Sustainability will push more by-products into pig feed – Keep track of mycotoxins!

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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.

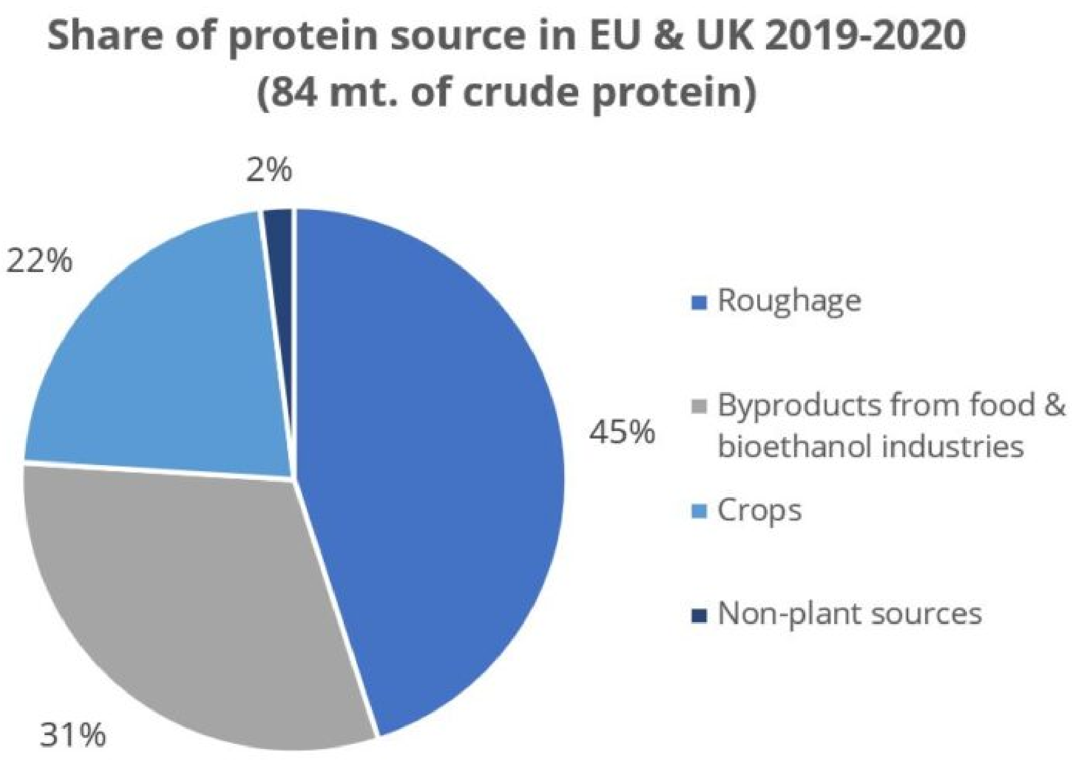

Figure 1: By-products are a crucial protein source (data from FEFAC Feed&Food 2021 report)

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).

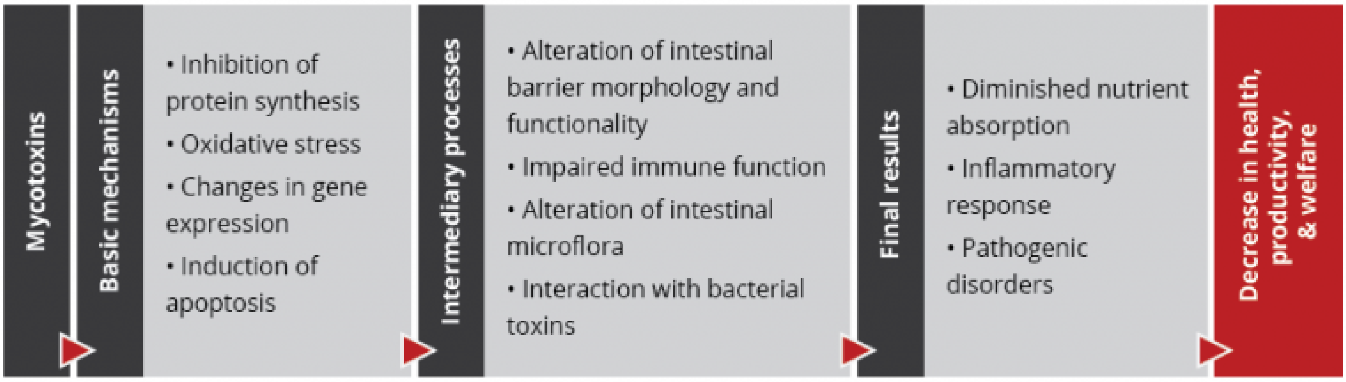

Figure 2: Mycotoxins' impact on the GIT and consequences for monogastric animals

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:

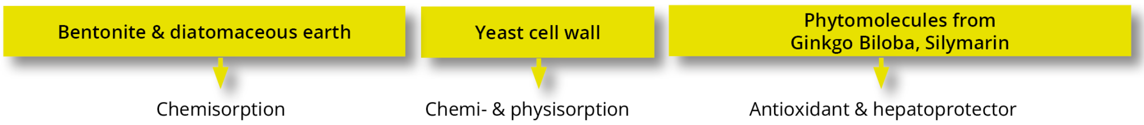

Figure 3: Moa of Solis Max 2.0

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.

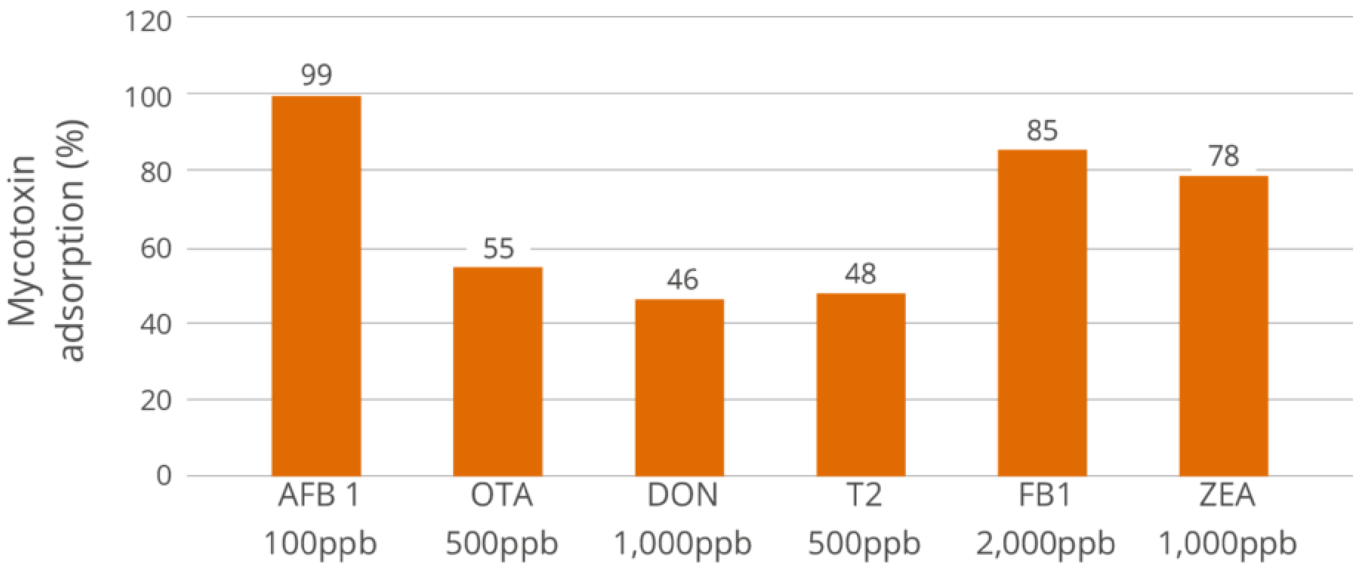

Figure 4: SOLIS MAX 2.0 (1 kg/t of feed) adsorption capacity against different mycotoxins (%)

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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