The role of enzymes in poultry nutrition and digestion

Over the last 60 years, the agriculture industry has accomplished some amazing feats, including producing more meat with less land. However, there are many challenges producers are still grappling with. In the livestock industry specifically, one of the biggest challenges is the rising cost of feed, which can account for up to 70% of total production expenses.

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Furthermore, around 25% of the available nutrients in animal feeds are unutilised and excreted in the faeces, which is creating environmental concerns globally.

So, how can producers keep their operations profitable and their animals performing at their best while simultaneously reducing their impact on the environment?

Although there is no magic bullet for answering this question, one of the most promising solutions is feed enzymes, which aid digestion by promoting the release of nutrients that are typically unavailable to the animal. By utilising portions of feedstuffs that are unavailable to birds, these enzymes work to decrease the environmental impact of agriculture while also helping producers save money by lowering their feed costs.

Enzymes are well-known to be an effective solution for optimising feed efficiency. Over the past 20 years, feed enzyme utilisation has evolved – and so has Alltech's approach to the subject.

NSPs and the digestibility of nutrients in poultry

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 (for example 3-5 hours). The gastrointestinal tracts (GI) of birds are 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.

However, an evaluation of the poultry diet reveals that 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 (Table 1). The concentrations and types of these fibrous polysaccharides vary among grains and can negatively alter their nutritional values. The cell-wall polysaccharides of cereals are comprised of:

- Arabinoxylans.
- Cellulose.
- Beta-glucans.
- Mannans.
- Galactans.
- Xyloglucan.
- Pectic polysaccharides.

These NSPs are subdivided into soluble and insoluble fractions. Insoluble NSPs act as a physical barrier encapsulating nutrients, while soluble NSPs increase the viscosity of digesta and also decrease its rate of passage. Both NSPs can result in reduced nutrient digestibility and absorption.

Unutilised nutrients can promote the

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Table 1. Relative NSPs (%) in feed ingredients.

Ingredients	Arabin-oxylans	Cellulose	Pectin	Beta-glucans	Oligos-accharides	Total NSP
Corn	4.3	2.0	0.9	0.3	0.8	8.3
Wheat	7.1	1.8	0.4	0.6	0.1	10.0
Sorgum	3.7	1.1	0.4	0.1	0.2	5.5
Barley	8.1	3.9	0.5	4.3	0.1	16.9
Soybean meal	0.4	5.9	9.1	0.7	9.6	25.7
Canola meal	0.3	6.1	7.1	0.8	3.7	18.0
Corn DDGS	11.7	10.7	2.7	–	0.2	25.3
Wheat DDGS	12.2	3.7	0.9	0.3	0.8	17.0

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growth of microbes in the hindgut of birds and lead to more opportunities for bacteria – including salmonella, among others – to proliferate.

It is widely accepted that dietary components can influence bacterial colonisation or disease expression. This is consistent with research in the field, during which scientists have often observed that dietary changes can 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 utilisation of nutrients with enzymes

Enzymes are proteins that serve as catalysts, naturally speeding up the rate of a chemical reaction. Digestive enzymes are naturally produced in the GI tract and help birds digest feed components. However, many feed components, including phytate and NSPs, cannot be digested by poultry because of a lack of enzymes in the GI tract.

These components are known as anti-nutritional factors, as they interfere with the digestive process. This can lead to issues, such as:

- Decreased digestibility.
- Increased feed passage.
- Poor litter quality.
- Shifts in the microbiota of the hindgut and litter.
- Diminished overall performance.

Feed enzymes can help break down those anti-nutritional factors to not only increase the nutrient availability of these components but also to diminish the negative impact of the components on the digestion and absorption of other nutrients and the microbial load in the hindgut. The increased digestibility and utilisation of nutrients can minimise the available nutrients for the growth and proliferation of microbiota – including pathogenic bacteria, such as Salmonella, E. coli and Clostridium spp. – in the hindgut.

Table 2. Layer performance overview.

Diet	Feed intake (g/lay/day)	Hen day production (%)	Feed conversion (kg/d)
1. Control corn-soy commercial nutrient level diet	4.3	2.0	0.9
2. Corn-soy diet with 0.15% less Ca and available P vs diet 1 (Low Ca & P diet) + commercial phytase	7.1	1.8	0.4
3. Low Ca & P diet + 0.02% Allzyme Spectrum	3.7	1.1	0.4
4. Low Ca & P diet with 90 kcal.kg less ME compared to diet 1 (Low nutrient diet) + 0.02% Allzyme Spectrum	8.1	3.9	0.5
P-value	0.4	5.9	9.1

Diet	Egg weight (g)	Eggshell breaking strength (Kgf)*	Eggshell percentage
1. Control corn-soy commercial nutrient level diet	60.3	4.47	10.1
2. Corn-soy diet with 0.15% less Ca and available P vs diet 1 (Low Ca & P diet) + commercial phytase	59.2	4.48	10.2
3. Low Ca & P diet + 0.02% Allzyme Spectrum	59.5	4.52	10.2
4. Low Ca & P diet with 90 kcal.kg less ME compared to diet 1 (Low nutrient diet) + 0.02% Allzyme Spectrum	59.9	4.58	10.3
P-value	0.52	0.68	0.67

* kilograms of force

Table 3. Egg quality overview.

Phytase, carbohydrase and protease are typically considered the most common feed enzymes in the animal feed industry. Each of these three feed enzyme categories serves a specific role and function in the animal that ultimately benefits producers. However, certain enzymes can only react with certain substrates.

For example:

- Carbohydrases break down NSPs and fibre to increase the digestibility of carbohydrates in feed, thereby increasing the amount of nutrients an animal can use for energy. 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 increase the digestibility of proteins by breaking apart the proteins that bind starch within feed ingredients or some denatured proteins.
- Phytases increase the utilisation of phosphorus in the feed by increasing the digestibility of phytate in the plant-based components of feed. The excretion of phosphorus in the manure can be decreased also to favour the environmental impact for poultry producers.

Get the most out of the diet with a unique technology

The diet composition, NSP diversity and variability will 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.

One feed enzyme that has been shown to enhance the digestibility of poultry feed ingredients is Allzyme Spectrum from Alltech.

Allzyme Spectrum is a new-generation multi-enzyme complex that maximises nutrient utilisation and digestibility by breaking down the problematic substrates typically found in a poultry diet, such as NSPs and phytic acid. Allzyme Spectrum has illustrated a proven efficacy in laboratory research, university trials and commercial settings.

This extensive work has shown that Allzyme Spectrum can save 90 calories per kilogram of feed in non-organic poultry diets.

This efficiency gain provides flexibility in reformulation, helping producers save money and optimise animal performance.

Additionally, studies of Allzyme Spectrum in layer diets have shown that when enzymes were provided, there were no differences in feed intake, hen day production or feed conversion, despite reduced nutrient inputs compared to the control diet (Table 2).

On top of these benefits, the layers fed a commercial diet or diets containing reduced levels of nutrients with enzymes did not produce eggs of a different weight, a different eggshell-breaking strength or a different eggshell percentage (Table 3).

The enzymes in poultry 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 create more 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, thereby 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. ■