A holistic approach to animal health and nutrition: From feed issues to intestinal permeability – A conversation in Berlin

Recently, The Poultry Site's Sarah Mikesell interviewed Predrag Persak, EW Nutrition's Regional Technical Manager for Northern Europe. The conversation covered topics as wide as sustainability and challenges in poultry production, and as narrow as intestinal permeability. Thanks to The Poultry Site for the great talk!

Watch the video

Sarah Mikesell, The Poultry Site: Hi, this is Sarah Mikesell with *The Poultry Site*, and today we are here with Predrag Peršak. He is the Regional Technical Manager for Northern Europe with EW Nutrition. Thanks for being with us today, Predrag.

Predrag Peršak, EW Nutrition: Nice to be here, Sarah. Thank you for inviting me.

SM: Very good. It's nice to visit with you. And today, Predrag and I are in Berlin, Germany, at an exclusive event for the poultry industry called *Producing for the Future*, which is sponsored by EW Nutrition. You are one of our speakers today, Predrag, so I'm going to ask you just a few questions to let everybody know a little bit about your presentation.

You've described animal nutrition as "never boring and never finished." What makes this field so dynamic and constantly evolving for you?

PP: I've been in animal nutrition for about 25 years. And in those 25 years, I would say that not even half a year passed without something extraordinary happening. From genetics to animal husbandry, especially here in Europe, we also have a lot of pressure from consumers and slaughterhouses to adapt production to the needs of the customers.

Sustainability, sourcing raw materials, and the variety of raw materials available in Europe – and the constant development of new ones – make life for an animal nutritionist very, very interesting. It's also very challenging, and through these challenges you learn a lot.

So, applying what we learned 20 years ago is simply not enough anymore. For someone who wants to be challenged every day with new things, this is definitely the right industry to be in – especially now.

SM: Excellent. Can you explain your holistic approach to animal nutrition and how considering multiple factors benefits practical applications on farms?

PP: The concept of a holistic approach in animal nutrition is not new. But for me – being both a veterinarian and a nutritionist – it means having deeper insight into the animal itself, into all the metabolic processes, and also into the external influences: husbandry, genetics, diseases, and management. Looking at how all of these interact, we can only really solve problems by looking at the animal as a whole system.

The same applies to feed production. You cannot look at a feed mill as just one compartment. You have to look at sourcing raw materials, their quality, how they are processed – milling, pelleting, and other technologies – and then see how that feed performs on the farm.

So, a holistic approach can be applied both from the animal perspective and from the feed production perspective, across all steps and processes. This is something we use and promote daily in our work with customers.

SM: Very good. You've worked with unconventional protein and fiber sources. We're hearing a lot more about that recently. What are those, and what potential do they bring to animal nutrition?

PP: When I talk about unconventional protein and fiber sources, we need to remember that the global feed production scene is very diverse. What applies in the U.S. or Brazil does not necessarily apply in Europe or the Far East.

Here in Europe, we try to use not by-products but co-products of food production. For example, different fractions of rapeseed or sunflower meal, which are widely produced in Europe but not often used by mainstream nutritionists due to certain limitations. By finding the right processing methods and combining them with technologies, we can make these unconventional materials usable in mainstream nutrition.

The same goes for fiber sources. Both fermentable and structural fibers are increasingly important for intestinal and digestive development, as well as for overall animal health. So, processing fibers in ways that maximize usability while minimizing negative effects is a big part of my work.

SM: From a cost standpoint for producers, are those lower-cost inputs, or just alternatives they need to look at?

PP: In Germany we have a perfect expression for this: "yes and no." There is always pressure on price, especially in poultry, because food must be accessible to everyone. But at the same time, food must not harm the environment or human health, and we should use all resources not fit for humans but still usable for animals.

So, it's not only about cost – about availability and sustainability. Working with just two, three, or five raw materials for a long time is not the way forward. The way forward is to think of everything that can be used properly, for the benefit of the animals, and ultimately to produce enough food for the world.

Also, using locally available products is important. Feed production is very diverse around the world—raw materials in Southeast Asia differ completely from those in Europe, Brazil, or the U.S. Using technologies to enable the use of locally produced by-products makes production not only sustainable, but also economically viable for local communities. That's really the core of the feed industry: using what is produced locally.

SM: Interesting. Very cool. How does your interdisciplinary work across poultry, pigs, and ruminants give you unique insights that might be missed with a narrower focus?

PP: I come from a small feed mill in a small country, Croatia. There, you don't have deep specialization by species or even by category, as you find in larger markets. Specialization has its advantages, but it can also limit creativity and "outside-the-box" thinking.

By working with ruminants, I learned about fermentation processes – knowledge that can be applied to pigs and even to poultry. For example, fermentation can reduce anti-nutritional factors, allowing higher inclusion levels of certain raw materials in poultry diets.

With pigs, fermentation of fibers – especially in piglets – is crucial, and some of that knowledge could be applied to turkeys, where we still face health issues.

So, working across species demands a lot – it leaves little time for other things – but it opens up unique perspectives and cross-species applications that benefit the entire livestock industry.

SM: I was talking with someone yesterday about mycotoxins – there's a lot of research in pigs but less in poultry. That's kind of what you're talking about, right? Applying knowledge across species?

PP: Absolutely. We're focused now on poultry, but we can learn from poultry too – not only about feeding but also about farm management, biosecurity, and more. These lessons can also apply to pigs or ruminants.

It's all holistic – you cannot solve everything with nutrition alone. It's always a package.

SM: You presented today about the importance of intestinal permeability. Why is it important, and how can understanding it impact animal health and performance outcomes?

PP: Intestinal permeability is one of the key features we use to describe gut health. Personally, I'm very practical. For 20 years we've talked about "gut health," but the real question for veterinarians and nutritionists is: what do we actually do with that knowledge?

In my presentation, I explained intestinal permeability as a "point of no return" in gut health. When leaky gut develops, everything else can deteriorate – faster or slower – but it won't return to normal without intervention.

By comparing how different stressors or pathogens impact intestinal permeability, we can better understand severity and decide where to focus. Nutritionists already pay attention to thousands of factors, but we need to identify the most impactful ones. That was my key message: focus on the most important drivers.

SM: And leaky gut has really become something the whole industry is talking about, right? I've even seen it in human health – my doctor has posters about it.

PP: Exactly. Across cows, pigs, and poultry, leaky gut is getting a lot of attention. It's a physiological or pathophysiological feature that marks the point of no return.

We can talk about dysbiosis and all the causes, but once you reach leaky gut, you understand where intervention is needed. And it's not just hype. For example, recently *Nature* published research showing certain types of human bone marrow conditions are linked to leaky gut and microbial influence on blood processes.

So, this is not a passing trend. It's fundamental. And once we solve one issue, another door opens. That's why this industry is never boring.

SM: Very good. Well, thank you for all the information today, Predrag.

PP: Thank you, Sarah. It was a pleasure to talk with you.

Watch the video on The Poultry Site.

Optimizing the Use of DDGS in Poultry Feeds with Xylanase

Author: Ajay Bhoyar, Sr. Global Technical Manager, EW Nutrition

As the poultry industry seeks economical and nutritious feed ingredients, distillers' dried grains with solubles (DDGS), a co-product of grain-based ethanol production, presents a valuable option providing beneficial protein, energy, water-soluble vitamins, xanthophylls, and linoleic acid. However, the inherent variability in DDGS nutrient composition and high fiber content can pose challenges for consistent inclusion in poultry feeds. The strategic use of feed enzymes has become a significant area of focus to overcome these limitations and further enhance the nutritional value of DDGS in poultry diets. This article will explore the optimization of DDGS utilization in poultry feeds by emphasizing the inclusion of xylanase enzyme that can efficiently degrade the insoluble arabinoxylans. By understanding the factors affecting DDGS quality and strategically employing xylanase, poultry producers can potentially achieve higher inclusion rates of this readily available byproduct, aiming to reduce feed costs while maintaining or even improving production performance and overall health.

Price competitiveness of DDGS

The price of DDGS relative to other feed ingredients, primarily corn and soybean meal, is a significant factor in its global utilization. DDGS often partially replaces these traditional energy (corn) and protein (soybean meal) sources in animal feeds, leading to significant diet cost savings for poultry producers. DDGS contains a high amount of a combination of energy, amino acids, and phosphorus. However, it is usually undervalued as its price is mainly determined based on the prevailing prices of corn and soybean meal.

Variability in the nutritional quality of DDGS

The nutrient composition of DDGS varies based on the starting grain, ethanol production methods, and drying processes. Generally, DDGS contains high levels of protein, fiber, and minerals, with varying amounts of fat and starch depending on the type of grain used and how it is processed. DDGS has a reputation for having variable nutrient composition, protein quality, and a high content of mycotoxins (Stein et al., 2006; Pedersen et al., 2007; Anderson et al., 2012). High quantities of DDGS in feed increase dietary fiber, adversely affecting nutrient digestibility.

The variations in production methods lead to significant differences in the following nutritional components of DDGS:

Crude Fat: This is one of the most variable components, ranging from 5 to 9 percent in reduced-oil DDGS and greater than 10 percent in traditional high-oil DDGS.

Energy: The apparent metabolizable energy (AMEn) for poultry varies among DDGS sources. Fiber digestibility and the digestibility of the extracted oil also contribute to this variability. The high temperatures during the drying stage of DDGS production accelerate lipid peroxidation, forming breakdown products from the fats. This peroxidation contributes to the changes and variability observed in the fat component of DDGS and is a factor that can affect nutrient digestibility and overall energy value.

Crude Protein and Amino Acids (especially Lysine): While crude protein content might not always increase inversely with fat reduction, the digestibility of amino acids, especially lysine, can be affected by drying temperatures. Lysine digestibility of DDGS is a primary concern of poultry nutritionists due to the susceptibility of this amino acid to Maillard reactions during the drying process of DDGS, which can reduce both the concentration and digestibility of lysine (Almeida et al. 2013). Prediction equations have been developed to accurately estimate actual AMEn and standardized ileal digestible amino acid content of DDGS sources based on chemical composition.

Phosphorus: The phosphorus content can vary depending on the amount of Condensed Distiller's Solubles (CDS) added. The bioavailability of phosphorus can also be influenced by processing. The phosphorus content in the corn DDGS may vary from 0.69 to 0.98 % (Olukosi and Adebiyi, 2013).

Fiber: The neutral detergent fiber (NDF) content is another variable component. Differences in processing conditions among ethanol plants can lead to variations in fiber digestibility.

Table 1. Variation in composition of corn DDGS sources (dry matter basis; adapted from (Pederson et al., 2014)

Analyte	Average	Range
Moisture %	8.7	6.5 – 12.5
Crude protein %	31.4	27.1 – 36.4
Crude fiber %	7.7	6.4 – 9.5
Ether Extract %	9.1	6.5 – 11.8
NDF %	35.1	30.2 – 39.7
ADF %	10.1	8.9 – 11.9

Nonstarch Polysaccharides (NSP) in DDGS

Non-starch polysaccharides (NSP) are a significant component of DDGS. The NSP profile of DDGS is crucial for understanding its digestibility and energy content. The corn DDGS has a complex fiber structure that may limit its digestibility in swine and poultry. NSPs in corn DDGS represent 25-34% of its composition, primarily insoluble (Pedersen et al. 2014). The complexity of the fiber structure in corn DDGS makes it more challenging to degrade with enzymes than wheat DDGS. Therefore, while including DDGS in the poultry feeds, choosing an exogenous xylanase enzyme that is highly efficient in breaking down both soluble and insoluble arabinoxylans is essential for maximum energy utilization.

Use of xylanase in DDGS diets for poultry

Supplementing exogenous enzymes in swine and poultry diets have numerous potential benefits including: reduction of digesta viscosity to enhance lipid and protein digestion; increase the metabolizable energy content of the diet; increase feed intake, growth rate and feed conversion; decreased size and alter the microbial population of the gastrointestinal tract; reduce water consumption and water content of excreta in poultry; reduce the amount of excreta as well as ammonia, nitrogen and phosphorus content (Khattak et al., 2006). The selection of a specific enzyme must be based on the type and availability of the target substrate in the diet.

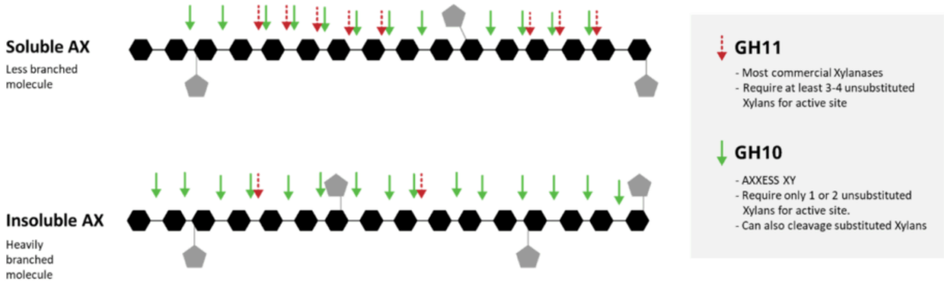
The improved energy utilization of DDGS in poultry can be achieved through the enzymatic degradation of fiber (NSP). Nonstarch polysaccharides within DDGS exist in matrices with starch and protein, so NSP degradation via exogenous enzymes can also release other nutrients for subsequent digestion and absorption (Jha et al. 2015).

The cell wall matrix in corn DDGS is more complex. Moreover, the most readily degradable arabinoxylan for the fiber-degrading enzymes is modified during DDGS production (Pedersen et al. 2014). Many studies reported a greater branch density and complexity of corn arabinoxylan than wheat (Bedford, 1995; Saulnier et al.,1995a; Jilek and Bunzel, 2013; Yang et al., 2013). These observations indicate that the fiber-degrading enzymes applied for the degradation of corn DDGS need to be targeted towards highly complex substrates. This calls for selecting xylanase, which effectively breaks down the insoluble arabinoxylans in diets.

Axxess XY: Highly effective xylanase in breaking down soluble and insoluble arabinoxylans

A bacterial GH10 family xylanase, like Axxess XY, is more beneficial in animal production due to their efficient mechanism of action, broader substrate specificity, and better thermostability. Generally, the GH10 xylanases exhibit broader substrate specificity and can efficiently hydrolyze various forms of xylan, including soluble and insoluble substrates. GH10 xylanases exhibit higher catalytic versatility and can catalyze the cleavage of the xylan backbone at the non-reducing side of substituted xylose residues, whereas GH11 enzymes require unsubstituted regions of the xylan backbone (Collins et al., 2005; Chakdar et al., 2016).

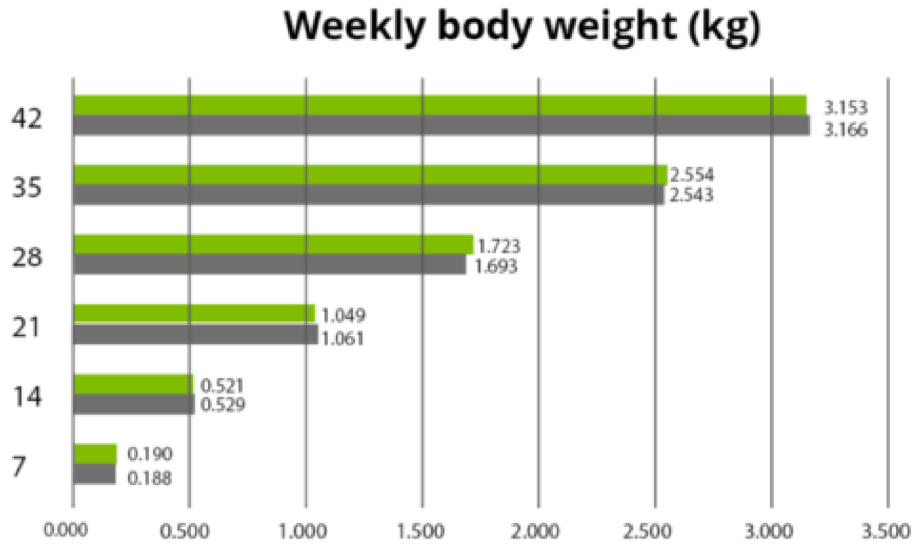
Fig.1. Activity of a bacterial GH10 xylanase against soluble and insoluble arabinoxylans

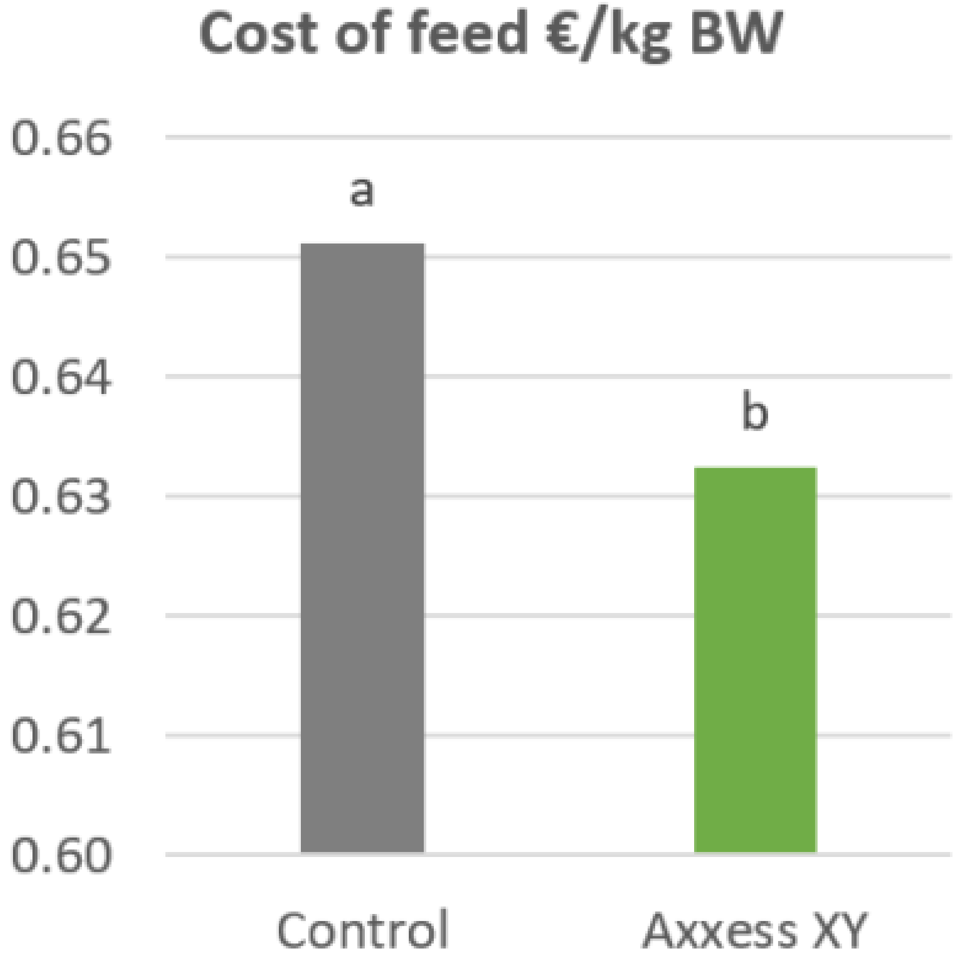


Axxess XY facilitates DDGS use and reduces the cost of broiler production.

Including xylanase enzyme, which is highly effective in breaking down soluble and insoluble arabinoxylans in poultry feeds, can reduce feed costs, allowing higher inclusion of DDGS while maintaining the bird's commercial performance.

In a recently conducted 42-day trial at a commercial farm, Axxess XY maintained broiler performance with a 100 kcal/kg reduction in metabolizable energy and 8% use of Corn DDGS in a corn-SBM based diet (Figure 2). This significantly reduced feed cost/kg body weight.





Incorporating DDGS into poultry diets presents a sustainable and cost-effective solution, but its full potential is often limited by variability in nutrient composition and high fiber content. Xylanase enzymes, particularly those in the GH10 family like Axxess XY, can overcome these barriers by breaking down complex arabinoxylans and unlocking inaccessible nutrients. With proven benefits in energy utilization, nutrient digestibility, and overall production efficiency, xylanase inclusion emerges as a strategic approach to optimize DDGS usage, ultimately supporting economic and environmental sustainability goals in poultry production.

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Consequences of genetic improvements and nutrient quality on production performance in swine

Conference Report

Achieving high performance and superior meat quality with preferably low investment – and here, we speak about feed costs, which account for up to 70% of the total costs – is a considerable challenge for pig producers. The following will focus on the effects of genetic enhancements and nutrient quality on overall pig performance.

Effect of body weight and gender on protein deposition

Based on Schothorst Feed Research recommendations for tailoring nutritional strategies to enhance feed efficiency and overall productivity, the following facts must be considered:

- Castrates, boars, and gilts have significantly different nutritional requirements due to variations in growth rates, body composition, and hormonal influences. For instance, testosterone significantly impacts muscle development and protein metabolism, increasing muscle mass in males. In contrast, ovarian hormones may inhibit muscle protein synthesis in females, contributing to differences in overall protein deposition. Boars, therefore, require higher protein levels to support muscle growth. Castrates typically have a higher FCR compared to gilts and boars due to higher feed intake. Split-sex feeding allows for diet adjustments to optimize growth rates and reduce feed costs per kilogram gained.
- Different body weight ranges: because puberty is delayed in modern genetics, we can produce heavier pigs without compromising carcass quality. Given that a finisher pig with 80-120 kg bodyweight consumes about half of the total feed of that pig, Dr. Fledderus concluded that extra profit could be realized with an extra feed phase diet for heavy pigs. Implementing multiple finisher diets can help reduce feed costs by allowing for lower nutrient concentrations, such as reducing the net energy and standardized ileal digestible lysine in later phases, without compromising performance.

Decision-making according to feedstuff prices

Least cost formulation is commonly used by nutritionists to formulate feeds for the lowest costs possible while meeting all nutrient requirements and feedstuff restrictions at the actual market prices of feedstuffs. However, diet optimization is more complex. The real question is, "How do you formulate diets for the lowest cost per kilogram of body weight gain?" You must always consider your specific situation, as economic results vary greatly and depend mainly on the prices of pork and feed and pig growth performance (e.g., feed efficiency, slaughter weight, and lean percentage).

How can you optimize your feeding strategy? Reducing net energy (NE) value will result in more fiber entering the diet. This makes sense if fiber by-products are cheaper than cereals. In contrast, an increase in the NE value will increase the inclusion of high-quality proteins and synthetic amino acids. It will use more energy from fat and less from carbohydrates.

The effects of diet composition on meat quality and fat composition also need to be considered.

How can nutrition improve meat quality?

Nutritional strategies not only improve the sensory attributes of pork but also enhance its shelf life, ultimately leading to higher consumer satisfaction and better marketability. Some of the factors Dr Fledderus considered included:

Improving fat quality

The source of dietary fat significantly impacts the quality of pork fat. Saturated fats tend to produce firmer fat, while unsaturated fats can lead to softer, less stable fat deposits. Diets high in unsaturated fats are more prone to lipid oxidation, negatively affecting shelf life and overall meat quality. The deposition of polyunsaturated fatty acids is only from dietary fat. Saturated fats in pork, partly originates from dietary fat and are also synthesized de novo. So, the amount of polyunsaturated fatty acids in pork depends on the content and composition of dietary fat, which can negatively affect the shelf life and perception of pork meat.

The iodine value (IV) is a measure of the degree of unsaturation in fats. A higher IV indicates a higher proportion of unsaturated fatty acids, leading to softer fat. Pork fat with an IV lower than 70 is considered high quality, as it tends to be firmer and more desirable for processing.

As per the American Oil Chemists Society, IV is calculated as:

$$IV = [C16:1] \times 0.95 + [C18:1] \times 0.86 + [C18:2] \times 1.732 + [C18:3] \times 2.616 + [C20:1] \times 0.785 + [C22:1] \times 0.723$$

(brackets indicate concentration (%) of C16:1 palmitoleic acid, C18:1 oleic acid, C18:2 linoleic acid, C18:3□-linoleic acid, C20:1 eicosenoic acid, C22:1 erucic acid per crude fat)

Implications

Dr. Fledderus concluded that the pigs' nutritional requirements are dynamic and influenced by factors such as required meat and fat quality, heat stress, slaughter weight, and genetic developments. Tailoring diets based on gender and body weight is crucial for optimizing protein deposition. Accurate information is essential to formulate diets that achieve optimum economic results, not just the least cost.

Continuous monitoring of feedstuff prices and nutritional content allows for timely adjustments in diet formulations, ensuring that producers capitalize on cost-effective ingredients while maintaining nutritional quality.

EW Nutrition's Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Jan Fledderus, Product Manager and Consultant at the S&C team at Schothorst Feed Research, with a strong focus on continuously improving the price/quality ratio of the diets for a competitive pig sector and one of the founders of the Advanced Feed Package, was a reputable guest speaker in these events.

Recent advances in energy evaluation in pigs

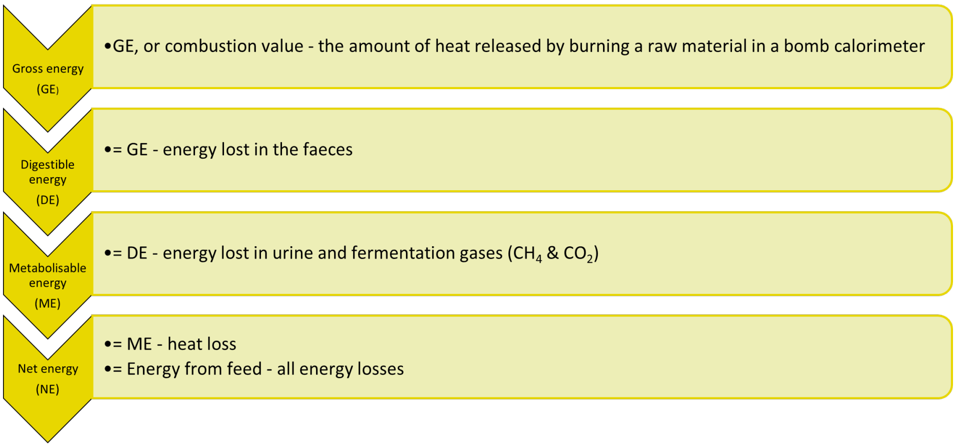
Conference Report

During the recent EW Nutrition Swine Academies in Ho Chi Minh City and Bangkok, Dr. Jan Fledderus, Product Manager and Consultant at Schothorst Feed Research, discussed that much money is involved in a correct energy evaluation system. “Net energy is 70% of feed costs, and feed is about 70% of total costs.” Therefore, an accurate energy evaluation system is important as it will give:

- Flexibility to use different raw materials
- Reduction of formulation costs
- Best prediction of pig performance
- Match the available dietary energy requirement of the feed to the pig’s requirement

Energy evaluation systems for pigs

The energy value of a raw material or complete feed can be expressed using different energy evaluation systems. Net energy (NE) in pigs refers to the amount of energy available for maintenance and production after accounting for energy losses during digestion, metabolism, and heat production. It is a crucial concept in swine nutrition as it provides a more accurate measure of the energy value of feed ingredients compared to other systems like digestible energy (DE) and metabolizable energy (ME). Diets formulated using NE are lower in crude protein than those using DE or ME because the heat lost during catabolism and excretion of excess nitrogen is considered in the NE system.



Effect of energy

Energy is derived from three nutrients: lipids (fats and oils), carbohydrates, and proteins. Using NE values instead of DE or ME values can lead to changes in ingredient ranking when formulating diets. For example:

- Ingredients high in fat or starch may be undervalued in DE systems but receive appropriate recognition in NE evaluations.
- Conversely, protein-rich or fibrous ingredients may be favored in DE systems.

Table 1: Energy values (kcal/kg) of nutrients

Nutrient	Energy	Starch	Protein	Fat
Gross energy	GE	4,486 (100)	5,489 (122)	9,283 (207)
Digestible energy	DE	4,176 (100)	4,916 (118)	8,424 (202)
Metabolizable energy	ME	4,176 (100)	4,295 (103)	8,424 (202)
Net energy	NE	3,436 (100)	2,434 (71)	7,517 (219)
Heat production (kcal/kg)		740	1,861	907
Heat production (% of NE)		22%	76%	12%

Calculation of net energy

Net energy (kcal/kg dry matter) is calculated as:
= 2,577 x digestible crude protein
+ 8,615 x digestible crude fat
+ 3,269 x ileal digestible starch
+ 2,959 x ileal digestible sugars
+ 2,291x fermentable carbohydrates

Factors affecting nutrient digestibility

This raises the obvious question, ‘What is the nutrient digestibility of your raw materials?’ Dr. Fledderus considered several factors that affect nutrient digestibility and, therefore, NE values, including

- **Age:** as pigs grow, their digestive systems mature, leading to improved nutrient digestibility. Younger pigs typically have lower digestibility rates due to an underdeveloped gastrointestinal tract. Older pigs typically exhibit higher digestibility, especially for fibrous diets, as their digestive systems become more efficient at breaking down complex nutrients.
- **Physiological stage:** the digestibility of diets can vary between pregnant and lactating sows. Digestibility is generally higher for gestating sows; lactating sows may have slightly lower digestibility due to higher feed intake. Also, lactating sows do not consume enough feed to meet their energy needs, leading to body tissue mobilization and weight loss.
- **Feed intake and number of meals per day:** Increased feed intake and more frequent meals can enhance nutrient digestibility. Regular feeding helps maintain gut motility and reduces the risk of digestive disturbances. Studies indicate that pigs fed multiple smaller meals exhibit better nutrient absorption than those fed larger meals less frequently.

- **Use of antibiotics and feed additives:** including exogenous enzymes and other additives can improve nutrient breakdown and overall digestibility of complex feed components, further influencing ingredient rankings within different energy evaluation systems. Antibiotics can lead to dysbiosis, negatively impacting overall gut health and digestion.
- **Feed processing:** gelatinized starch is more easily broken down by digestive enzymes, resulting in higher and faster digestibility compared to raw or unprocessed starch. This increased digestibility leads to a greater proportion of energy being absorbed in the small intestine, contributing positively to the NE value of the feed. As the particle size of feed ingredients decreases, the NE increases. While smaller particles generally improve digestibility, excessively fine grinding can lead to adverse effects such as increased risk of gastric ulcers in pigs.
- **Intestinal health:** a healthy gut is crucial for optimal nutrient absorption. Factors such as the presence of beneficial microbiota and the integrity of the intestinal barrier play significant roles in nutrient digestibility. Conditions like inflammation or dysbiosis can impair nutrient absorption and decrease overall performance.

NE system shows better the “true” energy of the diet

Dr. Fledderus concluded that the NE system offers a closer estimate of pigs’ “true” energy available for maintenance and production (growth, lactation, etc.). This leads to better ingredient rankings, reduced crude protein levels, which decreases nitrogen excretion, and enhanced nutrient utilization, contributing to more sustainable pig production practices. This aligns with increasing demands for environmentally responsible farming methods.

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Start right with your piglet nutrition

Conference Report

“A good start is half the battle” can be said if we talk about piglet rearing. For this promising start, piglets must eat solid feed as soon as possible to be prepared for weaning. Dr. Jan Fledderus, Product Manager and Consultant at the S&C team at Schothorst Feed Research, shows some nutritional measures that can be taken to keep piglets healthy and facilitate the critical phase of weaning.

Higher number of low-birth-weight pigs in larger litters

Litter size affects piglet quality. Larger litter sizes from hyperprolific sows often result in higher within-litter variation in birth weights. This variability can lead to a higher proportion of low-birth-weight piglets, which are more susceptible to health issues and have lower survival rates. Additionally, low birthweight pigs have an increased risk of mortality, and an improvement in birth weight from 1kg to 1.8 kg can result in 10 kg more body weight at slaughter.

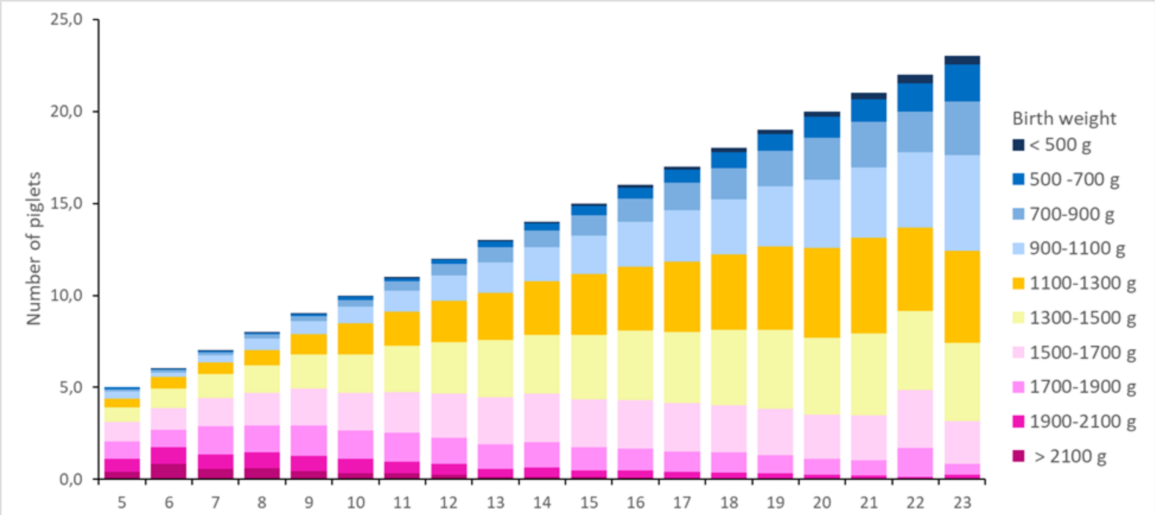


Figure 1: Effect of litter size on birth weight distribution (Schothorst Feed Research Data were collected from 2011 to 2020, based on 114,984 piglets born alive from 7,952 litters).

Implementing management practices for low-birth-weight pigs, such as split suckling, can significantly enhance nutrient intake, support immune function, and ultimately contribute to better survival rates and overall health for these vulnerable piglets.

Weaning age determines intake of creep feed

Pigs that consume creep feed before weaning restart faster to eat, have a higher feed intake, and less diarrhea after weaning. For instance, in a field trial, pigs that consumed feed 10 days before weaning had a 62% incidence of diarrhea, whereas in pigs that consumed feed only 3 days pre-weaning, diarrhea incidence increased to 86%.

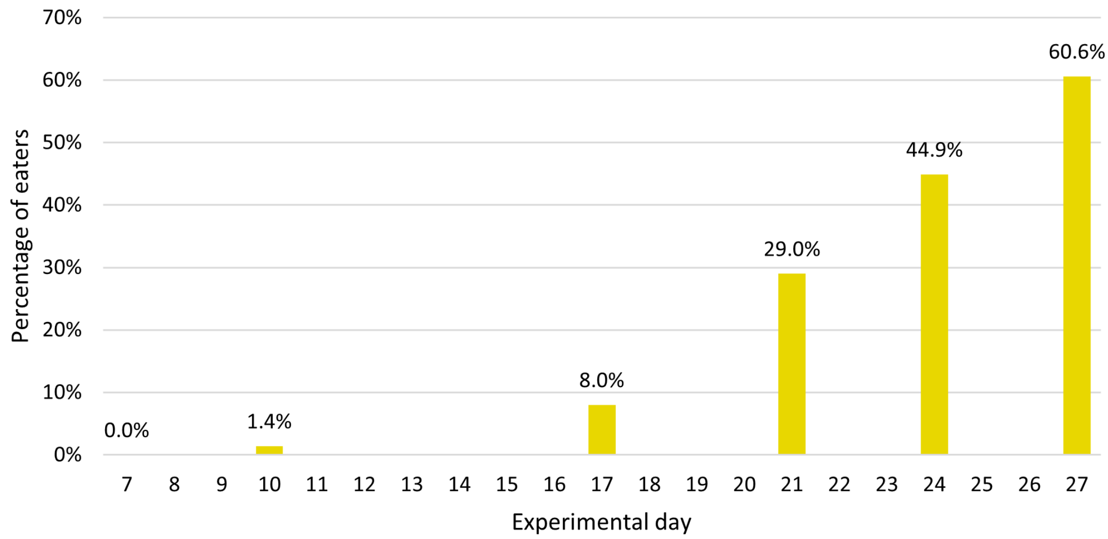


Figure 2: Influence of age on the percentage of pigs consuming creep feed

“As age is the most critical factor for a high percentage of pigs eating before weaning, there is a trend in the EU to increase the weaning age, where some farmers go to 35 days,” remarked Dr. Fledderus.

Furthermore, weaning age is positively correlated with weaning weight. Every day older at weaning improves post-weaning performance and reduces health problems.

Feed management

Creep feed for 7-10 days pre-weaning is essential, not to increase total feed intake, but to train the piglet to eat solid feed to avoid the 'post-weaning dip.' After about 15 days of age, piglets can consume more than is provided by milk alone. Dr. Fledderus strongly recommended creep feeding for at least one week before weaning. "Consuming feed before weaning will result in fewer problems with post-weaning diarrhea," he said.

In addition to creep feeding, a transition diet, from 7 days pre- and 7 days post-weaning, is advised. The composition or form of the transition diet should not be changed.

The key objective of post-weaning diets is to achieve a pH of 2-3.5 in the distal stomach. Pepsin, the primary enzyme responsible for protein digestion, is activated at a pH of around 2.0. Its activity declines significantly at a pH above 3.5, which can lead to poor protein digestion and nutrient absorption.

Fiber as a functional ingredient

Fiber was previously considered a nutritional burden or diluent, but now it is regarded as a functional ingredient. Including dietary fiber, mainly inert fiber such as rice or wheat brans, can increase the retention time of the digesta in the stomach. This extended retention allows for more prolonged contact between digestive enzymes and nutrients, facilitating improved digestion and absorption of proteins and other nutrients. Not only is pH reduced, but because more proteins are hydrolyzed to peptides, there is less undigested protein as a substrate for the growth of pathogenic bacteria and the production of toxic metabolites in the hindgut.

"Size of fiber particles also matters," said Dr. Fledderus. Coarse wheat bran particles (1,088 µm) have been shown to be more effective than finer particles (445 µm) in reducing E. coli levels in the gut. The larger particle size helps prevent E. coli from binding to the intestinal epithelium, allowing these bacteria to be excreted rather than colonizing the gut.

The understanding of dietary fiber's role in pig nutrition has evolved, with recent findings indicating that fiber can actually increase feed intake in piglets, contrary to earlier beliefs that it might decrease intake. High-fiber diets often increase feed intake as pigs compensate for lower energy density. This can help maintain growth rates when formulated correctly.

EW Nutrition's Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Jan Fledderus, Product Manager and Consultant at the S&C team at Schothorst Feed Research, one of the founders of the Advanced Feed Package and with a strong focus on continuously improving the price/quality ratio of the diets for a competitive pig sector, was a reputable guest speaker in these events.

Nutritional strategies to maximize the health and productivity of

sows

Conference Report

During lactation, the focus should be on maximizing milk production to promote litter growth while reducing weight loss of the sow, stated Dr. Jan Fledderus during the recent EW Nutrition Swine Academies in Ho Chi Minh City and Bangkok. A high body weight loss during lactation negatively affects the sow's performance in the next cycle and impairs her longevity.

Milk production – 'push' or 'pull'?

"Is a sow's milk production driven by "push" – the sow is primarily responsible for milk production, or "pull" – suckling stimulates the sow to produce milk?" asked Dr. Jan Fledderus at the beginning of his presentation. The answer is that it is primarily a pull mechanism: piglets that suckle effectively and frequently can activate all compartments of the udder, leading to increased milk production. Therefore, the focus should be optimizing piglet suckling behavior (pull) to enhance milk production. This highlights the importance of piglet vitality and access to the udder in maximizing milk yield."

Modern sows are lean

Modern sows have been genetically selected for increased growth rates and leanness, which alters their body composition. This makes traditional body condition scoring (BCS) methods, which rely on subjective visual assessment and palpation of backfat thickness, less effective. This may not accurately represent a sow's true condition, especially in leaner breeds where muscle mass is more prominent than fat. Technology, such as ultrasound measurements of backfat and loin muscle depth, provide more accurate assessments of body condition and can help quantify metabolic reserves more effectively than visual scoring.

Due to their increased lean body mass, we must consider adjusted requirements for amino acids, energy, digestible phosphorus, and calcium. Their dietary crude protein and amino acid requirements have increased drastically.

Importance of high feed intake for milk production

Sows typically catabolize body fat and protein to meet the demands of milk production. Adequate feed intake helps reduce this catabolism, allowing sows to maintain body condition while supporting their piglets' nutritional needs.

Feeding about 2.5kg on the day of farrowing ensures that sows receive adequate energy to support the farrowing process and subsequent milk production. Sows that are well-fed before farrowing tend to have shorter farrowing durations due to better energy availability during labor.

A short interval between the last feed and the onset of farrowing (□3 hours) has been shown to significantly reduce the probability of both assisted farrowing and stillbirths without increasing the risk of constipation. To enhance total feed intake, feeding lactating sows at least three times a day is helpful.

Dr. Fledderus recommended a gradual increase in feed intake during lactation, then from day 12 of lactation to weaning, feeding 1% of sow's bodyweight at farrowing + 0.5 kg/piglet. For example, for a 220kg sow with 12 piglets:

(220 kg x 0.01) + (12 x 0.5 kg) = 2.2 +6 = 8.2 kg total daily feed intake

Energy source – starch versus fat

The choice between starch and fat as an energy source in sow diets has substantial implications for body composition and milk production.

Starch digestion leads to glucose release, stimulating insulin secretion from the pancreas. Insulin is essential for glucose uptake and utilization by tissues. Enhanced insulin response can help manage body weight loss by promoting nutrient storage and reducing the mobilization of the sow's body reserves.

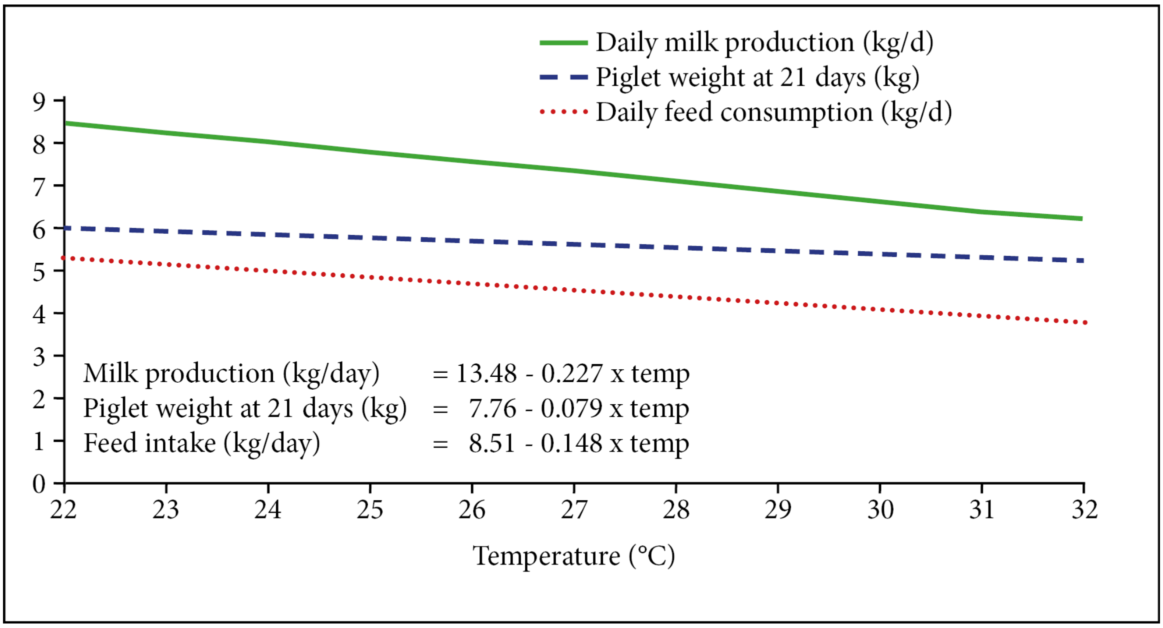
Sows fed diets with a higher fat supplementation had an increased milk fat, which is crucial for the growth and development of piglets.

Table 1: Effect of energy source (starch vs. fat) on sows' body composition and milk yield (Schothorst Feed Research)

	Diet 1	**Diet 2**	**Diet 3**
Energy value (kcal/kg)	2,290	2,290	2,290
Starch (g/kg)	300	340	380
Fat (g/kg)	80	68	55
Feed intake (kg/day)	6.7	6.7	6.8
Weight loss (kg)	15	11	10
Weight loss (kg)	3.1	2.7	2.3
Milk fat (%)	7.5	7.2	7.0
Milk fat (%)	260	280	270

Heat stress impacts performance

The optimum temperature for lactating sows is 18°C. A meta-analysis concluded that each 1°C above the thermal comfort range (from 15° to 25°C) leads to a decrease in sows' feed intake and milk production and weaning weight of piglets, as shown below.



Effect of heat stress on lactating sows (according to Ribeiro et. al., 2018 Based on 2,222 lactating sows, the duration of lactation was corrected to 21 days)

To mitigate the effects of heat stress, which reduces feed intake, it is beneficial to schedule feeding during cooler times of the day. This strategy helps maintain appetite and ensures that sows consume sufficient nutrients for milk production. Continuous access to cool, clean water can also enhance feed consumption.

Pigs produce much heat, which must be "excreted". Increased respiratory rate (>50 breaths/minute) has been shown to be an efficient parameter for evaluating the intensity of heat stress in lactating sows.

When sows resort to panting as a mechanism to dissipate heat, this rapid breathing increases the loss of carbon dioxide, resulting in respiratory alkalosis. To prevent a rise in blood pH level, HCO_3 is excreted via urine, and positively charged minerals (calcium, phosphorous, magnesium, and potassium) are needed to facilitate this excretion. However, these minerals are crucial for various physiological functions. As their loss can lead to deficiencies that affect overall health and productivity, this mineral loss must be compensated for.

Implications for management

Implementing effective nutritional strategies together with robust management practices is crucial for maximizing the health and productivity of sows. The priority is to stimulate the sow to eat more. This not only enhances milk production and litter growth but also supports the overall well-being of the sow. Regularly assessing sow performance metrics – such as body condition score, feed intake, and litter growth – can help identify areas for improvement in nutritional management.

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Dietary interventions for resilient poultry gut health in the AMR era

*by **Ajay Bhoyar**, Global Technical Manager, EW Nutrition*

Gut health is critical for profitable poultry production, as the gastrointestinal tract (GIT) plays a dual role in nutrient digestion and absorption while serving as a crucial defense against pathogens. A healthy gut enables efficient feed conversion, robust immune function, and resilience against diseases, reducing reliance on preventive and therapeutic antibiotics. Optimum gut health has become increasingly important in poultry production to combat antimicrobial resistance (AMR), a pressing global challenge threatening animal agriculture and public health.

AMR arises when bacteria develop antibiotic resistance, often due to overuse or misuse in human and animal settings. Predictive models suggest that by 2050, AMR could result in 10 million annual deaths and a 2.0%–3.5% reduction in global gross domestic production, amounting to economic losses between 60 and 100 trillion USD. In poultry, AMR compromises flock health, leading to higher mortality, reduced growth performance, and elevated treatment costs, directly impacting profitability. Additionally, resistant pathogens increase the risk of zoonotic disease transfer, posing serious food safety concerns.

Stricter regulations and rising consumer demand for antibiotic-free poultry products drive a shift toward sustainable, antibiotic-free production systems. However, A lack of understanding about strategies to replace AMU and their effectiveness under field conditions hampers change in farming practices (Afonso et al., 2024). Addressing AMR requires a holistic approach, encompassing enhanced biosecurity, innovative health-promoting strategies, and sustainable management practices. This paper explores practical dietary interventions to support poultry gut health while reducing dependency on antimicrobials, offering solutions for the long-term sustainability of poultry production.

Gut Mediated Immunity in Chickens

The gut is a critical component of the immune system, as it is the first line of defense against pathogens that enter the body through the digestive system. Chickens have a specialized immune system in the gut, known as gut-associated lymphoid tissue (GALT), which helps to identify and respond to potential pathogens. The GALT includes Peyer's patches, clusters of immune cells in the gut wall, and the gut-associated lymphocytes (GALs) found throughout the gut. These immune cells recognize and respond to pathogens that enter the gut.

The gut-mediated immune response in chickens involves several mechanisms, including activating immune cells, producing antibodies, and releasing inflammatory mediators. GALT and GALs play a crucial role in this response by identifying and responding to pathogens and activating other immune cells to help fight off the infection.

The gut microbiome is a diverse community of microorganisms that live in the gut. These microorganisms can significantly impact the immune response. Certain beneficial bacteria, for example, can help stimulate the immune response and protect the gut from pathogens.

Overall, the gut microbiome, GALT, and GALs work together to create an environment hostile to pathogens while supporting the growth and health of beneficial microorganisms.

Key Factors Affecting Poultry Gut Health

The key factors affecting broiler gut health can be summarized as follows:

1. Early gut development: Gut-associated immunity responds to early feeding and dietary nutrients and is critical for protecting against exogenous organisms during the first week of life post-hatch.
2. Feed and Water Quality: The form, type, and quality of feed provided to broilers can significantly impact their gut health. Consistently available cool and hygienic drinking water is crucial for optimum production performance.
3. Stressors: Stressful conditions, such as high environmental temperatures or poor ventilation, can lead to an imbalance in the gut microbiome and an increased risk of disease.
4. Infections and medications: Exposure to pathogens or other harmful bacteria can disrupt the gut microbiome and lead to gut health issues. A robust immune system is important for maintaining gut health, as it helps to prevent the overgrowth of harmful bacteria and promote the growth of beneficial bacteria.
5. Biosecurity: Keeping the poultry environment clean and free of pathogens is crucial for maintaining gut health, as bacteria and other pathogens can quickly spread and disrupt the gut microbiome.
6. Management practices: Best practices, including proper litter management, can help maintain gut health and prevent gut-related issues.

Dietary Interventions for Optimum Gut Health

Gut health means the absence of gastrointestinal disease, the effective digestion and absorption of feed, and a normal and well-established microbiota (Bischoff, 2011). Various dietary measures can be taken to support the healthy functioning of the GIT and host defense. Water and feed safety and quality, feeding management, the form the feed is provided in (e.g., pellets), the composition of the diet, and the use of various feed additives are all tools that can be used to support health (Smits et al., 2021).

Various gut health-supporting feed additives, including organic acids, probiotics, prebiotics, phytochemicals/essential oils, etc., in combination or alone, have been explored as an alternative to antimicrobials in animal production. There were differences in the impacts of the strategies between and within species; this highlights the absence of a ‘one-size-fits-all’ solution. Nevertheless, some options seem more promising than others, as their impacts were consistently equivalent or positive when compared with animal performance using antimicrobials (Afonso et al., 2024). Including insoluble fibers, toxin binders, exogenous enzymes, and antioxidants in the feed formulations also play a crucial role in gut health optimization, which goes beyond their primary functions to combat AMR challenges.

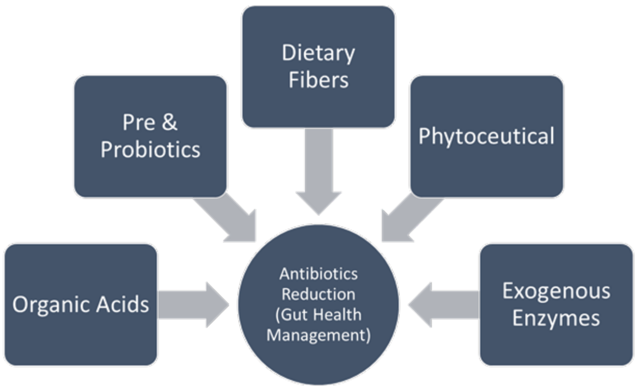


Fig. 1: Multifactorial approach to gut health management in reduced antimicrobial use

Organic Acids

The digestive process extensively includes microbial fermentation, and as a result, organic acids are commonly produced by beneficial bacteria in the crop, intestines, and ceca (Huyghebaert et al., 2010). Organic acids’ inclusion in the poultry diet can improve growth performance due to improved gut health, increased endogenous digestive enzyme secretion and activity, and nutrient digestibility. Butyrate is highly bioactive in GIT. It increases the proliferation of enterocytes, promotes mucus secretion, and may have anti-inflammatory properties (Bedford and Gong, 2018; Canani et al., 2011; Hamer et al., 2008). These effects suggest that it supports mucosal barrier function. Butyrate is becoming a commonly used ingredient in diets to promote GIT health.

Including organic acids in the feed can decontaminate feed and potentially reduce enteric pathogens in poultry. Alternately, the formaldehyde treatment of feed is highly effective at a relatively low cost (Jones, 2011; Wales, Allen, and Davies, 2010).

Organic acids like formic and citric acid are also used in poultry drinking water to lower the microbial count by lowering the water’s pH and preventing/removing biofilms in the water lines. By ensuring feed and water hygiene, producers can minimize pathogen exposure, enhance bird health, and significantly reduce their reliance on antibiotics.

Probiotics, Postbiotics, Prebiotics and Synbiotics

Probiotics and prebiotics have drawn considerable attention to optimizing gut health in animal feeds. Probiotic supplementation could have the following effects: (1) modification of the intestinal microbiota, (2) stimulation of the immune system, (3) reduction in inflammatory reactions, (4) prevention of pathogen colonization, (5) enhancement of growth performance, (6) alteration of the ileal digestibility and total tract apparent digestibility coefficient, and (7) decrease in ammonia and urea excretion (Jha et al., 2020). Certain Lactobacilli or Enterococci species may be used with newly hatched or newborn animals; single or multi-strain starter cultures can be used to steer the initial microbiota in a desired direction (Liao and Nyachoti, 2017). Apart from using probiotics in feed and drinking water, probiotic preparations can be sprayed on day-old chicks in the hatchery or immediately after placement in the brooding house. This way, the probiotic strains/beneficial bacteria gain access to the gut at the earliest possible time (early seeding). Postbiotics are bioactive compounds produced by probiotics during fermentation, such as short-chain fatty acids, peptides, and bacterial cell wall components. Unlike live probiotics, postbiotics are stable, safer, and provide consistent health benefits.

Prebiotics like mannan-oligosaccharides (MOS), inulin, and its hydrolysate (fructo-oligosaccharides: FOS) play an important role in modulating intestinal microflora and potential immune response. Prebiotics reduce pathogen colonization in poultry and promote selective stimulation of beneficial bacterial species. Synbiotics are a combination of probiotics and prebiotics. This synergistic approach offers dual benefits by promoting the growth of beneficial bacteria and directly combating pathogens.

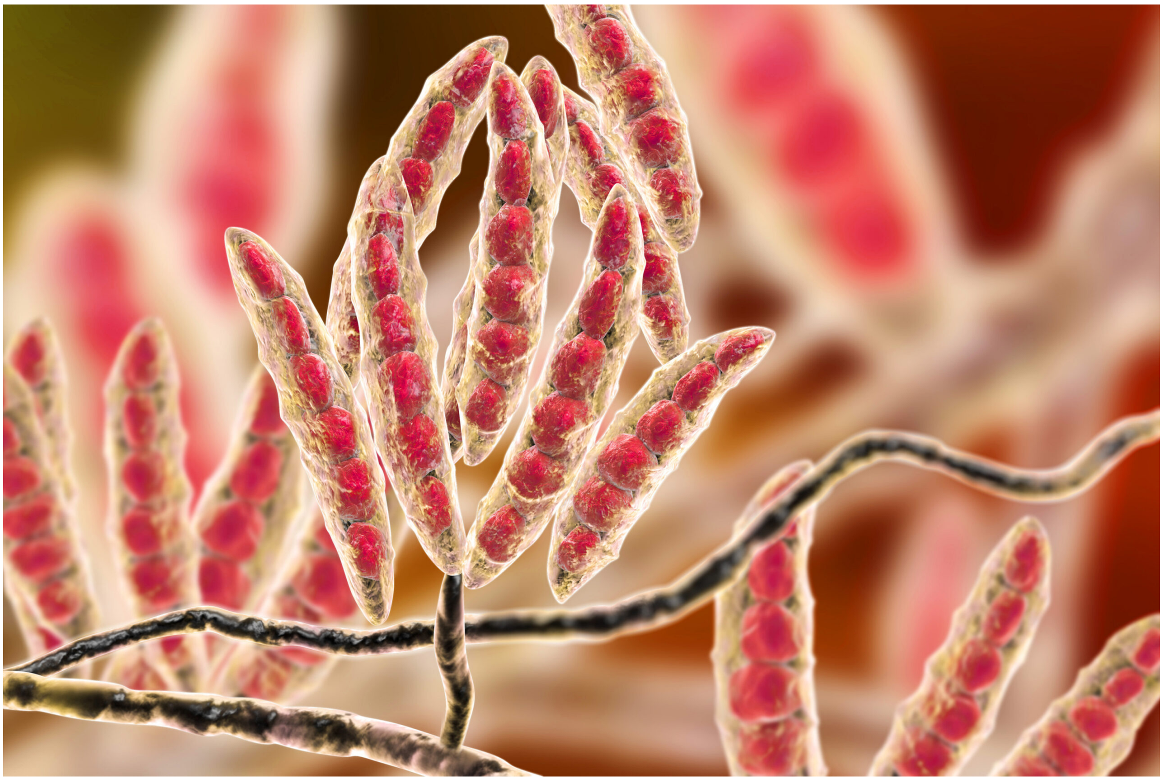
Dietary Fibers (DF)

The water-insoluble fibers are regarded as functional nutrients because of their ability to escape digestion and modulate nutrient digestion. A moderate level of insoluble fiber in poultry diets may increase chyme retention time in the upper part of the GIT, stimulating gizzard development and endogenous enzyme production, improving the digestibility of starch, lipids, and other dietary components (Mateos et al., 2012). The insoluble DF, when used in amounts between 3–5% in the diet, could have beneficial effects on intestinal development and nutrient digestibility.

Dietary fibers influence the development of the gizzard in poultry birds. A well-developed gizzard is a must for good gut health. Jiménez-Moreno & Mateos (2012) noted that coarse fiber particles are selectively retained in the gizzard, ensuring a complete grinding and a well-regulated feed flow. Secretion of digestive juices regulates GIT motility and feed intake. Including insoluble fibers in adequate amounts improves the gizzard function and stimulates HCl production in the proventriculus, thus helping control gut pathogens.

Toxin Risk Management

Mycotoxins may have a detrimental impact on the mucosal barrier function in animals (Akbari et al., 2017; Antonissen et al., 2015; Basso, Gomes and Bracarense, 2013; Pierron, Alassane-Kpembi and Oswald, 2016)**.** Mycotoxins like Aflatoxin B1, Ochratoxin A, and deoxynivalenol (DON) not only suppress immune responses but also induce inflammation and even increase susceptibility to pathogens (Yuhang et al., 2023). To avoid intestinal health problems, poultry producers need to emphasize avoiding levels of mycotoxins in feedstuffs and rancid fats that exceed recommended limits (Murugesan et al., 2015; Grenier and Applegate, 2013).



Fusarium mycotoxin

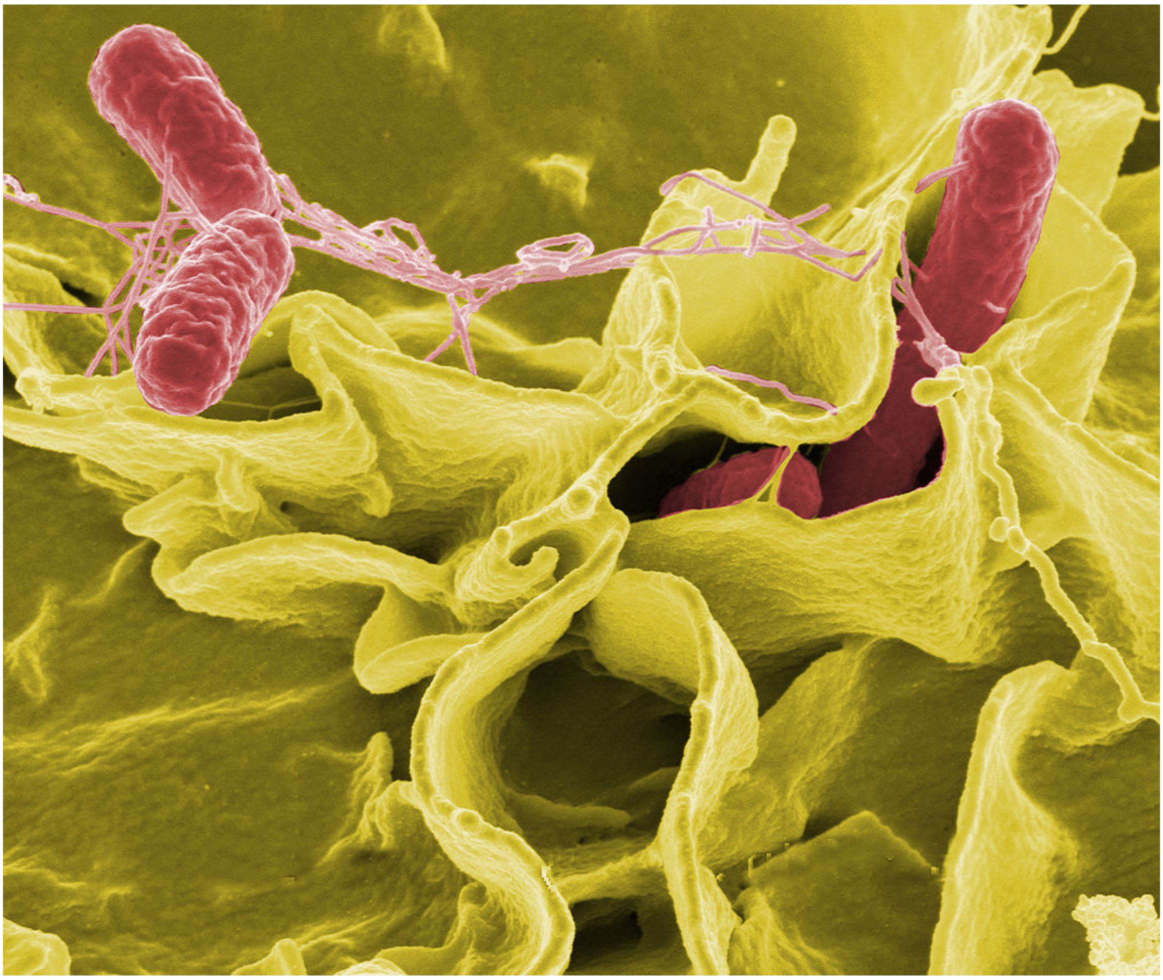
Bacterial lipopolysaccharides (LPS), also known as endotoxins, are the main components of the outer membrane of all Gram-negative bacteria and are essential for their survival. In stress situations, the intestinal barrier function is impaired, allowing the passage of endotoxins into the bloodstream. When the immune system detects LPS, inflammation sets in and results in adverse changes in gut epithelial structure and functionality. Dietary Intervention to bind these endotoxins in the GIT can help mitigate the negative impact of LPS on animals. Given this, toxin risk management with an appropriate binding agent able to control both mycotoxins and endotoxins appears to be a promising strategy for reducing their adverse effects. Further, adding antioxidants and mycotoxin binders to feed can reduce the effects of mycotoxins and peroxides and is more necessary in ABF programs (Yegani and Korver, 2008).

Essential oils/Phytomolecules

Essential oils (EOs) are important aromatic components of herbs and spices and are used as natural alternatives for replacing antibiotic growth promoters (AGPs) in poultry feed. The beneficial effects of EOs include appetite stimulation, improvement of enzyme secretion related to food digestion, and immune response activation (Krishan and Narang, 2014)

Essential oils (EOs), raw extracts from plants (flowers, leaves, roots, fruit, etc.), are an unpurified mix of different phytomolecules. The raw extract from Oregano is a mix of various phytomolecules (Terpenoids) like carvacrol, thymol and p-cymene. Whereas the phytomolecules are active ingredients of essential oils or other plant materials. Phytomolecule is clearly defined as one active compound.

These botanicals have received increased attention as possible growth performance enhancers for animals in the last decade via their beneficial influence on lipid metabolism, and antimicrobial and antioxidant properties (Botsoglou et al., 2002), ability to stimulate digestion (Hernandez et al., 2004), immune enhancing activity, and anti-inflammatory potential (Acamovic and Brooker, 2005). Many studies have been reported on supplementing poultry diets with some essential oils that enhanced weight gain, improved carcass quality, and reduced mortality rates (Williams and Losa, 2001). The use of some specific EO blends has been shown to have efficacy towards reducing the colonization and proliferation of Clostridium perfringens and controlling coccidia infection and, consequently, may help to reduce necrotic enteritis (Guo et al., 2004; Mitsch et al., 2004; Oviedo-Rondón et al., 2005, 2006a, 2010).



Salmonella

Antimicrobial properties of phytomolecules hinder the growth of potential pathogens. Thymol, eugenol, and carvacrol are structurally similar and have been proven to exert synergistic or additive antimicrobial effects when combined at lower concentrations (Bassolé and Juliani, 2012). In in-vivo studies, essential oils used either individually or in combination have shown clear growth inhibition of Clostridium perfringens and E. coli in the hindgut and ameliorated intestinal lesions and weight loss than the challenged control birds (Jamroz et al., 2006; Jerzsele et al., 2012; Mitsch et al., 2004). One well-known mechanism of antibacterial activity is linked to their hydrophobicity, which disrupts the permeability of cell membranes and cell homeostasis with the consequence of loss of cellular components, influx of other substances, or even cell death (Brenes and Roura, 2010; Solórzano-Santos and Miranda-Novales, 2012; Windisch et al., 2008; O'Bryan et al., 2015).

Apart from use in feed, the liquid phytomolecules preparations for drinking water use can prove to be beneficial in preventing and controlling losses during challenging periods of bird's life (feed change, handling, environmental stress, etc.). Liquid preparations can potentially reduce morbidity and mortality in poultry houses and thus the use of therapeutic antibiotics. Barrios et al. (2021) suggested that commercial blends of phytomolecule preparations may ameliorate the impact of Necrotic Enteritis on broilers. Further, they hypothesized that the effects of liquid preparation via drinking water were particularly important in improving overall mortality.

In modern, intensive poultry production, the imminent threat of resistant Eimeria looms large, posing a significant challenge to the sustainability of broiler operations. Eimeria spp., capable of developing resistance to traditional anticoccidial drugs, has become a pressing global issue for poultry operators. The resistance of Eimeria to traditional drugs, coupled with concerns over drug residue, has necessitated a shift towards natural, safe, and effective alternatives. It was found that if a drug to which the parasite has developed resistance is withdrawn from use for some time or combined with another effective drug, the sensitivity to that drug may return (Chapman, 1997).

Several phytogenic compounds, including saponins, tannins, essential oils, flavonoids, alkaloids, and lectins, have been the subject of rigorous study for their anticoccidial properties. Among these, saponins and tannins in specific plants have emerged as powerful tools in the fight against these resilient protozoa. Botanicals and natural identical compounds are well renowned for their antimicrobial and antiparasitic activity so that they can represent a valuable tool against Eimeria (Cobaxin-Cardenas, 2016). The mechanisms of action of these molecules include degradation of the cell wall, cytoplasm damage, ion loss with reduction of proton motive force, and induction of oxidative stress, which leads to inhibition of invasion and impairment of Eimeria spp. development (Abbas et al., 2012; Nazzaro et al., 2013). Natural anticoccidial products may provide a novel approach to controlling coccidiosis while meeting the urgent need for control due to the increasing emergence of drug-resistant parasite strains in commercial poultry production (Allen and Fetterer, 2002).

Role of Feed Enzymes Beyond Feed Cost Reduction

Feed enzymes have traditionally been associated with improving feed efficiency and reducing feed costs by enhancing nutrient digestibility. However, their role can extend well beyond economic benefits, profoundly impacting gut health and supporting reduced antimicrobial use in poultry production. Exogenous enzymes reduce microbial proliferation by reducing the undigestible components of feed, the viscosity of digesta, and the irritation to the gut mucosa that causes inflammation. Enzymes also generate metabolites that promote microbial diversity which help to maintain gut ecosystems that are more stable and more likely to inhibit pathogen proliferation (Bedford, 1995; Kiarie et al., 2013).

High dietary levels of non-starch polysaccharides (NSPs) can increase the viscosity of digesta. This leads to an increase in the retention time of the digesta, slows down the nutrient digestion and absorption rate, and may lead to an undesired increase in bacterial activity in the small intestine (Langhout et al., 2000; Smits et al., 1997). Further the mucosal barrier function may also be adversely affected. To solve this problem, exogenous enzymes, such as arabinoxylanase and/ or ß-glucanase, are included in feed to degrade viscous fibre structures (Bedford, 2000). The use of xylanase and ß-glucanase may also cause oligosaccharides and sugars to be released, of which certain, for example, arabinoxylan oligosaccharides, may have prebiotic properties (De Maesschalck et al., 2015; Niewold et al., 2012).

New generation xylanases coming from family GH-10 are known to effectively breakdown both soluble and insoluble arabinoxylans into a good mixture of smaller fractions of arabino-xylo-oligosaccharides (AXOS) and xylo-oligosaccharides (XOS), which exert a prebiotic effect in the GIT. Awati et.al. (2023) observed that a novel GH10 xylanase contributed to positive microbial shift and mitigated the anti-nutritional gut-damaging effects of higher fiber content in the feed. With a substantial understanding of the mode of action and technological development in enzyme technology, nutritionists can reliably consider new-generation xylanases for gut health optimization in their antibiotic reduction strategy.

Conclusions

The challenge of mitigating antimicrobial resistance (AMR) in poultry production necessitates a multidimensional approach, with gut health at its core. Dietary interventions, such as organic acids, probiotics, prebiotics, phytomolecules, toxin binders, and feed enzymes, promote gut resilience, enhance immune responses, and reduce reliance on antimicrobials. These strategies not only support the health and productivity of poultry but also address critical global issues of AMR and food safety.

While no single solution fits all circumstances, integrating these dietary tools with robust biosecurity measures, sound management practices, and continued research on species-specific and field-applicable strategies can pave the way for sustainable, antibiotic-free poultry production. The transition to such systems aligns with regulatory requirements and consumer expectations while contributing to global efforts against AMR.

Ultimately, embracing holistic and innovative dietary strategies ensures a resilient gastrointestinal environment, safeguarding poultry health and productivity while protecting public health and environmental sustainability for future generations.

References: The references can be made available upon request to the author.

Health management of nursery piglets through nutrition

Conference Report

An optimized gut function is essential for pigs’ overall health and performance. When managed correctly, gut health can significantly enhance growth, immunity, and productivity. However, if gut health is compromised, it can lead to lifetime negative impacts on a pig’s performance.

Early feed intake enhances GIT development

Dr. Edwards emphasized that good health and performance in the nursery are closely linked to maintaining feed intake, which is essential for developing stomach capacity and function. A larger stomach capacity increases the exposure to digestive enzymes and prolongs stomach dwell time.

Acid output takes time to develop and develops in response to substrate. It directly influences stomach pH and is closely related to pepsin output, which, on its part, influences protein digestibility and the risk of diarrhea.

Protein and immunity

Protein is a double-edged sword, warned Dr. Edwards:

- Excess or undigested protein can create inflammation and oxidative stress in the body. This occurs when the metabolism of surplus protein leads to the production of reactive oxygen species (ROS), which can damage cells and tissues, further exacerbating inflammatory responses. Chronic inflammation may impair immune responses, making pigs more susceptible to infections and diseases.
- On the other hand, a deficiency in amino acids can limit immune response. Amino acids do more than build muscle – they are critical for synthesizing antibodies and other immune-related proteins. Without adequate levels, pigs may struggle to mount effective immune responses, increasing their vulnerability to pathogens.

Table 1: Effects of amino acids on pig gut health and functions (Yang & Liao, 2019)

Amino acid	Functions
Glutamine/glutamate	• Metabolic fuel for rapidly dividing cells, including lymphocytes, enterocytes • maintains or enhances villus height/crypt depth • enhances microbial diversity • is utilized to synthesize GSH and protect against oxidative stress • stimulates both innate and adaptive immunity
Arginine	• promotes intestinal healing and reverses intestinal dysfunction • has anti-inflammatory effects
Cysteine	• is utilized to synthesize GSH (antioxidant) • utilized to synthesize taurine (antioxidant/cell membrane stabilizer) • utilized for mucin synthesis (physical protection)
Threonine	• utilized for mucin synthesis • important component of immunoglobulins • enhances microbial diversity
Glycine	• anti-inflammatory effects • utilized to synthesize GSH (antioxidant)
Methionine	• acts as an antioxidant by protecting other proteins against oxidative damage • important for the proliferation of lymphocytes

Diets should be formulated to all ten essential amino acids (arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine) while ensuring a ratio of about 50:50 for essential amino acids to non-essential amino acids is optimal for nitrogen retention and utilization in pigs.

During immune challenges, the pig's amino acid requirements, including methionine, cysteine, tryptophan, threonine, and glutamine, increase relative to lysine. Well-known examples are threonine, a key component of mucin (and immunoglobulins), supporting gut health and integrity during stress, and glutamine, a major energy source for rapidly dividing cells in the immune system.

Microbiome evolution and modulation

The microbiota of the pig evolves from birth up to about 20 weeks of age. The alpha diversity (the number of species) and species richness increase with age. The pig microbiome consists of both permanent members that establish stable populations throughout life and transient members that may fluctuate based on dietary changes or environmental factors.

Microbiome modulation through the diet

Diet can influence the rate and maturity of microbiota evolution. For instance, diets rich in fiber and specific carbohydrates can promote the growth of beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*. In contrast, diets high in protein can increase potentially harmful bacteria if not appropriately balanced.

Understanding these dynamics is critical for optimizing nutrition strategies that support gut health and overall performance in pigs. Proper management of dietary components can lead to healthier microbiomes, enhancing nutrient absorption and immune responses throughout the pig's life.

The following strategies accelerate the maturation of the microbiome, the gut, and the immune system:

- Promoting and maintaining feed intake: consistent feed intake is crucial for microbial development. Early access to solid feed helps establish a diverse microbiome.
- Raw material continuity: variability in feed composition can disrupt microbial communities, leading to dysbiosis. A step-wise approach to diet changes, with a broad range of ingredients at low inclusion levels, is recommended.
- Regulating digest transit time: the rate at which digesta moves through the gastrointestinal tract affects nutrient absorption and microbial colonization. Strategies to optimize transit time, such as increasing particle size and incorporating insoluble fibers, can enhance nutrient digestibility and promote a healthy microbiome by allowing beneficial microbes to thrive.
- Feeder access: adequate access to feeders encourages regular feeding behavior, supporting consistent nutrient intake and microbial activity. Frequent feeding can help maintain stable gut conditions conducive to microbial growth.
- Inert fiber: helps maintain gut motility and provides substrates for beneficial bacteria, contributing to a balanced microbiome.
- Minimizing stress: stress can negatively impact gut integrity and microbial balance, increasing susceptibility to infections and other health issues.
- Limiting the use of antibiotics helps preserve the natural gut microbiota, which is essential for maintaining health and preventing disease. The use of antibiotics can lead to dysbiosis, making pigs more vulnerable to infections and impairing immune responses.

Limitations in the use of AGPs, Zn, and Cu require rethinking in pig nutrition

Reduced access to in-feed antibiotics and pharmacological levels of zinc and copper have exposed nutritional shortcomings for nursery pigs. Preventive strategies through nutrition, carefully designed diets, and optimal use of eubiotics and functional ingredients are the keys to getting pigs off to a healthy and efficient start.

Nursery nutrition programs should be designed for long-term gut health, efficiency, and functionality. The level of investment will depend on the weaning age/weight, health status, labor quality, etc., noted Dr. Edwards.

EW Nutrition's Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Megan Edwards, an Australian animal nutrition consultant with global research and praxis experience and a keen interest in immuno-nutrition and functional nutrients, was an esteemed guest speaker at this event.

BioStabil Plus improves grass silage quality and cattle profitability

*by **Dr. Vesna Jenkins**, Global Product Manager, EW Animal Care*

Making silage enables the farmer to store forage, providing a cost-effective feed when required. From silage making through to feeding out, however, the challenge is to ensure that valuable dry matter, energy and protein are not lost. Any losses would require supplementation from other sources at extra cost. In the case of protein, farmers would need to purchase additional soybean meal, for example, to maintain cow productivity.

Clostridia: The Main Villain

One of the greatest challenges to making good silage is the presence of **Clostridia** bacteria, which can negatively impact animal health, performance and profitability. These bacteria pose a health risk to both beef and dairy cattle and can negatively influence cheese quality through the late blowing defect.

During the ensiling process, Clostridia break down protein, reducing silage nutritional value, and produce butyric acid, which decreases silage palatability and affects feed intake. Clostridia can easily enter through soil contamination and thrive in forage with low dry matter, high buffering capacity, or lower levels of soluble carbohydrates and nitrate.

Negative impacts of Clostridia

- Health risk to cattle
- Reduced nutritional value of silage
- Declined feed intake, leading to diminished productivity
- Late blowing defect in cheese

Trial results

A recent scientific trial by the Swedish University of Agricultural Sciences (SLU) tested the effect of **BioStabil Plus** silage inoculant on difficult to ensile grass-clover forage (28% DM) challenged with Clostridia. The research demonstrated a clear effect of BioStabil Plus on multiple parameters.

The application of BioStabil Plus to glass-clover forage resulted in:

- **Improved dry matter (DM) retention** (Figure 1)
- **Enhanced protein preservation** (Figure 2)

Both outcomes contribute to feed cost savings.

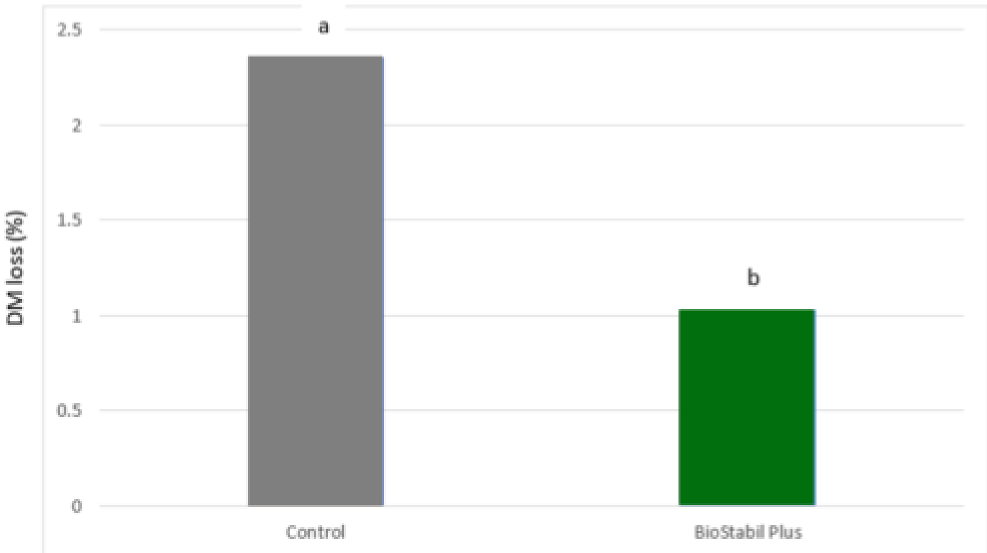


Figure 1. Significantly lower dry matter loss in grass-clover silage treated with BioStabil Plus (90 days past ensiling, P<0.001). Source: Swedish University of Agricultural Sciences and EW Nutrition.

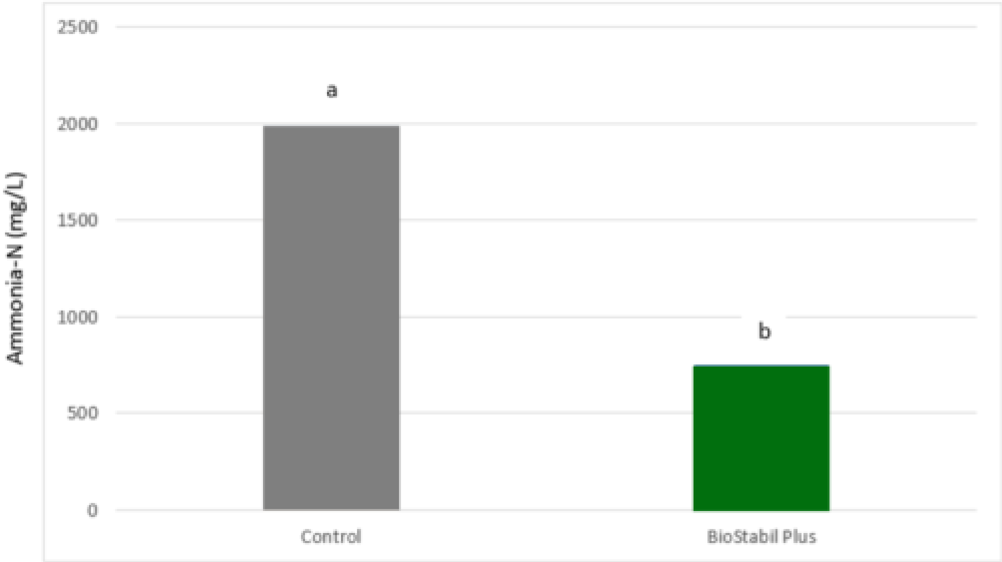


Figure 2. Less ammonia-N with BioStabil Plus, significantly higher protein preservation (90 days past ensiling, P<0.001). Source: Swedish University of Agricultural Sciences and EW Nutrition.

Benefits of BioStabil Plus

Protection Against Nutrient Loss – BioStabil Plus protects against dry matter, energy, and protein losses in the fermentation period. It contains the rapid-growing lactic-acid-producing homofermentative strain ***L. plantarum*** **DSM 19457**, ensuring sufficient lactic acid production for a rapid pH drop in ensiled forage (Figure 3).

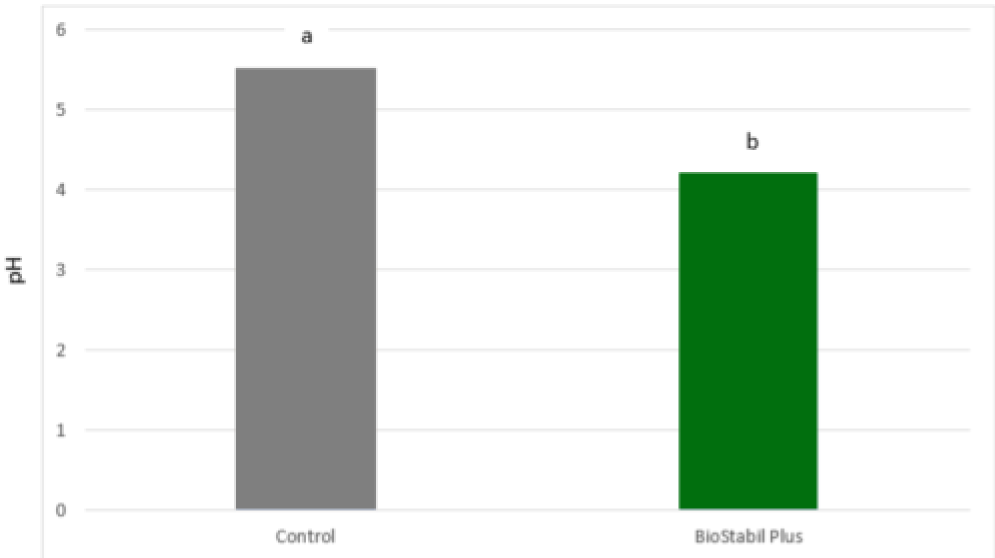


Figure 3. Lower pH in grass-clover silage challenged with Clostridia and treated with BioStabil Plus compared to Clostridia challenged forage without inoculant (90 days past ensiling, P<0.001). Source: Swedish University of Agricultural Sciences and EW Nutrition.

Reduction of Clostridial Load – BioStabil Plus reduces the Clostridial load as evidenced by significantly lower butyric acid production (Figure 4). Lower butyric acid content maintains silage palatability, feed intake, and avoids final dairy product quality issues.

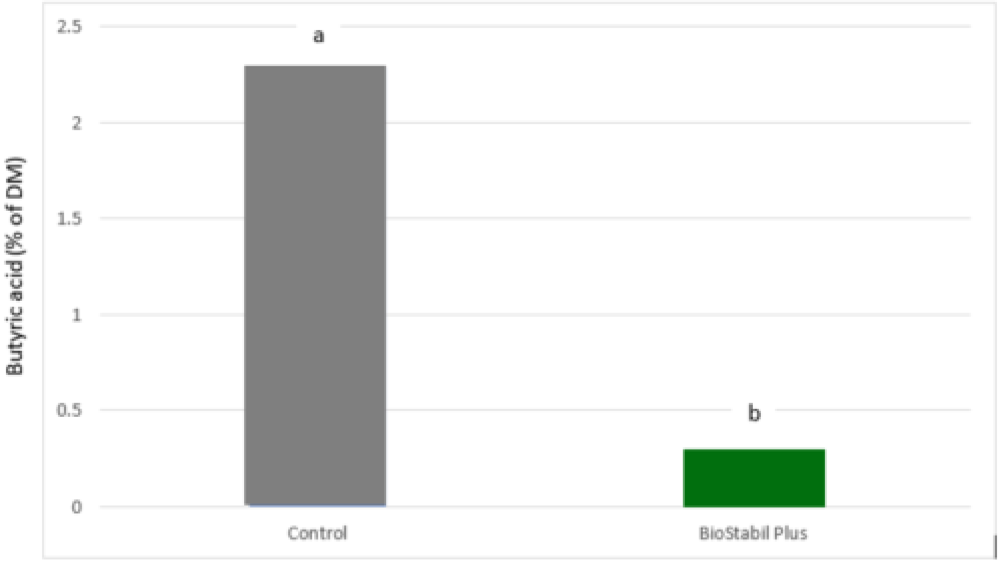


Figure 4. Significantly lower butyric acid with BioStabil Plus showing minimal Clostridia presence (90 days past ensiling, P<0.001). Source: Swedish University of Agricultural Sciences and EW Nutrition.

Enhanced Aerobic Stability – BioStabil Plus contains heterofermentative strains ***L. buchneri*** **DSM 19455** and ***L. brevis*** **DSM 23231**, producing an optimal level of acetic acid for enhanced aerobic stability during the feed-out phase. An EFSA scientific opinion on ***L. brevis*** **DSM 23231** specifically outlines its ability to reduce Clostridia risk.

Protecting your profit margin

BioStabil Plus protects against the growth of undesirable bacteria such as Clostridia, yeasts and molds during and after ensiling, helping prevent loss of valuable dry matter, energy and protein from the silage.

Producing high-quality, palatable, well-preserved silage ensures that the investment in silage making is not wasted. Most importantly, the preserved energy and protein maximize profitability through higher production of milk or meat and generate feed cost savings that support producers' margins.

Contact your local EW Nutrition representative to access valuable resources and advice on all aspects of optimized silage management.

Sustainability will push more by-products into pig feed – Keep

track of mycotoxins!

Mycotoxin Team EW Nutrition

Most grains used in feed are susceptible to mycotoxin contamination, causing severe economic losses all along feed value chains. As skyrocketing raw material prices force producers to include a higher proportion of economical cereal by-products in the feed, the risks of mycotoxin contamination likely increase. This article reviews why mycotoxins cause the damage they do – and how effective toxin-mitigating solutions prevent this damage.

Mycotoxin contamination of cereal by-products requires solutions

Cereal by-products may become more important feed ingredients as grain prices increase. However, from a sustainability point of view and considering population growth, using cereal by-products in animal feed makes much sense. Distiller's dried grains with solubles (DDGS) are a good example of how by-products from food processing industries can become high-quality animal feed.

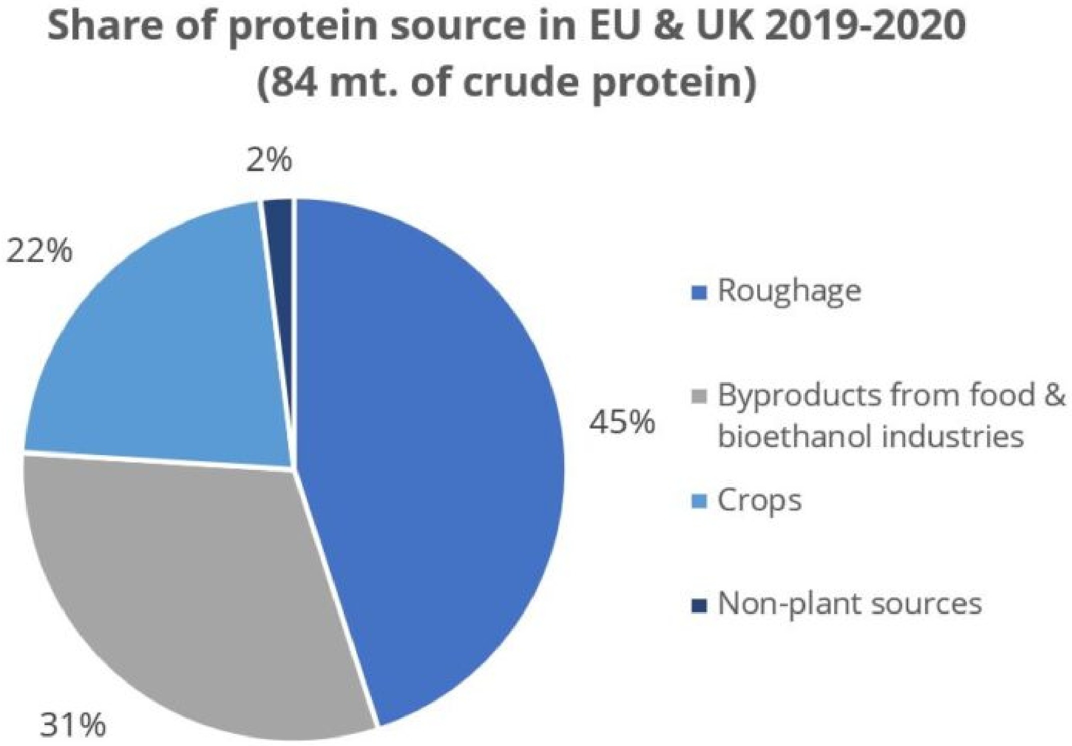


Figure 1: By-products are a crucial protein source (data from FEFAC Feed&Food 2021 report)

Still, research on what happens to mycotoxins during food processing shows that mycotoxins are concentrated into fractions that are commonly used as animal feed (cf. Pinotti et al., 2016; Caballero and Heinzl, 2022). To safeguard animal health and performance when feeding lower-quality cereals, monitoring mycotoxin risks through regular testing and using toxin-mitigating solutions is essentialy.

Problematic effects of mycotoxins on the intestinal epithelium

Most mycotoxins are absorbed in the proximal part of the gastrointestinal tract. This absorption can be high, as in the case of aflatoxins (ca. 90%), but also very limited, as in the case of fumonisins (< 1%); moreover, it depends on the species. Notably, a significant portion of unabsorbed toxins remains within the lumen of the gastrointestinal tract.

Importantly, studies based on realistic mycotoxin challenges (e.g., Burel et al., 2013) show that the mycotoxin levels necessary to trigger damaging processes are lower than the levels reported as safe by EFSA, the Food Safety Agency of the European Union. The ultimate consequences range from diminished nutrient absorption to inflammatory responses and pathogenic disorders in the animal (Figure 2).

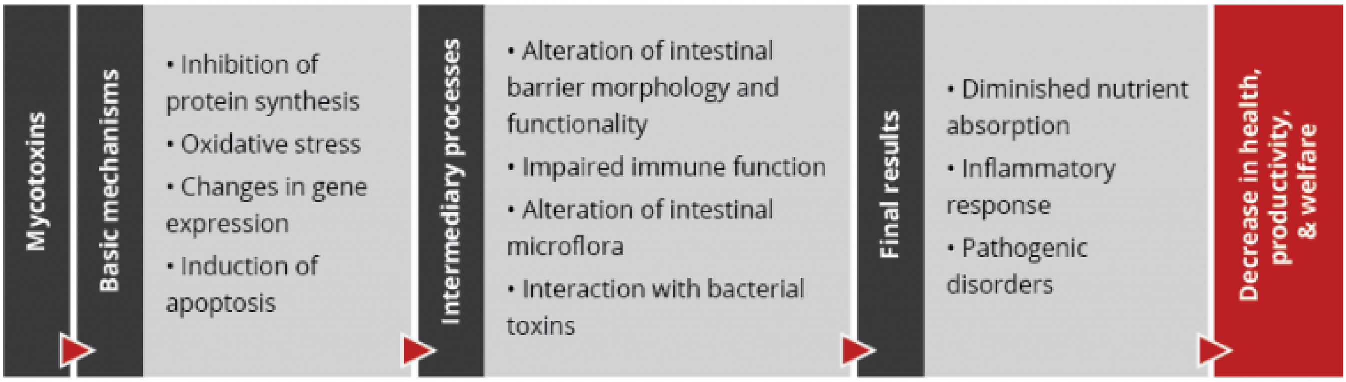


Figure 2: Mycotoxins' impact on the GIT and consequences for monogastric animals

1. Alteration of the intestinal barrier's morphology and functionality

Several studies indicate that mycotoxins such as aflatoxin B1, DON, fumonisin B1, ochratoxin A, and T2, can increase the permeability of the intestinal epithelium of poultry and swine (e.g., Pinton & Oswald, 2014). This is primarily a consequence of the inhibition of protein synthesis.

As a result, there is an increase in the passage of antigens into the bloodstream (e.g., bacteria, viruses, and toxins). This increases the animal's susceptibility to infectious enteric diseases. Moreover, the damage that mycotoxins cause to the intestinal barrier entails that they are also being absorbed at a higher rate.

2. Impaired immune function in the intestine

The intestine is a very active immune site, where several immuno-regulatory mechanisms simultaneously defend the body from harmful agents. Immune cells are affected by mycotoxins through the initiation of apoptosis, the inhibition or stimulation of cytokines, and the induction of oxidative stress.

3. Alteration of the intestinal microflora

Recent studies on the effect of various mycotoxins on the intestinal microbiota show that DON and other trichothecenes favor the colonization of coliform bacteria in pigs. DON and ochratoxin A also induce a greater invasion of *Salmonella* and their translocation to the bloodstream and vital organs in birds and pigs – even at non-cytotoxic concentrations.

It is known that fumonisin B1 may induce changes in the balance of sphingolipids at the cellular level, including for gastrointestinal cells. This facilitates the adhesion of pathogenic bacteria, increases in their populations, and prolongs infections, as has been shown in the case of *E. coli*. The colonization of the intestine of food-producing animals by pathogenic strains of *E. coli* and *Salmonella* also poses a risk to human health.

4. Interaction with bacterial toxins

When mycotoxins induce changes in the intestinal microbiota, this can increase the endotoxin concentration in the intestinal lumen. Endotoxins promote the release of several cytokines that induce an enhanced immune response, causing inflammation, thus reducing feed consumption and animal performance, damage to vital organs, sepsis, and death of the animals in some cases.

The synergy between mycotoxins and endotoxins can result in an overstimulation of the immune system. The interaction between endotoxins and estrogenic agents such as zearalenone, for example, generates chronic inflammation and autoimmune disorders because immune cells have estrogen receptors, which are stimulated by the mycotoxin.

Increased mycotoxin risks through by-products? Invest in mitigation solutions

To prevent the detrimental consequences of mycotoxins on animal health and performance, proactive solutions are needed that support the intestinal epithelium's digestive and immune functionality and help maintain a balanced microbiome in the GIT. This becomes even more important as the current market conditions will likely engender a long-term shift towards including more cereal by-products in animal diets.

Trial data shows that EW Nutrition's toxin-mitigating solution SOLIS MAX 2.0 provides adequate protection against feedborne mycotoxins. The synergistic combination of ingredients in SOLIS MAX 2.0 prevents mycotoxins from damaging the animals' gastrointestinal tract and entering the bloodstream and additionally acts as antioxidant and liver-protecting:

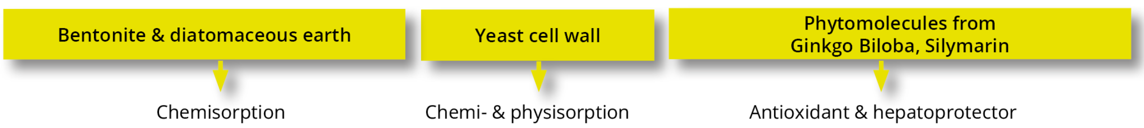


Figure 3: Moa of Solis Max 2.0

In-vitro study shows strong mitigation effects of SOLIS MAX 2.0 against a wide range of mycotoxins

Animal feed is often contaminated with two or more mycotoxins, making it essential for an anti-mycotoxin agent to be effective against a wide range of different mycotoxins. A trial with SOLIS MAX 2.0 was conducted at an independent laboratory in Spain with an inclusion level of the product of 0.10% (equivalent to 1 kg per ton of feed). A phosphate buffer solution at pH 7 was prepared to simulate intestinal conditions in which a portion of the mycotoxins may be released from the binder (desorption). The following mycotoxins were evaluated in the test (see Table 1):

Table 1: Mycotoxin challenges

Mycotoxin	Challenge (ppb)
Aflatoxin B1 (AFB1)	100
Deoxynivalenol (DON)	1,000
Fumonisin B1 (FB1)	2,000
T-2 toxin (T-2)	500
Ochratoxin A (OTA)	500
Zearalenone (ZEA)	1,000

Each mycotoxin was tested separately by adding a challenge to buffer solutions, incubating for one hour at 41°C, to establish the baseline (table). At the same time, a solution with the toxin challenge and Solis Max 2.0 was prepared, incubated, and analyzed for the residual mycotoxin to find the binding efficacy. All analyses were carried out using high-performance liquid chromatography (HPLC) with standard detectors.

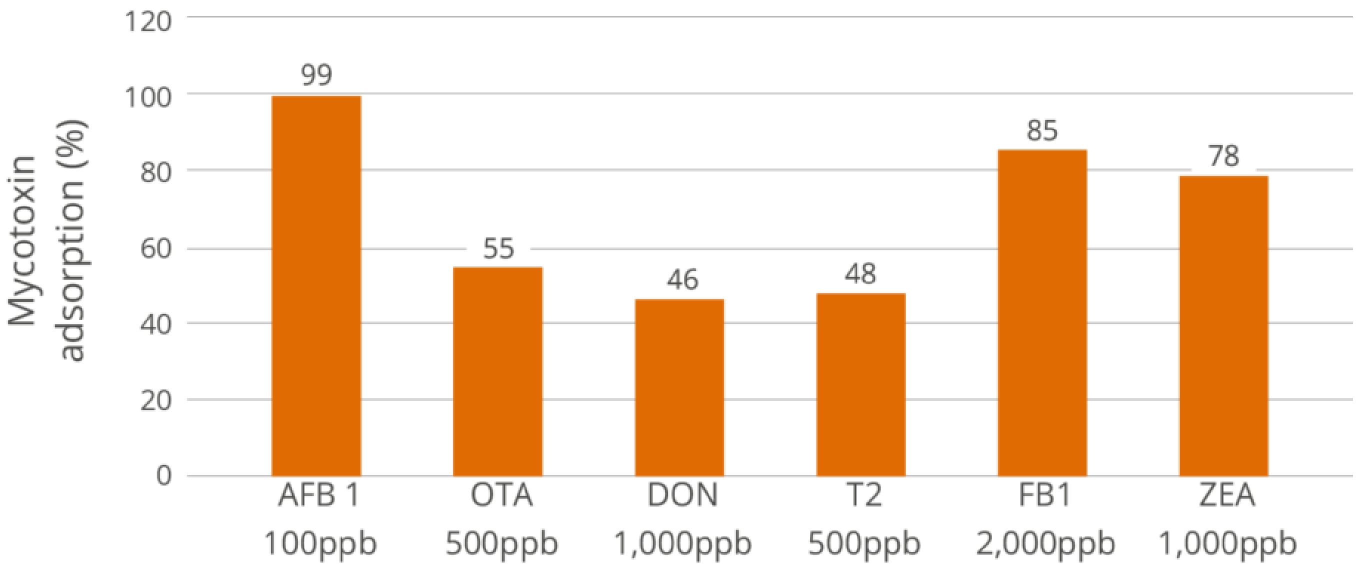


Figure 4: SOLIS MAX 2.0 (1 kg/t of feed) adsorption capacity against different mycotoxins (%)

The results (Figure 4) demonstrate that SOLIS MAX 2.0 is a highly effective solution against the most common mycotoxins in raw materials and animal feed.

Mycotoxin risk management for better animal feed

A healthy gastrointestinal tract is crucial to animals' overall health: it ensures that nutrients are optimally absorbed, provides adequate protection against pathogens through its immune function, and is key to maintaining a well-balanced microflora. Even at levels considered safe by the European Union, mycotoxins can compromise different intestinal functions, resulting in lower productivity and susceptibility to disease.

The globalized feed trade, which spreads mycotoxins beyond their geographical origin, climate change, and raw material market pressures additionally escalate the problem. On top of rigorous testing, producers should mitigate unavoidable mycotoxin exposures by using solutions such as SOLIS MAX 2.0 – for stronger animal health, welfare, and productivity.

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