The mycotoxin challenge: countering one of the biggest hidden threats

Mycotoxin contamination is a complex concern across the food production industry. Over recent years there has been extensive research surrounding the effect of mycotoxin load upon animal health and the potential losses that can occur in high producing livestock. Because mycotoxins are carcinogenic, many countries have maximum levels that may be present in feeds, however, these levels differ widely between countries due to a lack of agreement surrounding what is considered a 'safe' level for consumption.

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Fungi release mycotoxins as a response to stressful environmental changes, namely temperature, moisture or aeration along with contact with aggressive agents.

Contamination can occur from mould growth at a seed level, whilst the crop is developing in the field or whilst in storage on farm.

There is also a geographical trend in the prominence of specific mycotoxins, with aspergillus finding optimal conditions in tropical regions and penicillium and fusarium more adapted to the climate of North America and Europe, resulting in mycotoxins becoming an international feed trade issue.

In terms of pig production there are five key classes of mycotoxins namely tricothecenes, zearalenones, ochratoxins, aflatoxins and fumonisins. More specifically within these families there are two types of mycotoxin producing fungi linked to poor animal health and performance.

Firstly, pathogenic fungi, originating from the field and resulting in plant disease of crops pre-harvest. In this instance, mycotoxins are directly released into the plant as a defence mechanism to mould growth. Secondly, saprophytic fungi, occurring at the post-harvest stage. This is commonly known as the 'storage' mycotoxin, only surviving on dead organic matter post-harvest and commonly seen with the feeding of by-products if kept in storage for extended time periods.

In both cases, certain environmental conditions are required for fungi to thrive, these vary on the type of fungus, humidity level and oxygen availability.

The presence of fungi within animal feed does not automatically imply toxicity and it is important to consider that each feed material may become infected by a variety of fungi, all capable of producing multiple mycotoxins that are almost impossible to distinguish with the naked eye.

As a result, a high number of mycotoxins may already be present in a raw material before it is received and processed at feed mill or farm level. These levels may then increase during heat treatment, ensilaging or storage. As knowledge about the processes and conditions that exaggerate contamination has increased, research has been conducted to determine the most efficient way to prevent damaging implications to animal health.

Why the concern in swine?

Swine are particularly sensitive to mycotoxins. The type and concentration of mycotoxin present within feed, along with the age and phase of production of the pig determines the extent to which animals are affected. Breeding animals and young stock are generally the most susceptible and present with the most severe symptoms including suppressed feed conversion ratio (FCR), fertility and immunity issues along with sudden death.

Increasing international trading of raw materials has also been a considerable influencing factor in the prevalence of mycotoxins. It is now likely that a sample of a complete ration contains components sourced from widely varying geographical origins increasing the chance of the feed mixture containing a range of mycotoxins.

As aflatoxin and deoxynivalenol (DON) are regulated by the European Union because of their risk to human health, testing for these mycotoxins is common amongst the feed industry.

However, more extensive testing through liquid chromatography indicates the presence of multiple mycotoxins and a more synergistic effect on swine health and performance.

Raw material analysis

The Alltech 2015 Harvest Analysis examined a range of raw materials

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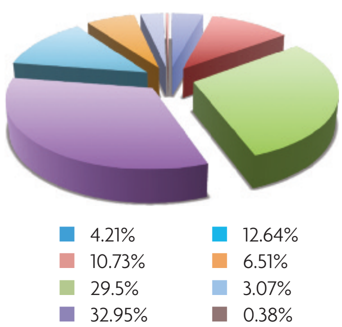
Occurrence of each mycotoxin group	%
Aflatoxin (B1)	7
Total aflatoxins	13
Ochratoxins	20
B trichothecenes	54
Fusaric acid	56
A trichothecenes	7
Fumonisins	75
Zearalenones	25
Other penicilliums	13
Other aspergillus	3.8
Ergot toxins	15

Number of mycotoxins per sample

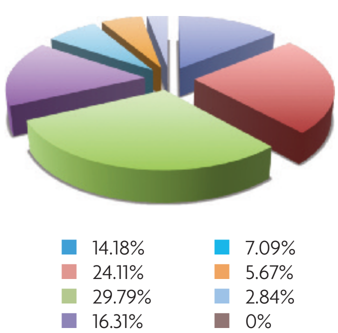


Corn: Of 261 samples collected, 100% were contaminated with an average of four mycotoxins per sample. The key toxin groups were fumonisins, Type B tricothecenes and fusaric acid, with a higher risk rating across all stages of concern being the potential synergistic effect of multiple mycotoxin contamination.

Wheat: Of 141 wheat samples collected, 100% of samples were contaminated with an average of 2.9 mycotoxins. The most prominent groups were type B tricothecenes and fumonisins with a high overall risk rating across all stages of pig production. Particular concern lies with using contaminated wheat for the production of liquid pig feed. Addition of moisture and changing temperature to already contaminated wheat may worsen the synergistic effects of specific mycotoxins or accelerate the release of more.

Occurrence of each mycotoxin group	%
Aflatoxin (B1)	2
Total aflatoxins	6
Ochratoxins	24
B trichothecenes	56
Fusaric acid	16
A trichothecenes	7
Fumonisins	45
Zearalenones	21
Other penicilliums	19
Other aspergillus	5
Ergot toxins	23

Number of mycotoxins per sample



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for mycotoxin contamination using the Alltech 37+ test; LCMS/MS analytical method for the detection of mycotoxins.

This broad spectrum test uses a combination of liquid chromatography and mass spectrometry to identify both individual and 'masked mycotoxins' to calculate the total risk rating to individual species at each stage of production.

For species particularly sensitive to mycotoxins such as swine, global analysis of raw materials helps to ensure awareness of specific mycotoxin threats that may influence productivity from individual harvests.

Feed manufacturers and pig producers can then be more aware of the risk level at the time of sourcing raw materials and make any necessary remediation strategies.

As mycotoxins are heavily influenced by climatic conditions, toxin load will vary significantly between harvests.

Monitoring this through ongoing testing helps to provide an early indication of any potential issues before they present as symptoms in pigs on farm.

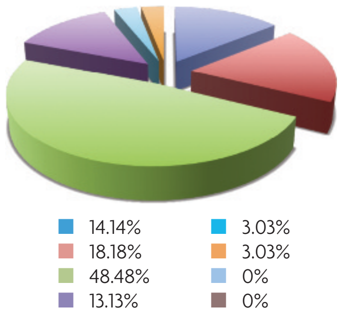
Of raw materials analysed using the Alltech 37+ analysis from the harvest 2015 to date there are some consistent mycotoxins identified across all crops sampled.

As with the feeding of all raw materials however, it is important to determine the overall risk of each raw material based on the level of inclusion within a diet.

A higher risk raw material for example, may be diluted with other feedstuffs to reduce overall mycotoxin load consumed by the animal.

Occurrence of each mycotoxin group	%
Aflatoxin (B1)	5
Total aflatoxins	16
Ochratoxins	18
B trichothecenes	43
Fusaric acid	13
A trichothecenes	16
Fumonisins	34
Zearalenones	2
Other penicilliums	20
Other aspergillus	7.1
Ergot toxins	32

Number of mycotoxins per sample



Barley: Of 99 samples of barley collected, 100% of samples were contaminated with an average of 2.4 mycotoxins per sample. The most prominent mycotoxin groups were the type B tricothecenes and fumonisins posing a moderate risk to all stages of pig production. The risk from barley is considerably lower to date than that of corn. This may be due to the generally cooler harvest of 2015, with reduced rainfall in the countries in which the majority of barley is grown.

What does analysis mean for pig performance?

The feed analysis results from the 2015 harvest demonstrate three consistent mycotoxin groups occurring on a global level in raw materials fed to pigs:

● Fumonisins

Fumonisins are particularly toxic to swine with fumonisin B1 linked directly to Porcine Pulmonary Edema (PPE), an acute and fatal disease caused by pulmonary hypertension of fluids in the thorax and resulting in interstitial oedema.

The Veterinary Laboratories Agency (VLA) concluded that acute PPE can occur following consumption of fumonisins for 3-6 days at dietary concentrations of >100ppm.

Mortality of the herd is on average between 50-100%. Symptoms include discolouration of mucous membranes, weakness and usually death, often within 24 hours. Sows affected late in gestation usually abort within 2-3 weeks and at the stage of PPE development, no effective treatment is available.

Avoidance of mouldy corn is the key prevention, this can be challenging as the majority of this is contained in a mixed feed.

However, broken, small and poorly formed grains provide the environment for fumonisin development, therefore avoiding these and conducting scrupulous grain cleaning is proven to considerably reduce fumonisin concentration. Advisory exposure guideline from the FDA recommend total dietary exposure for swine to be <10ppm.

● Ochratoxins

Ochratoxins are produced by both penicillium and aspergillus moulds and so is common both from crops in the field and raw material storage.

The three forms, A, B and C are released at both stages and are common in both temperate and tropical climates, found commonly in barley, oats, wheat and maize. Pigs are particularly susceptible to ochratoxin, of which ochratoxin A poses the most significant threat to immunity.

Clinical symptoms include acute kidney damage, which is often significant enough to result in carcase condemnation and substantial financial losses to the producer.

● Deoxynivalenol (DON)/ tricothecene group

DON is considered one of the most common tricothecenes, originating from fusarium mould and found frequently in grains on a global scale. Known as 'feed refusal' mycotoxins due to loss of appetite being one of the first observable symptoms presented by infected pigs.

Early research suggests these compounds alter brain neurochemistry to increase serotonin and tryptophan levels through the inhibition of hepatic protein synthesis. This results in loss of appetite and muscle coordination, drowsiness and lethargy. Continued exposure to trichothecenes can influence both liveweight gain and fertility as demonstrated by Diaz and Llano (2006.)

The study involved feeding 36 Yorkshire gilts diets containing grains naturally contaminated with fusarium mycotoxins along with a similar control group fed a diet free from fusarium.

Those in the experimental group demonstrated reduced average daily gain and increased percentage of stillborn piglets to those in the control group.

Prevention and remediation

Increasing demands on animal performance brings new challenges to the modern farm. Mycotoxins and their impact on the health and performance of swine are inherently linked to these demands and if left untreated, can directly influence productivity and subsequent profitability.

Since the first reported incident of mycotoxicosis in the 1960s there has been numerous efforts to minimise and completely eliminate the effects of these contaminants. Due to the wide range of mycotoxins and the extensive list of factors influencing their growth, total protection is a physiologically impossible task.

There are however a number of preventative strategies that can be implemented to reduce the level of mycotoxins present both in field crops and later in storage to prevent the harmful effects on animal health and performance.

Investment in crops and insect management is a key aspect of prevention.

Developing crops that are resistant to fungi growth and prevention of insect infestation will help to reduce opportunities for fungal infection and subsequent mycotoxin load.

Managing the harvest around periods of humidity and rainfall will prevent any excess moisture in the harvested crop, reducing the opportunity for mould to develop in storage.

Storing commodities at lower temperatures wherever possible and ensuring feed mill and mixing equipment is kept clean and free from moisture will help prevent mould development during storage and mixing.

Feed mills can manage this by committing to a mycotoxin HACCP plan, which includes a testing timetable to ensure all deliveries are tested and those of seasonal high risk are thoroughly checked before submission for milling.

Finally, consideration must also lie at the stage of consumption by livestock.

Therefore the final practical preventative action is in the form of a broad-spectrum mycotoxin adsorbent such as those with a modified yeast cell wall extract.

Raju and Devegowda (2000) demonstrated that Mycosorb A+ (Alltech Inc) was beneficial in reducing the adverse effects of mycotoxicosis in swine.

Inclusion of the modified yeast cell wall extract improved body weight gains and antibody titres suppressed by ochratoxin, aflatoxin and T-2 toxin.

Swamy (2002) found similar results in starter pigs fed fusarium contaminated grains. Experimental pigs had depressed weight gain and feed intake in the first week, this reduced and returned to previous levels with the addition of Mycosorb A+.

Concluding remarks

To effectively manage the inevitable challenge of mycotoxin contamination, it is critical to understand the level of mycotoxin threat within the supply chain. This will ensure the correct steps can be taken to mitigate risk and prevent risk to animal health and performance.

This involves establishing the correct monitoring procedures as well as identifying critical control points across the food chain from seed planting of the crop through to feed milling and storage on farm to ensure the balance is made between economical feeding and optimal animal performance. ■

References are available from the author on request