The role of enzymes in nutrition: GIT integrity and poultry productivity

Around 85-90% of poultry feed consists of plant materials, like grains with a high dietary fibre content. The fibre components of a typical grain-based diet mainly contain non-starch polysaccharides (NSPs), which, in cereals, form part of the cell wall structure.

The properties and different percentages of NSPs in plant cell walls are responsible for their anti-nutritive activities and can interfere with the bird's digestive process.

by Dr Kyle McKinney,
Global Director,
Alltech Enzyme Management Platform,
and Dr Dulmelis Sandu,
Poultry Veterinarian,
Alltech Technical Support Services.
www.alltech.com/enzyme-management

The concentrations and types of these fibrous polysaccharides vary among grains and negatively alter their nutritional values. The cell wall polysaccharides of cereals are comprised of arabinoxylans, cellulose, beta-glucans, mannans, galacatans, xyloglucan and pectic polysaccharides.

These NSPs are subdivided into soluble and insoluble fractions. Insoluble NSPs act as a physical barrier encapsulating nutrients, thereby reducing those nutrients' efficiency, utilisation and digestion. Soluble NSPs increase the viscosity of digesta, resulting in reduced nutrient digestibility and absorption. This higher digesta viscosity also decreases the rate of passage of digesta and leads to more opportunities for bacteria – including salmonella, among others – to proliferate.

It is widely accepted that dietary components can influence colonisation or disease expression. This is consistent with research in the field, where scientists have often observed that dietary changes either increase or decrease the incidence of salmonellosis, colibacillosis and/or necrotic enteritis. Moreover, the diversity of the microbiome in each gut section reflects, in part, the types of nutrient substrates in those sections — which, in terms of poultry gut health, are where exogenous enzymes come into play.

Increasing the availability of nutrients

The primary function of the digestive system of poultry is the conversion and digestion of feed into its basic components for absorption and utilisation by the bird.

The small intestine of the chicken is a metabolically critical organ that is relatively short and in which the rate of passage is quite rapid (3-5 hours).

The gastrointestinal tract (GIT) of birds is naturally adapted to make the best use of nutrients, even during periods of food scarcity, due to their ability to experience reverse peristalsis, which allows for a longer period of satiety and digesta exposure.

Enzymes are proteins that serve as catalysts to naturally speed up the rate of a chemical reaction.

Digestive enzymes naturally produced by the bird break down dietary ingredients into nutrients so the intestine can absorb them. However, some animals – including poultry – cannot effectively digest 10-25% of the feed they take in, especially the fibrous components. These are known as anti-nutritional factors, as they interfere with the digestive process.

This can lead to issues with decreased digestibility, increased feed passage, poor litter quality and shifts in the litter microbiota, as well as decreased performance parameters. Furthermore, some natural enzymes depend on co-factors.

These co-factors are often minerals, vitamins, vitamin-derived molecules and other organic molecules. If the bioavailability of these co-factors is hindered due to dietary insufficiency or issues with malabsorption, then the enzyme will not have this component and, as a result, will be unable to function.

Feed enzymes can help break down those anti-nutritional factors by working to increase the nutrient availability in starches, proteins and minerals, such as phosphorus and calcium, to help the bird reach its full growth potential. The most important function of exogenous enzymes in the GIT of poultry is the disruption of cell walls. This process liberates the enclosed nutrients, making them more accessible to the bird's endogenous enzymes and increasing nutrient availability.

Main feed enzyme categories

Phytase, carbohydrase and protease are typically considered the most common feed enzymes in the animal feed industry.

Each of these three feed enzyme categories has a specific role and function in the animal that benefits producers. However, certain enzymes can only react with certain substrates. For example:

- **Carbohydrases:**

Carbohydrases break down fibre to improve the digestibility of carbohydrates in feed, thereby increasing the amount of nutrients an animal can use for energy. Carbohydrases help degrade anti-nutritional factors, such as non-starch polysaccharides (NSPs).

Continued on page 15

Continued from page 13

The primary types of carbohydrases used in animal nutrition include xylanase, which breaks down arabinoxylans; beta-glucanase, which breaks down glucans; and cellulase, which breaks down cellulose.

- **Proteases:**

Proteases increase the digestibility of proteins and amino acids. Protease enzymes can break apart the proteins that bind starch within feed ingredients, resulting in more of the energy found in starch being available to the animal.

- **Phytases**:

Phytases increase the digestibility of phytate, which improves the overall availability of phosphorus in the diet. Adding phytase to the feed results in the decreased excretion of phosphorus content in the manure, contributing to a lower environmental impact for poultry producers.

The hidden problem of undigested feed

Undigested feed in the hindgut causes problems by promoting the proliferation of unfavourable bacteria, as well as the formation of excess gas with a high pH, which also produces toxins and leads to tissue damage. It can also lead to a leaky gut, which creates an opportunity for water and nutrient absorption and increases the potential for bacterial translocation via the haematogenous route to other organ systems in the body.

Furthermore, these unfavourable caecal contents then travel back through the digestive tract via retro-peristalsis, harming the GIT's integrity and performance.

The benefits of improved digestibility

Improved feed digestibility brought about by feed enzymes reduces the residence time of nutrients in the GIT and allows for fewer opportunities for the growth and proliferation of pathogenic bacteria, such as salmonella, E. coli and Clostridium spp.

Diet composition, NSP diversity and variability help determine which enzyme solution is right for each producer. Choosing a complex of enzymes that gets the most out of the whole diet to ensure a wider range of action while improving the nutritional value is highly recommended.

The use of solid-state fermentation (SSF) for commercial enzyme production has been extensively researched over the past 20 years. SSF systems can be tailored to address specific needs based on the microbial selection and multiple substrates in the diets.

One feed enzyme that has been shown to enhance the digestibility of protein-rich vegetable feed ingredients is Allzyme Vegpro. Studies of Allzyme Vegpro in soybean meal-based diets show that the true metabolisable energy improved by 5-9%, and the true digestibility of all of the most limiting amino acids for broiler chicken – such as methionine, lysine, cystine and others – also improved.

Allzyme Vegpro allows the protein in vegetable plant sources, such as soybean meal, to be available to endogenous and exogenous enzymes in the small intestine instead of being blocked by the cell wall and, as a result, unable to be utilised, giving the birds access to essential nutrients. This reduces the flow downstream of undigested feed into the intestinal microbiota in the hindgut, thereby supporting nitrogen cycling and nutrient transport.

The exogenous enzymes in animal feed can improve the digestibility of nutrients and, in turn, benefit the gut immune response by diminishing the likelihood that bacteria will be able to develop and cause further problems, such as salmonellosis, colibacillosis and/or necrotic enteritis.

The increased absorption provided by exogenous enzymes helps poultry by boosting their ability to ingest the necessary nutrients, enhancing bird performance and feed efficiency, while also reducing their environmental impact due to the diminished output of nutrients in excreta and the improved use of limited resources. ■