Transforming how we think about fibre and how it is measured

Fibre nutrition is still in its infancy compared with the current depth of knowledge in amino acids and certain vitamins and minerals. There is increasing interest in the use of high-fibre ingredients due to their perceived benefits on gut health.

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Significant advancements in carbohydrate analysis has enabled diet formulators to increase use of fibrous ingredients in their rations, typically to ameliorate post-weaning diarrhoea, induce satiety, or improve feed costs.

While some high-fibre ingredients may help reduce diet costs, others may not be cost effective in certain situations. We need to transform the way we think about fibre and the strategy we use to measure its success as a nutritional intervention.

Fibre refers to complex carbohydrate structures that are resistant to endogenous mammalian enzymes. Dietary fibre can be broken down by enzymes expressed by microbiota inhabiting the gut, subsequently producing fermentation byproducts that elicit health benefits to the animal.

Not all fermentation results in beneficial metabolites; protein fermentation produces putrefactive factors that are detrimental to animal health. Fermentation of undigested protein reaching the hindgut is a major contributing factor to post-weaning diarrhoea.

There are currently no recommendations to meet fibre requirements in monogastric animals. We incorporate fibrous ingredients into the diet not because the animal has a fibre requirement per se but rather to induce a specific response such as an improvement in faecal consistency or to stimulate satiety.

Certain characteristics of fibre elicit physiological effects on the gastrointestinal tract, the extent and location of which depend on the type of fibre. We currently characterise fibre as being soluble or insoluble, as opposed to fermentable or non-fermentable, because this can be easily and repeatably measured using available analytical procedures. However, solubility is not the same as fermentability, but soluble dietary fibre is typically more rapidly fermentable than insoluble dietary fibre.

Soluble fibres may increase the viscosity of digesta and delay gastric emptying. Viscosity can impose more issues in poultry than in pigs but may also play a significant factor in the growth of the young pig.

Fermentation of soluble fibres in the hindgut produce organic acids that are utilised as an indirect energy source for the host animal.

Significant amounts of organic acids may lower pH with anti-microbial effects that act as a competitive exclusion strategy by commensal and beneficial bacteria to outperform pathogens.

Fermentation byproducts also stimulate goblet cell production to increase mucus secretion, improving gut permeability against toxins and pathogenic bacteria.

On the other hand, insoluble fibre increases bulk and stimulates peristaltic movement of feed material through the intestinal tract. This also prevents stasis and limits the time pathogenic and opportunistic bacteria have to proliferate. Pathogens may also adhere to insoluble fibre, preventing attachment to the intestinal

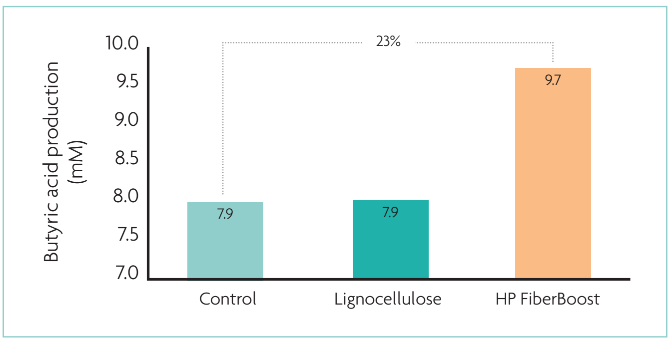
epithelium. The balance between soluble and insoluble fibres will depend on the desired response from the animal.

The beneficial role of butyric acid in gut health

Fibre fermentation in the hindgut results in the production of short-chain fatty acids that include acetate, propionate, and butyrate. The beneficial role of butyric acid in gut health is widely accepted in the realm of nutrition. The contention exists in its form of application and whether it is more effective to supplement via the feed or through stimulation of microbial production within the host.

Several bacterial species inhabiting the hindgut produce butyric acid through fermentation of prebiotic fibres. This is an effective way to supply butyric acid in the large intestine where it evokes benefits to the animal.

Fig. 1. Butyric acid production increases by 23% in piglets (15kg) when prebiotics are fed. Control were not fed supplemental fibre.



However, there are also several species that ferment undigested protein that reach the hindgut resulting in toxic byproducts that could damage the gut epithelium. Nutritionists reduce crude protein levels of early nursery diets in production systems with limited use of antibiotics or zinc oxide for this very reason.

Many of our common high-fibre ingredients contain nutrients other than fibre that may be utilised by the animal. Oats are a good source of prebiotic β-glucans but are also a good source of starch. Distillers dried grains with solubles (DDGS) contain high levels of insoluble fibre as well as an economical source of amino acids. Sugar beet pulp is high in soluble fibre making it highly fermentable, but this ingredient also contains a high concentration of insoluble fibre.

The point here is that traditional sources of high-fibre ingredients rarely contribute only fibre into the diet. Some ingredients may even introduce mycotoxins and other toxic compounds into the diet that will inhibit growth.

The various types of carbohydrate structures among high-fibre ingredients call for distinct feeding strategies. For example, post-weaning diarrhoea is often multi-factorial so several strategies must be done to address the issue, ranging from the diet to the environmental conditions the pigs are in.

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Antibiotics and the therapeutic use of zinc oxide have traditionally masked the harmful effects of some of the causal agents.

Without these technologies, strict biosecurity protocols, proper husbandry practices, and specific diet formulation strategies need to be implemented in conjunction with one another. From a nutritional standpoint, minimising undigested protein and rapidly fermentable carbohydrates reaching the hindgut by utilising the right fibres can help improve faecal consistency.

The challenge in supplementing fibre is identifying when to use which type of ingredient or fibre supplement.

It is important to consider the concentration of total dietary fibre in the complete ration. Increasing dietary fibre may result in unexpected consequences if the ration is not balanced to accommodate higher levels of fibre.

Although the animal can utilise fermentation byproducts as a source of energy, high levels of dietary fibre may also decrease digestibility of certain nutrients. It is important to be aware of what ingredients contribute to fibre in the diet.

For example, a wheat and barley-based ration will have a higher concentration of soluble and fermentable fibre compared with a diet using corn as its main cereal grain.

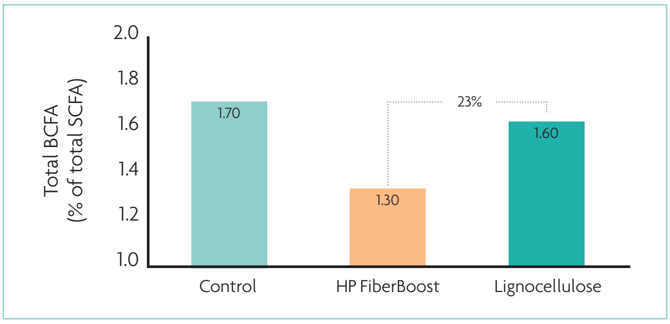

Fig. 2. Protein fermentation is 23% higher in piglets (15kg) when prebiotic carbohydrates are not available in the colon.

Is it possible to elicit the favourable effects of fibre without sacrificing performance?

Yes, but it requires an in depth understanding of the entire dietary fibre fraction using appropriate analytical techniques. The crude fibre method tells very little about the true fibre content of most feedstuff, hence the term crude.

The detergent fibre methods are an improvement over crude fibre, but do not provide the whole story. Total dietary fibre, specifically looking at insoluble and soluble fibres including low-molecular weight sugars, represent a more complete picture of the fibre fraction and its potential consequences when fed to an animal.

Food animal agriculture is deep-rooted in progress and innovation. Stakeholders constantly adapt to the ever-changing regulatory landscape that dictates how the industry can produce and market its products. Many parts of the world are limited in feed technologies that can used to improve growth performance.

The use of conventional antibiotic growth promoters has declined over the years and ractopamine hydrochloride is banned in many countries. Recently, pharmacological levels of zinc oxide is being phased out in the European Union. The next innovative feed solution may prove efficacious, but legislation will dictate its use whether the science is there to support it. An ingredient like a functional fibre will be unlikely to have any regulatory opposition because of how it is produced and how it affects the animal.

Next generation functional fibres

Next generation functional fibres are active ingredients that have beneficial physiological effects on the animal. HP FiberBoost is an enzyme-treated functional fibre that is designed to combine the physical benefits of insoluble fibre and the stimulating effect of prebiotic carbohydrates on gut health.

Specific enzymes hydrolyse sections of the carbohydrate framework to reduce viscosity while maintaining the desired structural functionality of fibre. This targeted cleaving enhances the concentration of prebiotic carbohydrate fractions that stimulate the proliferation of beneficial bacteria in the hindgut resulting in production of significant amounts of butyric acid. ■