# Mycotoxins and their role in bacterial and viral disease outbreaks

The most frequent type of mould developing on plants in the field is Fusarium, responsible for fusariosis. Fusarium itself is not a high threat to swine, but under stressful conditions it produces harmful mycotoxins like trichothecenes (mainly deoxynivalenol (DON) and T-2/HT-2 toxins), zearalenone and fumonisins (FUM).

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It was shown that 86% and 62% of feed ingredients are contaminated (above the limit of quantification) with deoxynivalenol and fumonisins respectively (Olmix-Labocea database).

These data are in accordance with the last large-scale studies published, showing the high prevalence of fusariotoxin polycontamination in feed materials.

Both DON and fumonisins have demonstrated deleterious effects on the health and performance of swine. DON is a potent inhibitor of protein synthesis and mitosis and can induce apoptosis by activating mitogen-activated protein kinases. Acute exposure to high doses of DON induces diarrhoea, vomiting, leukocytosis and gastrointestinal bleeding.

## Action of fumonisins

Fumonisins mainly act by inhibiting sphinganine N-acyl transferase and consequently disrupt the ceramide and sphingolipid metabolism. Fumonisins acute intoxication is characterised by functional pulmonary, cardiovascular and hepatic damage. Based on the acute toxicity of mycotoxins, the European Commission has determined maximum recommended levels of mycotoxins.

Nevertheless, recent studies suggest that DON and fumonisins' damages can occur even at levels lower than the EU recommendations. Several studies highlight the individual and synergistic impact of DON and fumonisins on intestinal health but also their role in bacterial and viral disease outbreaks, without acute symptoms of mycotoxicosis.

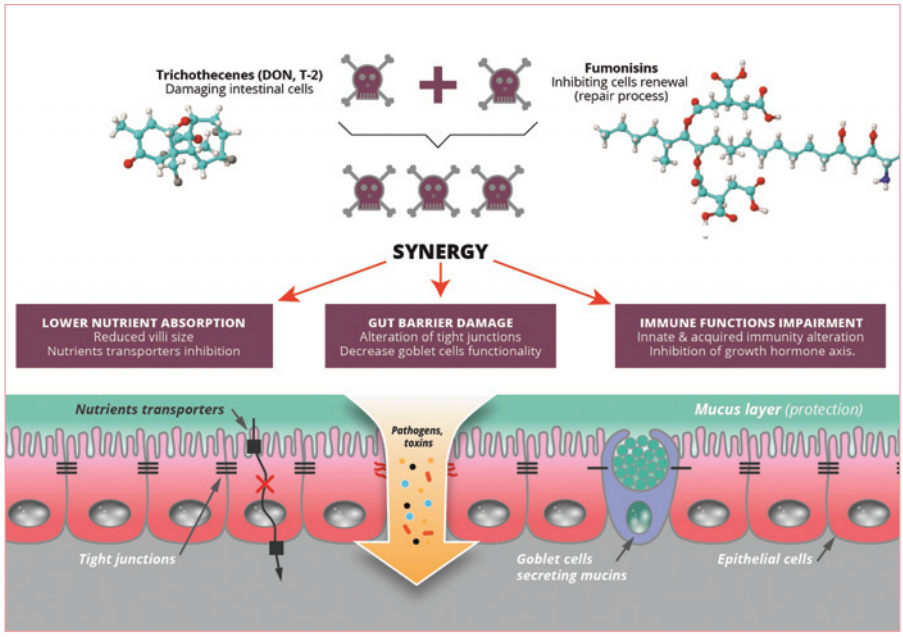


**Fig. 1. Effect of DON and fumonisins on the intestinal epithelium.**

The intestinal epithelium is a single layer of cells with dual function: selective filter for the absorption of nutrients, water and electrolytes as well as the main barrier against pathogens and toxins.

DON and fumonisins have been shown to impact both absorptive function and barrier function in the intestine.

## The role of mycotoxins in intestinal colonisation

The nutrient absorption in the intestine is proportional to the epithelial surface of contact. In the presence of DON, the protein synthesis is inhibited, while a reduction of lipid metabolism is observed in the presence of fumonisins.

Both lead to the reduction in proliferation and survival of epithelial cells, thus reducing the surface of absorption. DON and fumonisins both induce intestinal damages like reduced villi height, lesions and oedema that significantly impair nutrient absorption.

As a consequence, the intestinal concentration of protein increases in the presence of fusariotoxins to the benefit of pathogens development.

In 2003, Oswald et al. found that 5-8ppm of fumonisin B1 (FB1) in the feed, increases Escherichia coli colonisation in the intestines of piglets. Thus, ingestion of FB1 may induce sphingolipid changes in the gastrointestinal tract and modify bacterial receptors on the surfaces of epithelial cells. These changes may contribute to the increased colonisation of the intestinal tract by pathogenic bacteria according to the authors.

In 2011, Vandenbroucke et al., investigated the invasion of Salmonella typhimurium in porcine ileal loops and concluded that the invasion of Salmonella typhimurium was higher in the presence of DON.

## The role of mycotoxins in gut barrier efficacy

It is now well established that both DON and fumonisins at low levels, alter the intestinal barrier function by modulating the

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tight junction function, which decreases trans epithelial electrical resistance (TEER) in the gut.

Moreover, the reduction of the proliferation and survival of epithelial cells caused by DON and fumonisins also impacts the barrier function.

In addition, the number of goblet cells that synthesise and secrete mucins (main constituent of the protective mucus layer) decreases significantly when animals are exposed to DON.

Significant increases in the translocation of bacteria across intestinal epithelial cells have been demonstrated in the presence of DON and fumonisins (Fig. 1).

## The role of mycotoxins in immune defence

70% of animal immune tissues are located in the gut. DON and fumonisins have been shown to affect both innate and adaptive immunity.

Low to moderate toxin concentration dysregulates the expression of cytokines, chemokines and genes. DON has been shown to provoke pro-inflammatory response (increase of TNF-α, IL-1 α, IL-1β and IL-8), and affect the regulation of lymphocytes T (involved in adaptive immunity).

In 2011, Vandenbroucke et al. concluded that intestinal inflammation due to Salmonella typhimurium increases in presence of DON. Savard et al. concluded on a DON negative effect on PRRSV-specific humoral responses, in swine.

Fumonisins were shown to affect the recruitment of inflammatory cytokines (IL-1β, IL-6, IL-12, TNF-β and particularly IL-8) in the intestine in the event of an infection, thus increasing the susceptibility to E. coli and other pathogens.

Fumonisins also impair intestinal antigen presenting cells (APC), major histo-compatibility complex class II molecule and lymphocyte T stimulatory capacity leading to a prolonged intestinal enteric infection.

In addition to increasing the risk of intestinal and systemic infections, mycotoxins' effects on the immune system also modify vaccinal response.

A study showed that DON naturally contaminated feed significantly decreased the antibody response generated following vaccination for major virus like PRRS. The author concluded that the vaccine failure appears to be caused by an inefficient immune response following the ingestion of feed naturally contaminated with DON.

In addition to increased pathogen virulence and decreased vaccine efficacy, mycotoxins also seem to affect drug efficacy. In fact, some recent findings suggest that concurrent administration of drugs with fumonisins-contaminated feed might alter the expression of intestinal drugs, such as enrofloxacin (broad spectrum antibiotic including Escherichia coli, Pasteurella multocida and Mycoplasma gallisepticum).

## Conclusion

To conclude, DON and fumonisins increase the risk of bacterial or viral outbreaks by favouring intestinal colonisation, increasing the intestinal translocation of pathogens and affecting the immune system leading to higher sensitivity to infections.

This will have a huge impact on performance and profitability at farm level as it will decrease the level and quality of production, increasing also the cost of production.

Any strategy that aims to decrease the impact of mycotoxins on gut health, alleviating the effects of complex fusariotoxins will have a positive effect on performance and profitability.

Good monitoring of the raw materials used in the manufacturing of feed and the incorporation of a broad spectrum toxin binder should be part of these strategies. ■

**References are available from the author on request**