Interaction of mycotoxins and endotoxins on immunity and pig growth

The reasons for poor performance in pigs are multifactorial: feed and water intake, housing, environmental and social conditions. Mycotoxins are one of the most immunosuppressive factors coming from feed.

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Modern pig farming in closed, stable environments with high animal density can lead to poor indoor hygienic quality and high exposure to bacteria producing endotoxins.

What is the individual and synergetic impact of mycotoxins and endotoxins on pigs' inflammatory response and growth? What is the solution to protect animals against this threat?

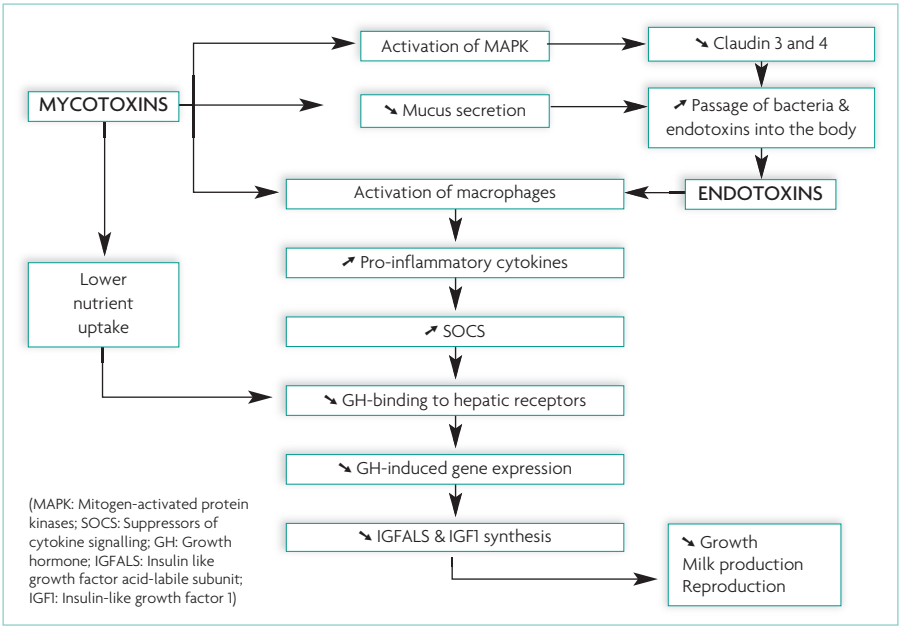

Fig. 1. Interaction of endotoxins and mycotoxins on growth hormone axis.

Effects on pig health

Mycotoxins are secondary metabolites of various fungi commonly found in feed and foodstuffs. Worldwide surveys indicate that deoxynivalenol (DON), a type-B trichothecene and fumonisins (FB) are the most frequently detected mycotoxins in various feed raw materials.

The toxic effects of Fusarium mycotoxins like FB and DON include reduced growth, feed refusal, immune suppression, gastrointestinal lesions and neurological and reproductive disorders.

The gastrointestinal tract represents the first barrier met by exogenous compounds and also the first target for mycotoxins (see Fig. 1). Both DON and FB have a direct effect on nutrient uptake through two mechanisms. Firstly, DON and FB damage the epithelial cells, decreasing the villi length and thus their surface, resulting in poor nutrient absorption and an increased risk of negative energy balance.

Secondly, DON has a direct effect on sodium-dependent glucose cotransporter 1 (SGLT1) leading to a down-regulation of intestinal glucose absorption also responsible for negative energy balance.

The lower nutrient uptake also alters the

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natural antioxidant absorption in the intestine contributing to immune depression.

In addition, oral exposure to mycotoxins impairs the barrier function of the intestine by activating MAPK, which reduces the expression of claudin proteins, the main components of tight junction proteins and decreases trans-epithelial electrical resistance.

Chronic ingestion of contaminated diets induces a reduction in the number of goblet cells and thus mucus secretion to the detriment of epithelium protection against pathogen adhesion. This previous mechanism results in an increased risk of trans-epithelial passage of both bacteria and endotoxins into the body.

Last but not least, DON and FB (even at low levels) cause the secretion of pro-inflammatory cytokines such as IL-1β, IL-2, IL-4, IL-5, IL-6 and TNFα as described in a review of Grenier and Appelgate in 2013.

These pro-inflammatory cytokines have both local and systemic effects (inflammation, fever and reduction in feed intake).

Effect of endotoxins

Endotoxins are lipopolysaccharides (LPS) derived from the cell membranes of Gram-negative bacteria.

Although endotoxins are linked within the bacterial cell wall, they are continuously liberated into the environment at cell death and during cell growth and division.

Intestinal epithelium is therefore permanently exposed to Gram-negative bacteria, which are able to directly deposit their toxic and pro-inflammatory constituents at the intestinal epithelial surface.

Endotoxins do not act directly against cells or organs but through activation of the immune system, especially through monocytes and macrophages, with the release of a range of pro-inflammatory mediators, such as cytokines.

As previously described, mycotoxins and endotoxins have synergetic action on the gut and immunity, working through a vicious circle by setting up a local inflammatory state at the gut level with the increase of pro-inflammatory cytokines production (Fig. 1).

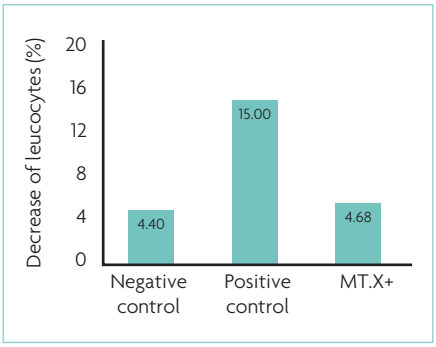

Fig. 2. Decrease of leucocytes level between week 1 and 4 of trial in blood of pigs fed a standard diet (negative control), a diet highly contaminated with DON and FB (positive control) or the contaminated diet supplemented with MT.X+ (Experimental trial, Spain).

The expression of these cytokines is followed by the up-regulation of several suppressors of cytokine signalling (SOCS), some of which are capable of impairing Growth Hormone (GH) signalling.

The GH signalling can also be affected by negative energy balance in case of impaired nutrients uptake caused by mycotoxins as described above. The negative action on GH leads to the reduction of IGF-1 (Insulin like Growth Factor 1) secretion, to the detriment of animal health and performance.

In fact, IGF-1 is a growth hormone that stimulates cell replication, cell differentiation and the synthesis of cellular products. Thus IGF-1 has an impact on productivity (growth, milk production, fertility). This synergistic effect between mycotoxins and endotoxins has been described in the literature.

Recently, Wu et al. showed that IGF-1 level is markedly decreased after pig's exposure to DON contaminated diets.

Wide spectrum toxin binders

The use of a wide spectrum toxin binder is a key factor to alleviate the above described effects from mycotoxins and endotoxins. DON and FB are complex mycotoxins with difficult adsorption by conventional detoxifying agents such as standard bentonite.

Ulvans, polyanionic polysaccharides present in green algae, are sulphated xylorhamno-glucoronans formed by a succession of disaccharides composed of uronic acid and sulphated rhamnose.

In a gastrointestinal model, the combination of those ulvans with bentonite reaches even better results than those obtained with activated charcoal for complex mycotoxins such as DON and FB with no alteration of the bioaccessibility of nutrients. This mix of ulvans and bentonite is used in Olmix toxin binders: MT.X+ and MMi.S (microgranulated form).

All over the world Olmix binders prove their efficacy in the protection of pigs. For instance in Spain, the decrease of leucocytes in blood was lower in pigs using MT.X+ compared to the control and the feed conversion rate of pigs between 15 and 30kg was improved (-1.67pt) thanks to Olmix binders in the presence of more than 1500ppb of DON (Fig. 2).

Mycotoxin and endotoxin control is very important to avoid their direct effects on pigs' intestinal health and immunity, as well as their indirect effects on IGF-1 altering pig performance.

To avoid the effects of mycotoxins and endotoxins on animal health and performance it is very important to use the widest spectrum binders. MT.X+ and MMi.S improve protection and also improve performance. ■

References are available on request from animalcarets@olmix.com

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