Mycotoxins and endotoxins and their control

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Mycotoxins and endotoxins impair animal health and immune status as well as feed production in various ways: these toxins are invisible, odourless and cannot be detected by smell or taste, but can significantly reduce performance in pig production.

Due to the complex nature of these naturally occurring contaminants and to their elaborate analytics a risk management concept has to be adopted in order to reduce the risk encounter to a defined and acceptable level.

Toxic fungal metabolites

Mycotoxins are toxic fungal metabolites that cause intoxication when consumed by animals. Fusarium, Aspergillus, and Penicillium are the most common moulds that produce these toxins and contaminate animal feeds through fungal growth prior to and during harvest, or during improper storage.

Aflatoxins are produced by many strains of Aspergillus flavus and A. parasiticus on many different commodities, including cereals, figs, oilseeds, and others.

Moreover, aflatoxin B1 is considered the main hepatocarcinogen in animals, although effects vary with species, age, sex, and general nutritional conditions.

Trichothecenes constitute a large group of mycotoxins produced by various species of moulds, in particular those belonging to the genus Fusarium. The most prevalent mycotoxins of these groups are deoxynivalenol (DON, vomitoxin) and T-2 toxin. An important issue is that some of these closely related compounds occur simultaneously and are proven to cause synergistic effects.

Different types of trichothecenes vary in their toxicity though all of them have high acute toxicity. They may cause haematological changes and immune suppression, reduced feed intake and skin irritations as well as diarrhoea and haemorrhages of internal tissues. Pigs seem to be the most sensitive farm animals to this group of mycotoxins.

Effects occurring at the lowest levels of trichothecenes were reduced feed intake and weight gain, as well as impairment of the immune system.

Experimental groups

Effects of Mycofix Plus against endotoxins associated with Gram negative bacterial diseases in pigs.

90 piglets chosen from 15 litters were used for this experiment. A 3 x 3 trial design was employed, meaning three groups with three replications each. Treatments were performed as follows:

- Group A (control): standard piglet diet with an average natural load of endotoxins of 9.05µg/g (average from 19 feed samples).
- Group B (positive control): standard piglet diet with an average natural load of endotoxins of 9.05µg/g (average from 19 feed samples) plus 100mg colistin/litre administered via drinking water for 21 days.
- Group C (treated): standard piglet diet with an average natural load of endotoxins of 9.05µg/g (average from 19 feed samples) supplemented with 0.2% of the feed additive formulation over the whole trial period.

Results

- Application of Mycofix Plus in pigs improved FCR (Fig. 1).
- Weight of pigs at day 56 and DWG (day 1-56) were significantly increased by the supplementation of Mycofix Plus (Fig. 2).
- Mycofix Plus reduced the incidence of diarrhoea in comparison with the control group and with the group supplied with the antibiotic colistin.

Hyperoestrogenic effects

Zearalenone (ZEA) is also produced by Fusarium species and has strong hyperoestrogenic effects, which result in impaired fertility, stillbirths in sows and a reduced sperm quality in boars. ZEA mostly affects breeding animals which have a very sensitive reproductive system.

Ochratoxin A (OTA), which is produced by a number of Aspergillus and Penicillium species causes renal toxicity, nephropathy and immunesuppression in pigs, resulting in reduced performance parameters in animal production.

Ergot alkaloids are present in the sclerotia of Claviceps species, which are common pathogens of various grass species and grains of cereals, such as wheat, rye, oats, barley and triticale. Pigs belong to the principal animals at risk.

Clinical symptoms of ergotism in animals include tail and ear necrosis eventually leading to gangrene, abortion, convulsions, suppression of lactation in sows, hypersensitivity and ataxia. As mentioned before, in pigs a high level of toxin intake results in vasoconstriction and subsequently

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Fig. 1. Comparison of feed conversion ratio on day 56 within the experimental groups.

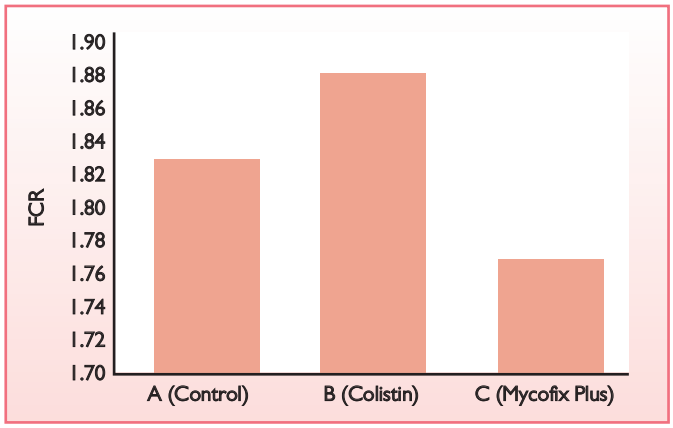
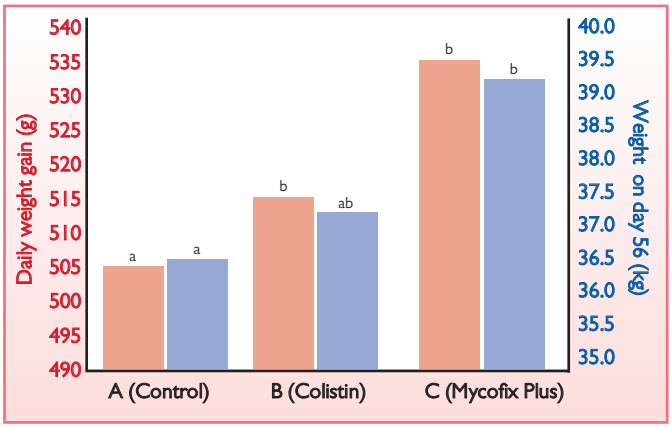


Fig. 2. Comparison of weight on day 56 and daily weight gain (day 1-56) within the groups.



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dry gangrene of hooves, ears and tails. Endotoxins are incredibly fascinating substances. On the one hand they stimulate the immune system in a positive way; on the other hand they cause endotoxic shock and death.

Classically, an endotoxin is a toxin that, unlike an exotoxin, is not secreted in soluble form by live bacteria, but instead is a structural component in the bacteria which is released mainly when bacteria are lysed. Endotoxins are commonly referred to in literature as lipopolysaccharides (LPS).

The toxic and non-variable part is the Lipid A (identical in all cell walls of Gram negative bacteria).

Endotoxins, unlike exotoxins, react with different blood proteins, cytokines (involved in the immune response), amongst others, thus inducing immune reactions.

The endotoxin is also called lipopolysaccharide (LPS) as it consists of a polysaccharide part (sugar, Core Polysaccharide and O Antigen) and a lipid moiety, known as lipid A and responsible for the toxic effect.

The polysaccharide chain is highly variable among different bacteria. Absorption effects, removal and detoxification of endotoxins are complex phenomena that depend on many factors and on the variable susceptibility amongst animals.

LPS kinetics inside the body implies a number of interactions; they can bind to high density lipoproteins, albumins, immunoglobulins, complement C3, and to a number of unknown proteins that altogether increase their half life in serum, preventing the uptake of LPS by the liver and the spleen as well as their engulfing by macrophages.

Development of shock

The greatest prognostic factor, however, is the development of shock. Septic shock is a syndrome characterised by hypotension, oliguria, hypoxia, acidosis, the development of microvascular abnormalities, and disseminated intravascular coagulation. Multiple organ failure is an all-too common sequel. Studies at necropsy reveal widespread tissue damage with particular involvement of the liver, lungs, kidneys and adrenal glands. Tissue lesions include oedema, haemorrhage, inflammatory infiltrates, fibrin thrombi and areas of tissue necrosis. Identical physiological and pathological changes may be seen in experimental animals receiving lethal doses of endotoxin.

The attachment of large numbers of pathogenic E. coli to the mucosa of the small intestine has been observed in porcine colibacillosis.

During bacterial growth in culture, LPS is continuously shed. A massive multiplication and invasion of the gut by E. coli, as easily happens during post weaning phase of the piglets, can lead to a moderate and sometimes severe toxic status after the release of endotoxin during mitosis.

Post-weaning diarrhoea is an expression of synergic effects of bacteria and their exotoxins with endotoxins. Early weaning enhances susceptibility to LPS. Adhesion factors play a crucial role in the pathogenesis of oedema disease, which is more an expression of already abundant production of endotoxins during E. coli turnover.

Characteristics of this syndrome are sudden death or nervous symptoms, such as blunting, staggering, ataxia, opisthotonus, subcutaneous oedema particularly in nose, ears, eyelids and larynx. Considerable mortality is associated with Gram negative infections, especially when they are complicated by shock.

The shock can also be a consequence of antibiotic administration as total endotoxin level has been reported to decrease after antibiotic treatment; whereas free endotoxin increased (free endotoxins are biologically more active than membrane bound endotoxins). Endotoxin release is paralleled by deterioration of the parameters involved in disease severity assessment. Several drugs have been investigated to counteract LPS. Antibiotics differ in potential for endotoxin liberation according to their bacteriostatic or bactericidal effect. Antibiotics can also bind endotoxins, polymyxin B or colistin being the example, but were shown to be toxic themselves. The most remarkable adverse effects of these drugs are nephrotoxicity (chiefly acute renal failure) and neurotoxicity. That is why a feed additive was tested for its positive effect on health and performance status of piglets exposed to endotoxins.

Conclusion

The present study shows that Mycofix Plus, composed of synergistically acting ingredients, ensures performance in the presence of an endotoxin challenge, resulting in improved final weight, DWG and FCR as well as in reduced diarrhoea incidence. Results indicate that Mycofix Plus supported the animals in the critical phase of weaning.

The positive effects of the feed additive result from the binding of the toxins by clay minerals, from the action of yeast components which bind bacteria and also exert an anti-inflammatory activity which acts synergistically with the anti-inflammatory effects enabled by algae and plant extracts also present in the product. ■