the typical insoluble, soluble and total NSP content in a variety of feed ingredients. More important is the regional and seasonal variation in total and insoluble NSP which can be effectively monitored if you have access to an NIR machine on site.

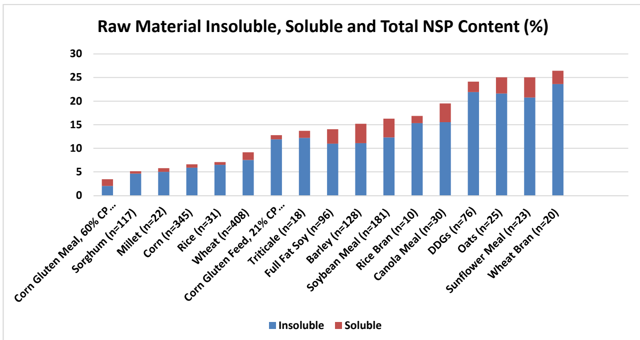


Figure 1: Insoluble, soluble and total NSP content in a variety of common feed ingredients. Adapted from Gomes et al., 2020

How to reduce the anti-nutritional effects of dietary fibre and potentiate its positive impacts?

Soluble and insoluble NSP continue to exhibit significant antinutritive properties for animals. These effects can be reduced with the use of carbohydrases, especially xylanase, due to the high inclusion of the arabinose and xylose complex normally present in diets (approximately 40 to 50% of the total NSP), and the high resistance of arabinoxylans to hydrolysis and disappearance in the GIT if a xylanase is not present.

Historically, the mechanism by which a xylanase was used was focussed on improving the nutritional digestible values from the ingredients due to viscosity reduction, improving intake and increasing the effectiveness of endogenous digestive enzymes. But nowadays this effect is not considered the most important benefit from using xylanase.

The soluble fibre proportion in cereal ingredients has decreased over time, reducing the impact of this soluble fibre in gut viscosity.

This change in the fibre solubility in cereals in recent years, has not made the use of carbohydrase irrelevant, the new generation xylanase products are able to provide other benefits to the animals due to the way they break down the arabinoxylan chain. In fact, this has highlighted an impact of fibre in monogastric nutrition that had so far been almost ignored: the beneficial impact of fibre in the lower gut fermentation and the development of a fibre-fermenting microbiome. Currently, the mode of action of exogenous enzymes is attributed to their ability to degrade the links between the fibre chains, generating fractions of a smaller degree of polymerisation called Xylo-oligosaccharides (XOS) or ArabinoXylo-oligosaccharides (AXOS), generating a pathway for the development of the intestinal microbiota *(Ribeiro et al., 2018).*

The resulting effect of exogenous xylanases would be to generate a range of these XOS. Such oligosaccharides have a beneficial effect on the microbiome that colonizes the distal portion of the gastrointestinal tract. Therefore, the beneficial effects resulting from the inclusion of xylanases in cereal-based diets may result in more robust modulation of the caecum microbiome, since it generates a series of highly fermentable compounds which can enter the caecum, in addition to direct activity on soluble and viscous arabinoxylans.

However, it must be clarified that the breakdown mechanism of arabinoxylan chains by all xylanases is not the same. Not all enzymes produce XOS with the correct degree of polymerization, for which the microbiome has a greater appetite, while some products may even hydrolyse these oligosaccharides to free sugars which would reduce these beneficial effects.

Furthermore, the development of this fibrolytic microbiome will increase the production of volatile fatty acids (VFA) such as acetic, propionic and butyric acids. These VFA's are energy sources for enterocytes, in turn improving intestinal health while also working as triggers for gut hormones such as PYY. This factor will determine an improvement in the digestibility of diets by increasing food retention in the stomach / gizzard.

This development of the fibrolytic microbiome through the action of XOS or AXOS generated by xylanase in vivo requires a slow process of adaptation, giving more benefit as the animal ages. If an adequate balanced fibre fermenting microbiome could be achieved more quickly, then animals would show the benefit more quickly and consistently.

When XOS with a specific degree of polymerization is used together with exogenous xylanases, a strong stimulating action of the fibre degrading bacteria in the distal fermentation chambers of the monogastric is generated, which is the so-called Stimbiotic effect: stimulation of the microbiome of the hindgut to degrade fibre.

In this way, we can define as Stimbiotic additives those that can stimulate a microbiome to degrade fibre and increase fibre fermentability, even when used in clearly low doses. This allows a significant contribution to the production of VFA, volatile fatty acids.

In addition, the positive effect on the digestibility pattern of nutrients like protein can reduce their concentration in the lower gut and thus steer the fermentation to a fibre fermentation rather than a putrefactive protein fermentation, which is desirable.

Further information or references please contact emea@abvista.com