Eliminating the negative effects of mycotoxins

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Mycotoxins affect up to 25% of the world's food crops. They are a health hazard to humans and reduce animal performance. Mycotoxins attract worldwide attention because of the significant economic losses associated with their impact on human health, animal productivity and both domestic and international trade.

The negative effects of mycotoxins present in human food have been widely known for decades. The direct intake of contaminated foods poses an acute medical danger. In the previous century tragic catastrophes occurred, for example in Russia, due to the consumption of grain that spent too much time on the fields. In Japan large scale food poisoning occurred due to the consumption of mouldy rice, the so-called 'yellow rice'.

On the other hand, the risks related to the indirect consumption of mycotoxin contaminated animal products should also not be underestimated. Research has shown that there is significant deposition of mycotoxins in animal products when mycotoxins are present in animal feed (Table 1).

Mycotoxin	Deposition (%)			
	Chicken meat	Chicken liver	Eggs	Milk
Deoxynivalenol	0	0	0.04	0.0004
Zearalenone	0.005	0.003	0.03	0.06
Ochratoxin A	3.3	0.5	0.2	N/A
Fumonisin B1	0	0	0.0001	0.004

Table 1. Deposition of mycotoxins in animal products.

The toxicological effects of mycotoxins on humans and animals have been identified in many clinical trials and animal studies. However, mycotoxin ingestion may also lead to subacute effects such as a reduced immunological status allowing pathogens to colonise the gastrointestinal tract (Table 2).

Certainly in animal production it is believed that in many cases the outbreak of salmonella and other pathogens may be related to the presence of mycotoxins in feed.

Consequently, the risk of zoonosis, which is a serious food safety issue, may also increase due to the presence of mycotoxins

Scientific developments

A review of the scientific literature shows that the insight into the effects of mycotoxins is expanding rapidly. This increased knowledge is driven by the development of novel analytical techniques that enable the simultaneous measurement of many different mycotoxins in complex biological matrices at low concentrations.

Unfortunately, the screening of feed raw materials with these advanced techniques shows that it is quite utopian to believe that there is often only a limited risk of encountering mycotoxin contamination in feed and feed raw materials.

Many samples would show no contamination when a traditional screening is performed based on the identification and quantification of a few typical 'marker mycotoxins'.

When using these more advanced methods which are able to quantify over 50 mycotoxins simultaneously, many samples that were previously classified as mycotoxin free will now often receive the label 'contaminated'. The industry may need to get accustomed to the idea that at a certain time in the future the analytical techniques will be so advanced that mycotoxin free raw materials will be the rare exception.

The main advantage of the progress in mycotoxin analyses is that researchers now have much better tools to look at other areas which have not been fully explored in the past, such as the interaction between mycotoxins.

Most people involved in animal production who have paid some attention to the mycotoxin issue know that higher concentrations of mycotoxins are not always required to cause significant economic losses.

Future research will undoubtedly reveal some of the interactions between currently known (and unknown) mycotoxins at lower concentration levels.

The current knowledge on the synergism and antagonism between mycotoxins (Fig. 1) will certainly increase dramatically in the coming years.

There are still many other advantages to the ability of novel analytical methods to detect more mycotoxins at lower concentrations. The study of mycotoxin absorption, deposition and excretion is of primordial importance in order to assess the safety of food products from animal origin.

It is expected that it will be possible to analyse a wider range of mycotoxin metabolites, which will allow a more accurate assessment of the total mycotoxin deposition into animal products.

Furthermore, an evaluation of the excretion of mycotoxins via faeces and urine will be possible for a much wider range of mycotoxins and mycotoxin metabolites on a more routine basis.

This offers advantages for both companies that are developing mycotoxin binders as well as to customers that want to evaluate the products available on the market.

Treatment	Weight gain (g)	Mortality (%)	Aspartate amino transferase (IU/L)
Control	875[a]	0	50[a]
S. gallinarum	720[b]	6	55[a]
OTA	700[b]	0	68[b]
OTA + S. gallinarum	550[c]	15	73[b]

Table 2. Effect of the mycotoxin Ochratoxin A on the pathogenicity of salmonella.

Fig. 1. Synergism (S) and antagonism (A) between mycotoxins.

	AFL	DON	DAS	NIV	T-2	HT-2	ZEA	FB1	OTA	CIT
AFL			S		S				S	
DON					S		S	S	A	
DAS										
NIV										
T-2						S				
HT-2										
ZEA										
FB1										
OTA										A
CIT										

AFL = Aflatoxin, DON = Deoxynivalenol, DAS = Diacetoxyscirpenol, NIV = Nivalenol, T-2 = T-2 toxin, HT-2 = HT-2 toxin, ZEA = Zearalenone, FB1= Fumonisin B1, OTA = Ochratoxin A, CIT = Citrinin.

Reducing the risk

In general, two approaches can be identified as the basis of any management programme to reduce the negative effects of mycotoxins in animal production. The first one simply aims at recovering the economical losses due to mycotoxin contamination. This is often not a good approach as products that cure the problems instead of avoiding them would pass some efficacy tests suc-

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cessfully.

However, the problem would not be solved at its roots and consequently any changes in the programme evaluation conditions such as initial health status of the animals, level of mycotoxin contamination or interactions between several mycotoxins may change the efficacy of the programme dramatically.

An alternative philosophy that can be used as a starting point is food safety. When a programme is developed with the aim to avoid absorption of mycotoxins by the animal and consequently also subsequent metabolism and deposition, then the problem is attacked at its fundaments.

Consequently, the programme will assure recovery of animal performance under a much broader range of different conditions.

In the context of food safety it is also of extreme importance not to focus on zootechnical performance alone. It is known that certain products have important growth promoting effects. Consequently, animal performance data may show significant recovery after mycotoxin ingestion, although an important amount of mycotoxins may still be absorbed by the animal. In general these types of 'masking' phenomena can be easily recognised in any animal trial by including a control group that receives the mycotoxin binder without mycotoxins being present.

The desired absence of growth promotion is proven when there is no difference between these two treatments (Table 3).

Mycotoxin masking can also be revealed when the organ status is evaluated (weight, appearance, histology). Increased organ weights are a simple indication of tissue damage or metabolic defence against the absorbed toxins (Table 4).

Several potential mycotoxin binders have been shown to improve animal performance without the organ weights recovering to normal levels. This indicates that mycotoxins are probably still being absorbed and that they can be deposited into animal products, which may lead to food safety issues. Again starting from the food safety philosophy it would not be appropriate to add products that support organ health as these may have growth promoting properties (and hide the mycotoxin risks) or hide the effect of mycotoxins, that have been absorbed and are circulating in the blood stream where they can damage a wide variety of tissues and organs.

In total a combination of seven criteria can be proposed to assess the performance of mycotoxin binders from a food safety perspective:

- Proof of broad spectrum mycotoxin binding performance.
- Maintain availability of essential nutrients to the animal.
- Evaluate growth promoting effects as growth promotion potentially masks mycotoxicosis.
- Improvement of zootechnical performance.
- Recovery of organ status.
- Data on mycotoxin excretion via faeces.
- Recovery of the immune status.

These criteria all seek to unequivocally prove that the mycotoxicosis is attacked at its roots. This means that the beneficial effects of the mycotoxin binder can be clearly attributed to reduced mycotoxin absorption by the animal and increased excretion of the toxins.

It is evident that when the origin of the problem is dealt with that animal performance and the economic return will also be restored to the normal level (Table 5).

Management of mycotoxins starts with prevention of mould growth through the application of appropriate mould inhibitor nutricines.

However, since mycotoxin contamination can be the result of mould growth during storage as well as mould growth in the field, curative interventions using mycotoxin inactivators need to be part of any food safety management programme (Fig. 2). Selection of the right mycotoxin inactivating agent has to be done with utmost care. Traditional mycotoxin binders/adsorbents may be very unselective and also bind essential nutrients. Alternatively, they can often be too selective and fail to show broad spectrum mycotoxin binding activity.

In the context of food safety, it is important not to focus on zootechnical performance alone. It is known that certain mycotoxin inactivators have growth promoting effects, thereby hiding the mycotoxin problem without eliminating the food safety risks.

The new generation mycotoxin inactivator nutricines developed by Kemin, called Toxfin, have proven to be efficacious in vitro and in vivo.

Animal tests have shown that this nutricine has a broad-spectrum mycotoxin binding activity and does not bind essential nutrients.

Zootechnical performance recovers through the excretion of the mycotoxins via the faeces rather than via growth promotion. Organ status as well as immune status also recover.

It is clear that most branded products available on the market at least have some potential to bind mycotoxins as demonstrated in a wide range of reported in vitro assays.

It is up to the users of these products to select the best product available assisted by the seven criteria proposed in this article. These criteria, which have been developed from a food safety perspective, will strongly assist in making animal products safer for human consumption. However, compliance to these seven rules will also assure that profitability of animal production is optimised to the maximum as all negative effects of a wide range of mycotoxins will be eliminated. ■

References available from the author on request

Treatment	Weight gain (g)	Feed consumption (g)	FCR
Negative control (mycotoxin free feed)	1564[a]	2554[a]	1.63[a]
Negative control + Toxfin mycotoxin binder	1568[a]	2514[a]	1.60[a]

Table 3. Absence of growth promoting effects by a mycotoxin binder.

Treatment	Liver	Kidney
Negative control	1.96[a]	0.62[a]
Negative control + mycotoxins	2.74[b]	0.85[b]
Negative control + mycotoxins + Toxfin	2.02[a]	0.63[a]

Table 4. Effect of mycotoxins and inclusion of a mycotoxin binder on relative organ weights (%).

Treatment	Weight gain (g)	Feed consumption (g)	FCR
Negative control	1564[a]	2554	1.63[a]
Negative control + mycotoxins	1455[b]	2557	1.76[b]
Negative control + mycotoxins + Toxfin	1581[a]	2486	1.57[a]

Table 5. Recovery of zootechnical performance due to the inclusion of a mycotoxin binder.

Fig. 2. The role of mycotoxin binders in a complete food safety programme.