SPEAKER **ABSTRACTS**

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THE FIBRE FRONTIER: NUTRITION FOR THE **SECOND BRAIN**

Fibres making up wheat cell walls in the context of broiler diets

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Abstract

In this paper, the non-starch polysaccharides (NSP) that make up most of wheat fibre in broiler diets are discussed. Wheat is the prevalent dietary energy source in European wheat-based broiler diets, although it contains large amounts of such NSP. They are mostly present in the wheat cell walls and are composed of arabinoxylan (AX), mixed linked β-glucan and cellulose. Due to their physicochemical properties, they evoke anti-nutritional effects in the gastrointestinal tract (GIT) of poultry and pigs. The viscosity-generating potential and the formation of a physical barrier of these NSP will decrease the feed digestibility of wheat-based broiler diets and, hence, negatively affect broiler performance. This anti-nutritional behaviour of wheat NSP in the GIT of animals led to a negative perception in the feeding industry about wheat as animal feed ingredient over the past decades. However, pressure on the use of antibiotics pushed nutritionists to search for alternative feed ingredients which could maintain the health status of poultry. Based on research and advances in the area of gut microbiota, the view on NSP in the animal feeding industry evolved from them being anti-nutrients to them being at the same time anti-nutrients as well as health- and growth-stimulating fibres, i.e. dietary fibre. Defining and analysing the different types of dietary fibre among animal feed ingredients and their functional value in the GIT of animals is still a major obstacle in the feeding industry. Hence, a better understanding of the functional-structural relationship of wheat NSP is needed.

Variability in cereal grain composition and nutritional value: the importance of fibre

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Abstract

Large variation in the nutritional value of cereal grains, within and between animal types, is due predominantly to differences in digestive tract anatomy, site and extent of microbial fermentation, and amount and type of dietary fibre. Energy available from digestion is reduced by grain fibre in pigs, broilers and ruminants. The effects are greatest for broilers and least for ruminants, reflecting large differences in intestinal microbial populations. Individual grain samples are often better suited for digestion by one animal type than another. In pigs, the extent of starch digestion in the small intestine scales with the rate of amylase diffusion into grain particles, grain particle size and the time particles have for digestion, determined by residence time of digesta to the terminal ileum. Amylase diffusion rate is influenced by endosperm tissue and cell wall integrity, solubility of grain protein matrix, composition of starch and processing methods. Rate of passage of digesta to the terminal ileum increases as fibre content of the diet increases to ~15% neutral detergent fibre (NDF), then declines with additional fibre causing distention of the stomach. Diet hydration capacity, which is influenced by soluble fibre content, slows digesta passage rate once it exceeds ~1.2 g water/g dry matter. Undigested starch reaching the colon causes a decrease in passage rate through activation of the ileal/colonic brakes. Voluntary feed intake in monogastric animals is related to rate of passage to the terminal ileum for nutritionally balanced grain-based diets. Approximately 15% of energy in starch fermented in the large intestine is lost to the pig as heat, methane and microbial products excreted in faeces. Algorithms predicting effects of diet fibre, water-holding capacity and amylase diffusion rate can be used to predict threshold grain particle size, where all starch is digested by the terminal ileum, and the likely loss of energy through fermentation.

The importance of the fibre fraction of the feed in non-ruminant diets

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Abstract

Dietary fibre (DF) is an accurate term to define in practice the fibre fraction of ingredients and diets and includes cell walls, stored non-starch polysaccharides and lignin. Fibre has been associated traditionally with reduced palatability and impaired nutrient utilisation in non-ruminant diets. However, DF has also an important role in animal feeding, and a minimum amount of fibre is required to maintain the physiological functions of the gastrointestinal tract (GIT). The impact of DF on GIT physiology and animal behaviour depends on the species, age, management and health status of the animal. In addition, the response differs considerably with the physico-chemical characteristics of the fibre source used. Solubility, degree of lignification, size, density and water holding capacity, are key factors affecting the benefits (or negative effects) of DF on performance of non-ruminant animals. In general, insoluble fibre sources such as oat hulls and other cereal co-products, are better adapted than soluble fibre sources such as sugar beet pulp to the physiology and function of the GIT of poultry. Soluble fibres increase the viscosity of the digesta which reduces feed intake and limit the contact between nutrients and endogenous enzymes in the lumen of the GIT. As a consequence, soluble fibres should be avoided in poultry feeding. In pigs, however, both types of fibre might be of benefit depending on age and health status of the animal (i.e., inclusion of sugar beet pulp in diets for gestating sows and oat hulls in diets for young weaned pigs). Currently, most nutritionists formulate diets for pigs and poultry based on crude fibre values, accepting that all fibre sources are "equivalent" in nutritional value and physiological effects on the GIT of the animals, which in most cases is not correct. Because of the complexity of the response, it is difficult to predict and give an accurate recommendation on the type and level of fibre to use in commercial diets for pigs and poultry.

Fibre – how and which structures can be modified by enzymes

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Abstract

Fibre represents a diverse group of cell wall (CW) polysaccharides along with lignin not digested by endogenous enzymes in the small intestine of non-ruminant species. Part of the CW, in addition to being indigestible by itself, encapsulates potentially available nutrients such as protein (amino acids), fat and minerals. This is particularly the case with the aleurone CW of cereals and the cotyledon CW of legumes and to a lesser extent the endosperm CW of cereals. There is convincing evidence that the aleurone and endosperm CW of cereals can be modified by enzymes, thereby enabling access for the endogenous enzymes to the cell content. The results obtained by cotyledon CW of legumes are, however, less convincing. The effect of enzymatic modification on the aleurone and endosperm CW of cereals is specifically a conversion of high-molecular weight arabinoxylan to arabinoxylan oligosaccharides.

Susceptibility of fibre to exogenous carbohydrases and impact on performance in swine

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Abstract

Feed represents a very large portion of the cost of raising a pig to market; indeed, the cost of meeting the energy specifications of a diet is the largest single item in the cost of production budget. Within this context, fibre plays a significant role as it represents a substantial but poorly utilized portion of typical commercial diets. It is therefore not surprising that enzymes attract a great deal of attention as a vehicle by which fibre can be used more effectively. Interestingly the mode of action of enzymes within the diet is poorly understood. Indeed, enzymes are providing unexpected health benefits, including but not limited to reduced mortality in the grow-finish phase. In any event, enzymes improve energy and nutrient digestibility – not always translated into faster or more efficient gain – and also impact the microbiome, gut barrier function and possibly oxidative stress. Suggestions are provided for future research topics and applications.

Multi vs. single application of enzymes to degrade fibre in diets for pigs

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Abstract

The largest quantities of fibre in most commercial diets for pigs originate from cereal grains and cereal grain co-products. The quantitatively most important fibre components in such diets are arabinoxylans and cellulose, which are poorly digested by endogenous and microbial enzymes in pigs. To increase fermentability of these components it is, therefore, necessary to add exogenous enzymes to the diets. Theoretically, four enzymes are needed to hydrolyse cellulose, whereas nine enzymes are needed to hydrolyse arabinoxylans. The greatest energy value of fermented cellulose will be obtained if cellulose can be fermented in the small intestine, but to achieve that, all four cellulose degrading enzymes need to be added to the diets. However, for arabinoxylans, the objective is not to achieve complete hydrolysis in the small intestine because absorbed pentoses do not contribute to the energy status of the pig. Instead, the objective is to hydrolyse arabinoxylans in the hindgut of pigs and microbial fermentation in the hindgut may be aided by addition of at least four enzymes to the diets. There are, however, only few studies with documented effects of addition of multiple enzymes to diets for pigs and more research in this area is needed.

The influence of fibre on gut physiology and feed intake regulation

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Abstract

Fibre is an intrinsic component of animal diets. Depending on chemical structure and physicochemical properties, fibre may affect both gut physiology and feed intake. In some species, viscous soluble fibres are linked to an increased satiety caused by gastric distension and a slower emptying rate, and thereby a reduced feed intake. This is at least partly caused by water binding and thus swelling of the fibre-containing stomach contents. Satiety effects induced by short-chain fatty acids produced in the lower digestive tract may also be of importance. Due to the unique grinding role of the avian stomach in the form of a gizzard, fibres in the form of large insoluble structures will have a major impact on the muscular development of this organ. Although development of the gizzard does not seem to have any systematic effect on feed intake, the increased grinding ability and the improved regulation of feed flow results in improvements in nutrient digestibility.

Dietary fibre, gut sensing and modulation of feed intake in pigs and chickens

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Abstract

Architectural and functional changes in the gastrointestinal tract (GIT) following high-fibre diets have been associated with changes in the digestibility of nutrients, in turn affecting the chemosensory mechanisms that orchestrate the hunger-satiety cycle in mammals and birds. Dietary fibre (DF) has been associated with a reduction of the area of absorption and the hydrolytic capacity of the intestinal epithelium. In addition, DF increases the differentiation of stem cells into goblet/secretory cells in detriment of other epithelial cells including enterocytes. As a result, the activity of brush border enzymes declines. This advocates for exogenous enzyme supplementation particularly in high-fibre diets in chicken and pigs. Furthermore, viscous DF prolongs small intestinal transit time and slows down the release and absorption of nutrients. As a consequence, DF causes fluctuations in nutrient availability and sensing along the GIT in non-ruminant animals. These effects, in turn, alter the release patterns of gut peptides (cholecystokinin -CCK-, glucose-dependent insulinotropic polypeptide -GIP-, glucagon like peptide-1 -GLP-1- and peptide tyrosine tyrosine -PYY-). Changes in the sensing mechanism are particularly important for fatty acids (FA) and amino acids (AA) relevant to the enteroendocrine system. The interaction between DF and the chemosensory system needs to be put in context of recent knowledge on feedback signals from the large intestine microbiome. Amongst potential practical applications, this review highlights the role of GIP in adiposity and how that can be used in fattening pigs to help reduce back fat deposition. Some of the more significant effects of DF can be reversed by dietary addition of exogenous enzymes.

Facts and thoughts on carbohydrase supplementation effects on amino acid digestibility in broiler chickens

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Abstract

Carbohydrases are widely used as feed additives in poultry. Traditionally, enzyme products were specific with lead activity of one or two enzymes, typically xylanases and β-glucanase. Main area of application were diets based on wheat, rye, and barley. More recent research considered multiple-carbohydrase mixtures, often combined with enzymes other than carbohydrases, and also targeted maize-based diets. Carbohydrase supplements can affect digestibility of nutrients other than carbohydrates, including amino acids. Published literature overall indicates a small increase in precaecal digestibility of amino acids in broilers when carbohydrases are supplemented. However, effects were not consistent among studies and highly variable. One possible reason is the variation that exists in composition and digestibility among batches of feed raw materials. In diets rich in non-starch non-cellulosic polysaccharides, the effect on amino acid digestibility is primarily related to the reduction of digesta viscosity achieved by enzyme supplementation. Causal relationships in maize-based diets are not well understood and the mode of action is difficult to study with multi-enzyme products. Partial depolymerisation of structural carbohydrates and better access to entrapped proteins may be one reason. Viscosity-related effects also change the composition of the intestinal microbiota. High digesta viscosity can stimulate the growth of pathogens. However, specific carbohydrate polymers originating from partial hydrolysis of complex structures have potential to support the growth of bacteria with positive effects on intestinal fermentation and overall bird development. It is unknown to date whether effects on the intestinal microbiota are related to amino acid digestibility.

Beta-glucans and beta-glucanase in animal nutrition, do we understand their full effects?

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Abstract

Feeding barley to poultry and pigs has long been known to be affected by β-glucan found in grain cell walls. For poultry, the β-glucan effect can be negative because of high viscosity found in the digestive tract reducing nutrient digestibility and destabilizing the resident microbiota. The effect in pigs is less because of lower digesta viscosity and an increased ability of small intestine bacteria to depolymerize β-glucan. Despite differences in the extent of the β-glucan effect, the use of exogenous β-glucanase effectively reduces or eliminates the negative effects and stabilizes the digestive tract microbiota. Despite this fundamental knowledge, research using humans, as well as in vitro models and other animal species, suggests that poultry and pigs might benefit from a more detailed understanding of β-glucan effects. Two areas with promise, particularly in a reduced or antibiotic free era, are positive effects of β-glucan on host immunity and the potential for β-glucan to serve as a prebiotic in animal feeds. Superimposed on this knowledge is the need to understand how exogenous β-glucanase can be used to produce hydrolysis products that optimize these areas.

Steering broiler intestinal microbiota through nutrition for improved health

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Abstract

Digestion and absorption of nutrients takes place in the small intestine, in the chicken essentially in the duodenum and jejunum. The remaining undigestible fraction, mostly plant cell wall polysaccharides (non-starch polysaccharides or NSP), are the natural substrate for the microbiota that live in the lower part of the intestine, essentially ileum and caeca. Dysbiosis can be defined as an unfavorable shift in the intestinal microbiota, leading to inflammation. It can be due to incomplete digestion of feed, leading to digestible nutrients becoming available to the microbes. In the immature gut ecosystem of the broiler, also insufficient capacity of the developing microbiota to break down the plant cell wall polysaccharides is an issue. Therefore, strategic use of NSP degrading enzymes (NSPases), prebiotics, and any other interventions supporting this functional segregation between the upper and the lower gastrointestinal tract, will reinforce a healthy microbiome. This microbiome has beneficial effects on the absorption and utilization of nutrients.

Adaptation of the microbiome towards fibre digestion: Effects of age and dietary ingredients

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Abstract

The dietary fibre fraction of European wheat-based poultry diets largely consists of non-starch polysaccharides (NSP), mainly arabinoxylans (AX). As poultry lack the metabolic capacity to produce carbohydrate active enzymes in order to degrade the NSP of cereal cell walls, they rely on their intestinal microbiome to hydrolyse and ferment the dietary fibre fraction of the feed. However, the colonisation by and composition of the gastrointestinal microbiota is strongly influenced by different host-specific and diet-related factors, which hence impact and modify dietary fibre digestion. In recent research, the importance of broiler age and the age-related microbial development on the capacity of broilers to degrade wheat AX was demonstrated. The first colonising microbiota were able to hydrolyse the dietary AX polymers, but not yet into fermentable compounds. However, as the broiler aged, adaptation of the microbial fibre degrading and fermentation capacity towards the AX substrates entering the hindgut was observed, which finally resulted in an increased fibre digestion with broiler age. Furthermore, to overcome the anti-nutritional effects of the dietary NSP substrates, endoxylanases are frequently added to the broiler's diet. Addition of these enzymes clearly improves fibre digestion, due to the modification of both the structural and physicochemical characteristics of the NSP substrates, thereby making them more available for microbial fermentation. Supplementation with 0.50% arabinoxylan-oligosaccharides (AXOS), in essence prehydrolysed AX, revealed that the fibre solubilizing and fermentation capacity of the intestinal microbiota can be kick started at young broiler ages. It is recommended that nutritional intervention strategies take into account the age-related and diet-adapted fibre degrading potential of the intestinal microbiota. Depending on dietary ingredients and broiler age, microbiota will contribute differently to fibre digestion.

Influence of feed processing on the gastrointestinal tract development and gizzard physiology in broilers

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Abstract

Of the various feed processing operations, grinding and pelleting are the important ones influencing the gastrointestinal tract development and nutritional physiology in broilers. The primary aim of grinding is to reduce the particle size, which increases the surface area enhancing the access of digestive enzymes to substrates. Fine grinding, however, negatively affects the development of the gizzard that plays an important role in nutrient utilisation and intestinal health. Coarser particles, on the other hand, result in a rapid and conspicuous enlargement of the gizzard highlighting that the anatomical development and digestive physiology of the gastrointestinal tract can be manipulated by dietary means. The presence of coarse particles in the gizzard enhances digesta motility and backflow within the gastrointestinal tract. Normal refluxes do not occur when birds are fed finely ground pelleted diets. Feed particle size influences the gizzard mass, nutrient utilisation and bird performance to a greater extent when the broilers are fed mash than pelleted diets. The particle size-reducing property of the pelleting process decreases the grinding requirement of the gizzard and negatively influences gizzard mass so that its function is reduced to that of a transit organ. Published data on the effects of feed processing on intestinal segments other than the gizzard, however, are contradictory and inconclusive.

New strategies influencing gut functionality and animal performance

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Abstract

Since the ban of antibiotic growth promoters in the European Union, there is a focus on looking at nutritional solutions to reduce the incidence of those diseases that increased in consequence. One strategy considers the inclusion and manipulation of dietary fibre as a mechanism to modulate the gastrointestinal environment and to bolster animal health. Thus non-starch polysaccharide (NSP) degrading enzymes (NSPase) such as xylanase, oligosaccharides such as xylo-oligosaccharides (XOS) and arabinoxylo-oligosaccharides (AXOS) and probiotics like live yeast have been suggested as a means to optimise fibre use to the advantage of the host and create a more favourable condition for intestinal health and function. These products increase the production of intestinal microbial derived NSPases in the hindgut thereby increasing the fibre fermentative capacity of the commensal microbiota, making use of fibre that otherwise would be excreted. However, many questions remain such as what types of fermentable oligosaccharides are produced by xylanases in the gastrointestinal tract (GIT) and which factors influence their production. Finally a new category of product termed "stimbiotic" is introduced in the scientific literature which describes products able to stimulate a fibre-degrading microbiome to increase fibre fermentability. This is distinct from a prebiotic mechanism which has been related to xylanase supplementation to date.

Challenges and constraints in analysis of oligosaccharides and other fibre components

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Abstract

Dietary fibres are plant components that resist digestion and that have physiological effects on human and animal health. Establishing a comprehensive definition of dietary fibre has been both controversial and challenging. The most internationally accepted definitions are those given by AACC International and the Codex Alimentarius Commission, which define dietary fibre based on both carbohydrate composition and physiological effects.

The evolving definition of dietary fibre has interacted with advances in the ability to quantify and characterise its diverse components. The earliest method for carbohydrate quantification in food and feed was by difference after measuring the more tractable components (water, protein, lipids and ash). Later methods employed gravimetric estimation of fibres after removal of digestible components of the sample. However gravimetric methods are incapable of characterising the structure of fibres or of measuring the small oligosaccharides, which have become of increasing interest for both human and animal nutrition due to their potential prebiotic benefits. A range of instrumental methods have therefore been applied to understand dietary fibre components more fully, including nuclear magnetic resonance spectroscopy (NMR) and chromatography.

Measuring total dietary fibre by chromatographic methods requires hydrolysis of polysaccharides into constituent monosaccharides. Acid hydrolysis is the usual method, but the kinetics of hydrolysis are affected by the nature of the carbohydrates and the sample matrix, such that optimising hydrolysis conditions for different samples remains challenging.

High performance anion exchange chromatography with pulsed amperometric detector (HPAEC-PAD) has emerged as the method of choice for polysaccharide quantification (via hydrolysis to monomers) and for oligosaccharide analysis. The ability to measure oligosaccharides has been driven by their increasing prebiotic importance and empowered by the availability of standards and new chromatographic methods, such that the understanding of how to produce and exploit these molecules is beginning to accelerate.

Assessing the complex ecology of intestinal microbiome

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Abstract

The intestinal microbiota of warm-blooded animals is a community, with metabolic activity higher than in many tissues of the host. The microbiota in the small intestine of monogastric animals is relatively simple, mainly comprising well-characterised lactic acid bacteria. In the lower intestine (caecum/colon), the majority of bacterial taxa are poorly characterised and the role of individual members of the bacterial community is not fully understood. As a physicochemical environment, these two intestinal segments are highly different and, consequently, prevailing fermentation diverges. Microbial community composition can be studied by culture-independent DNA-based methods, but many of the methods currently applied have their inherent flaws, which can easily lead to biased results. In particular, methods based on initial gene amplification by polymerase chain reaction (PCR) are more prone to biases than PCR-independent methods. Although most members of the microbiome have not been grown as pure cultures and characterised, it is possible to study entire communities under laboratory conditions. When no attempt is made to deconstruct the community, interbacterial cross-feeding and other interactions persist. Such methodological approach, referred to as ex vivo, can be used to study adaptation and specific activities at community level. In microbial metabolism, compounds characteristic of a fermentation type are produced and can be used as specific indicators. Poor protein digestibility in the small intestine leads to increased concentration of protein degradation products in the caecum of broiler chickens. Poor nutrient uptake in the upper intestine leads to bypass of simple sugars from ileum to caecum and often to caecal acidosis. To learn more about the role of microbiota in animal health and nutrition, it is highly important to study in detail the functions of bacteria, rather than their taxonomic position.

Fibre and fibre breakdown products as microbial and immune defence modulators

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Abstract

Dietary fibre (DF), like other compounds present in the diet, can interact with any of the defensive mechanisms located in the intestine - gut bacteria (first line of defence), epithelial cells (second line of defence) or immune cells (third line of defence) from these mucosal sites - thereby acting as immunomodulatory agents. As DF is a complex and heterogeneous group of carbohydrates with different characteristics, its mechanisms and effects on the microbial and host cells are also dependent on their type. There are only a few in vitro, in vivo and clinical interventions on different DFs assessing their protective potential as anti-infective agents in the gastrointestinal tract. The immediate defensive properties – microbiota-independent – of DF involve direct effects on the intestinal environment (i.e. they modify other bioactive components' bioavailability), interactions with pathogens and the host (i.e. modulating signalling pathways). In addition, some types of DF, which may be fermentable, can have microbiota-dependent effects on health. These mechanisms include their ability to change microbiota composition and consequently their functionality, which in turn promotes the production of short-chain fatty acids (SCFAs). These SCFAs have been described to potentially change the gut environment and influence both epithelial and immune cells located in the intestine through several mechanisms (i.e. gene expression modulation and direct receptor binding). Overall, these products lead to intestinal gut homeostasis.

Cross-feeding during human colon fermentation

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Abstract

The human colon microbiota represents a very complex microbial ecosystem. Its importance for human health and wel-being is of increasing interest, in particular through the use of probiotic and prebiotic strategies. This review discusses the degradation of complex polysaccharides and glycans of both dietary and endogenous origin. In particular the importance of prebiotics, such as inulin-type fructans, arabinoxylan(s) (oligosaccharides), and human milk oligosaccharides for the growth and activity of specific microbial communities that are known to confer health benefits, i.e., the bifidobacteria and colon bacteria that produce butyrate and/or propionate, are discussed. Both the biochemical pathways as well as cross-feeding interactions are dealt with, as the latter represent crucial mechanisms to maintain a healthy balance of the colon microbiota.

Nutritional significance of fibre in feed formulation and factors that influence fibre fermentation

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Abstract

In current practice fibre is not properly accounted for when formulating poultry diets. This is primarily because inaccurate 'crude fibre' values are still used and often only the anti-nutritional effects of fibre on viscosity and as a nutrient diluent are considered. However, more recent research has highlighted the advantageous impacts of fibre, including its ability to stimulate gastrointestinal tract development and optimise feed digestion. Of particular interest is how fibre fractions, in particular oligosaccharides, can be selectively fermented and utilised by beneficial microbiota, leading to production of lactic acid and short chain fatty acids and reduced proliferation of pathogenic bacteria. These smaller chain sugars are produced in the gastrointestinal tract as a result of non-starch polysaccharide (NSP)-degrading enzyme supplementation, but there is also heightened attention towards manufacturing these oligosaccharides commercially, producing a prebiotic supplement for poultry diets. The nature of the enzymatic treatment or procedure used to produce oligosaccharides dictates the degree of physiochemical changes that occur in the gut, and resulting response and nature of intestinal microbiota. Thus, a deeper understanding of the chemical and physical structure of fibre components could allow for tailored use of different fibres and enzymes to achieve the desired outcome when producing specific prebiotics in the gastrointestinal tract. Solubility, viscosity and fermentation capability are the main properties of fibre that affect the diversity and density of the microbiota populations in the digestive tract. Consequently, although it is important to accurately determine and formulate the total fibre content of the fibre poultry diets, elucidating the physiochemical properties and ability of the fibre source to be fermented may be of greater significance.

View of enzymes as an alternative to antibiotics

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Abstract

The animal industry still uses antibiotics to prevent disease and improve the yield of animal production in challenging conditions. However, the emerging public health crisis in relation to antibiotic resistance, due to the possibility of these bacteria being transferred to other animals and humans (farmers, veterinarians and consumers), has stimulated efforts to end the use of prophylactics in feed antibiotics. This review summarizes the current developments and perspectives regarding the use of the enzymes as an alternative to antibiotics, with a specific focus on carbohydrases. It is difficult to conclude that enzymes per se could replace antibiotics in efficient animal production. Nevertheless, it is important to recognize their role as a fundamental part of a multidisciplinary displacement intervention strategy that integrates a mixture of different additives and more efficient management programs. Positive effects of carbohydrase enzymes on performance are normally associated with increases in nutrient digestibility because of the release of encapsulated nutrients, as well as hydrolysis or partial hydrolysis of non-starch polysaccharides. There also seems to be an influence on the environmental physico-chemical conditions in digesta and the composition of the microbiota in the digestive tract.

Future prospects for non-starch polysaccharide degrading enzymes development in monogastric nutrition

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Abstract

The advent of antibiotic free diets throughout the world has sparked renewed interest over the last 10 years in all additives which can influence the microbiome in a positive manner, and enzymes, particularly non-starch polysaccharide degrading enzymes (NSPases) are part of this list. Nevertheless, there have been relatively few new NSPase products to emerge onto the market in the last 30 years, probably as a result of the lack of advancement in understanding of how they work in vivo. The three basic mechanisms of action proposed in the 1990's, viz; viscosity, cell wall and prebiotic, remain today with little development of any of them, until recently. In the last 5 years there has been a considerable advance in the understanding of how NSPases generate oligosaccharides in situ in the animal and how these may act as signalling molecules to stimulate the microbiome to become more active in their attack on dietary fibre. This is a development of the prebiotic mechanism and seems to be able to explain much if not the majority of the response to NSPase enzymes in vivo. The development of new enzymes in this field therefore needs to consider and address the optimisation of the products of cell wall hydrolysis, rather than maximum depolymerisation as has been targeted to date (particularly with the cell wall mechanism). A greater understanding of exactly what is needed should lead to more rapid development of new enzymes which deliver more value, more consistently, than any of the products available today. Unravelling the true mechanism of action should focus discovery on what could thus create a new surge in discovery of a new range of NSPases for the industry. This Chapter explains the background to this development and notes the ancillary properties of a feed enzyme which are pre-requisite for the product to succeed.

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