Several years of research for a better understanding: from xylanase to fibre degrading microbiome stimulation

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Enzymes like phytase and carbohydrases are well accepted in the feed industry and used in most monogastric feeds to achieve optimum performance and profitability whilst meeting environmental and welfare constraints. Over the years, these products have been continually improved to be ever more efficient, due to in-depth scientific research into the enzymatic mode of action enabling improved understanding of how best to apply such products for optimum performance results. One of the tools available for nutritionists is the use of carbohydrase to optimise the nutritional effects of fibre and improve animal performance. A recent paper from Bedford (2018) discussed the three principal modes of action hypothesized for carbohydrases: viscosity reduction, cell wall hydrolysis and the prebiotic effect. Viscosity reduction is understood to be relevant in diets high in viscous cereals such as rye, oats, barley and wheat, whilst the hypothesis regarding cell wall hydrolysis is now seriously questioned as carbohydrases don't have enough time in the bird to achieve complete breakdown of cell walls. The prebiotic effect was often cited and seen as a secondary effect but not really considered as a significant mode of action as it was viewed as being variable and difficult to measure. In addition, not a lot of consideration was given to the role of fibre in monogastric feeds mainly due to obsolete methods to analyse and characterize fibre presenting results that do not make sense from a biological viewpoint. Whilst the amount of total dietary fibre in a monogastric diet is not negligible it is often considered as a dietary diluent because it is almost undigestible and thus it was given little or no attention. If not digested, fibre is nevertheless a potential substrate for fermentation by the gut microbiome, with the bacterial population using this as a substrate, fermenting it into different components such as volatile fatty acids (VFA). The VFAs produced help to maintain gut integrity and serve as an energy source for the host, recovering some of the energy that would otherwise be lost. As more and more attention is given to find all of the possible strategies to maintain gut health it is logical to look more closely at the potential role of fibre and to determine how to optimise fermentation for a better gut condition.

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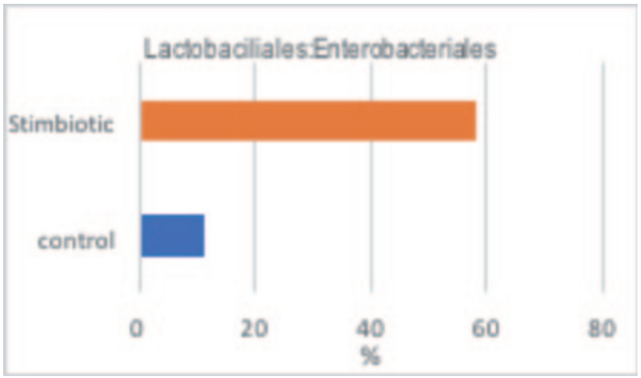

Figure 1. Effect of the stimbiotic on FCR and the ratio Lactobaciliales:Enterobacteriales in the colon of piglets.

Recent advances in enzymatic and chemical methods provide more information on Non-Starch Polysaccharides (NSPs), for instance further separating them into soluble and insoluble fractions which appear to be more biologically relevant than the original methods for fibre analysis. Understanding fibre content and characteristics, like solubility, helps to reduce the anti-nutritional effects that some of these components have, while simultaneously providing a desirable substrate for beneficial bacteria to ferment. This complexity, which is not captured by traditional methods, also explains the variability seen in the literature when looking at the impact of fibre especially when different components, characteristics, structures are classified under one unique word: "fibre" and where analytical methodologies don't completely fit with nutritional criteria.

More recently it has been shown that microbiome modulation by the arabinoxylan-oligosaccharides (AXOS) produced by carbohydrases can explain xylanase action through their ability to improve the fermentability of the fibre fraction from the feed. The gut microbiome increases its capacity to degrade and ferment fibre with age. Recent research has shown that some factors will be able to speed up the rapid establishment of a microbiome capable to degrade fibre, enabling the beneficial effects from fibre to be achieved earlier. In fact, a diet supplemented with xylanase and a specific XOS will both favourably accelerate and increase the fermentative capacity of the hindgut microbiome. These effects were seen at low dosages (g/ton) while in prebiotics typical doses of supplementation involve a few kg per tonne. Therefore, this type of product cannot be considered as a prebiotic as such, instead fitting into a new category suggested to be called "stimbiotic".

Stimbiotic supplementation is more effective than just an NSP enzyme in both poultry and swine; and is more efficient than a prebiotic at increasing VFA content. This is especially true when animals are exposed to poor sanitary conditions as shown in a piglet trial. In fact, rather than feeding a specific species of bacteria, stimbiotic products work by stimulating the group of bacteria involved in fibre fermentation to produce VFAs, and accelerating the capacity to deal with fibre earlier, whilst delivering the benefits from the energy release. In the literature, numerous benefits are attributed to XOS such as better gut integrity in broilers, laying hens and piglets as well as its involvement in the immunomodulation pathways. Several authors have also made the correlation between gut microbiome and growth performance.

Recent data has shown that the use of a stimbiotic can improve performance of broilers and piglets. This relates to a better gut environment that helps the animal to cope with the different challenges they are facing in the field, giving them the opportunity to extract more energy from the feed. In a recent study performed in piglets a large improvement of FCR was shown (9 points, $P<0.05$) when animals were supplemented with a stimbiotic. Along with the performance improvement, colon digesta analysis has shown an increase of Lactobaciliales (62.9% vs 59.2%) and Clostridiales (33.8% vs 31.1%). This effect can be explained by a direct stimulation of lactate as well as butyrate producing bacteria, with butyrate producing bacteria often cross feeding from lactate producers. A decrease of the Enterobacteriales (from 5.2 to 1.1%) was also noticed which led to a large improvement in the ratio between Lactobaciliales and Enterobacteriales (58.3 vs 11.5) indicating a better gut condition with the stimbiotic use (Figure 1).

To conclude, the product development leading to this new stimbiotic is based on several years of work regarding the understanding of xylanase mode of action and represent, s an important tool for optimising the utilisation of the poorly digested fibre fraction, leading to better gut condition and hence performance

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