Tackling mycotoxin toxicity: the importance of holistic intervention

Mycotoxins are fungal secondary metabolites posing a huge threat to the animal industry. These biologically active metabolites are notorious for their potency to disrupt cellular functions of intestines, kidney, liver, reproductive and immunological pathways in monogastric livestock.

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Swine and poultry are particularly susceptible to mycotoxicosis due to their diet containing higher percentages of cereals and grains. When temperature and humidity are conducive, moulds and multicellular fungi thrive and easily infest cereals and grains intended for animal feed. A complete elimination of mycotoxins from feed is therefore inconceivable. However, reducing the exposure of livestock to mycotoxins is essential.

Prevalence check: how well do you know your feed?

Continuous monitoring of feed ingredients and finished feeds for their mycotoxin load is one of the key foci of Kemin.

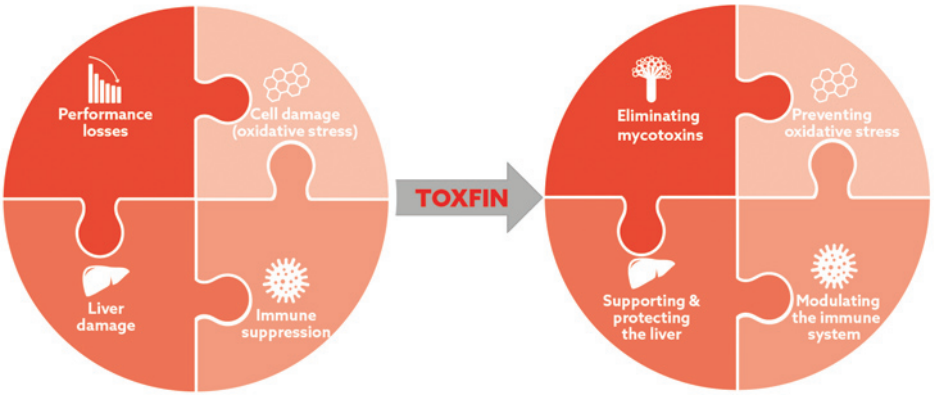


Fig. 2. TOXFIN range of formulations to combat mycotoxicosis in swine.

The Customer Laboratory Services group evaluates a variety of feed matrices and raw materials for six major mycotoxins – Deoxynivalenol (DON), Fumonisins (FUM), Zearalenone (ZEA), Ochratoxin A (OTA), Aflatoxins (AFLA) and Ht-2/T-2.

The prevalence data shows the seasonal variation in mycotoxin load and thereby the risks for animal production.

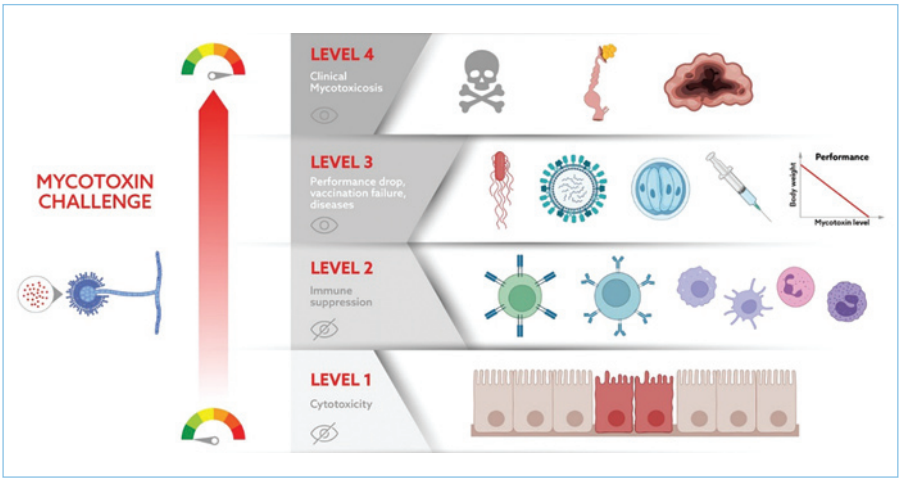
Kemin's 2022 mycotoxin survey involving hundreds of feed and feed raw material samples from Europe, indicated a high and constant risk (>50% positive samples) for DON throughout the year.

A reduction in prevalence for ZEA and OTA was observed in the second half of the year while FUM and Ht-2/T-2 increased slightly. During the second half of 2022, Kemin delved deeper into mycotoxin prevalence in piglet, gestation, and lactation feeds for pigs. The sampling done in quarter three revealed that 73% of samples tested positive for DON, 55% for ZEA and 45% for T-2/Ht-2 toxin.

In quarter four the situation stabilised for DON as only 28% of samples tested positive and 36% for ZEA.

The prevalence of Ht-2/T-2 toxin remained the same at 48%. This knowledge on prevalence aims to create awareness among livestock producers, especially pigs where mycotoxins are a huge economic threat.

Fig. 1. Evolution of mycotoxin challenge in monogastric species.



Understanding the toxicology of different mycotoxin classes

The level of toxicity and damage incurred by each class of mycotoxin vastly depends on the concentration, metabolic status of the animal and exposure duration. Zearalenone, an estrogenic mycotoxin has the potency to reduce the reproductive performance in swine.

Since ZEA has low acute toxicity, a concentration of ≤5mg/kg can lead to vulvovaginitis in young female pigs. ZEA-induced toxicosis goes beyond reproductive damage. ZEA and its metabolites depending on the concentration produce cytotoxic, hepatotoxic and haematotoxic effects in pigs.

	Control group (mg/kg BW)		Treatment group (mg/kg BW)	
Day 8	OTA	0.05	OTA	0.05
	TOXFIN	0	TOXFIN	150
Day 10	ZEA	3	ZEA	3
	TOXFIN	0	TOXFIN	150

Table 1. Scheme of trial set up.

Chronic exposure to high concentrations of DON cause dysregulation of the basic immune functions by tapering the expression of cytokines involved in immune reactions to invading pathogens. Concomitantly, the animal's ability to immunologically respond to vaccinations becomes compromised.

Trichothecenes in general, upon reaching the gastrointestinal tract (GIT), impair the viability of intestinal cells making the animals vulnerable to undesirable pathogenic infections. OTA poses a considerable threat to renal metabolic functions by disrupting the enzymatic reactions involved in the regular functioning of the kidneys.

Depending on the mode of action and concentration of mycotoxin, the symptoms develop and every so often not evident enough to treat. Nevertheless, the sub-clinical effects are seen through reduced nutrient uptake, digestion disorders, low immunity and thereby performance and economic losses.

A holistic solution for every pig producer

Kemin's TOXFIN range, formulated with a unique sorbent blend, effectively reduces the bioavailability of mycotoxins, and protects swine from their adverse effects. To holistically tackle mycotoxin-related health disorders, the key targets for TOXFIN include:

- Reducing the bioavailability of mycotoxins in the animal using unique blends of adsorbents.
- Tackling oxidative stress in sows and weaning piglets.
- Targeting liver and kidney health.
- Modulating the immune system.

A multi-mycotoxin challenge trial on healthy piglets was conducted to highlight the efficacy of TOXFIN in efficiently reducing the absorption of mycotoxins by the animal.

Toxicokinetic in vivo studies based on absorption involve quantifying the plasma concentration of different mycotoxins or their metabolites measured at different time points after oral bolus administration of the mycotoxins - Ochratoxin A (OTA) and Zearalenone (ZEA) with or without mycotoxin managing agent - TOXFIN.

Oral administration of mycotoxins and TOXFIN for control and treatment groups was performed using an intragastric tube based on the scheme presented in Table 1. After challenging the piglets, the time points of blood sampling for the first challenge (day 8) were 0 hours (just before administration), 0.25, 0.5, 0.75, 1, 1.5, 2, 3, 4, 6, 8, 12, 24, 48, 72 and 96 hours (post administration).

The time points of blood sampling for the second challenge (day 10) were 0 hours (just before administration) and 0.10, 0.20, 0.30, 0.45, 1, 1.5, 2, 3, 4, 6 and 8 hours (post administration).

Toxicokinetic modelling of the plasma concentration profiles of OTA, and phase II metabolite like glucuronide conjugate of ZEA (ZEA-GlcA) was performed to evaluate the efficacy of TOXFIN to reduce the bioavailability.

The calculated relative bioavailability represents the fraction of mycotoxins (or their metabolites) quantified in the plasma of piglets from the treatment group compared to the fraction of mycotoxins quantified in the plasma of piglets from the control group (Fig. 3).

The relative bioavailability of ZEA within 10 minutes of administration was significantly ($p<0.05$) reduced to 37.6% by TOXFIN. The relative bioavailability of OTA within two hours of administration was significantly ($p<0.05$) reduced to 72.6% by TOXFIN.

	Negative control group	Positive control group	Treatment group
Challenge	No challenge	5ppm DON	5ppm DON
Treatment	No treatment	No treatment	2kg/ton TOXFIN

Table 2. Scheme of trial set up.

To highlight the efficacy of TOXFIN in safeguarding the overall health, a trial on 28-day old, weaned piglets challenged with DON at 5ppm for a duration of 21 days was conducted as per the scheme in Table 2.

Swine is particularly sensitive to DON, making them susceptible to DON-induced toxicosis even at low concentrations.

To evaluate the capacity of TOXFIN to minimise the nephrotoxicity of DON, urea was quantified as a biomarker for kidney health.

The unique formulations of TOXFIN, efficiently safeguarded the metabolic activity of kidneys which reflected in a 44% reduction ($p<0.05$) of excreted urea in blood compared to positive control as in Fig. 4.

Complete detoxification of feed ingredients and finished feeds is unattainable given the various environmental factors that come into play. Nevertheless, a carefully curated mycotoxin control programme during animal production will alleviate the detrimental effects of mycotoxins.

From the above trials, it is evident that a comprehensive solution such as TOXFIN, can efficaciously reduce the bioavailability of mycotoxins and safeguard the functioning of vital organs thereby achieving safe and sustainable pig production.

Key takeaways

- Consistent monitoring of feed to evaluate the prevalence of different classes of mycotoxins is essential for pig producers.
- Unique adsorbent blends under TOXFIN range effectively reduces mycotoxin bioavailability in pigs.
- The TOXFIN range includes all-in-one formulations to holistically protect swine from several aspects of mycotoxicosis. ■

Fig. 3. Relative bioavailability (%) of ZEA in control and treatment (TOXFIN) groups.

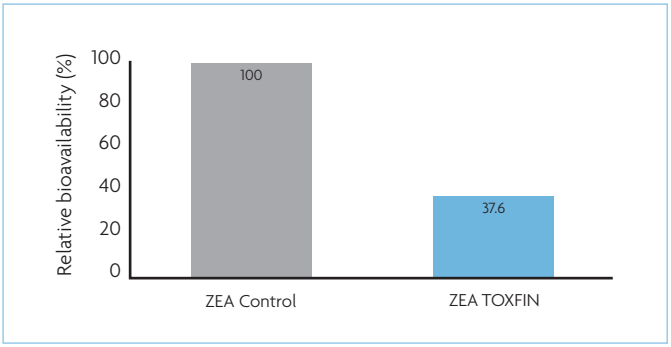


Fig. 4. Urea (mg/dL) measured as an indicator of kidney health.