Management of mycotoxin contamination in raw materials and feeds

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Mycotoxins are well known for their various adverse effects. They can be carcinogenic, suppress the immune system, adversely affect reproduction and reduce bird performance. They are produced by various fungal species that are able to grow on almost any kind of raw material used in poultry feeds either in the field or during storage. Today, more than 300 different mycotoxins have been identified but only around 40 have been studied in poultry species.

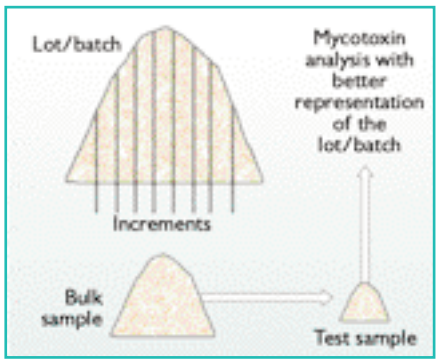
In order to reduce as much as possible the risks from mycotoxins, the management of animal feed raw materials has to be by a complete approach.

This article highlights different strategic points that have to be focused on for the effective management of this problem and the technical support available to both feed producers and farmers.

The sampling

The challenge of sampling is to have a true representation of the mycotoxin contaminations present in many tonnes in a test sample of less than 1kg. From a feed batch of several tonnes, several samples have to be taken from different parts in order to have a good representation. These samples are then mixed together in a homogenous way as a bulk sample of several kg. Then, a representative 500g sample is taken from this bulk sample and this is sent to the laboratory for analysis.

Fig. 1. General approach to mycotoxin analysis.



Batch weight		Number of samples	Weight of each sample (g)	Bulk sample (kg)	Test sample (g)
<50kg		3	300	1	500
50-500kg		5	200	1	500
500kg-1t		10	100	1	500
1-3t		20	100	2	500
3-10t		40	100	4	500
10-20t		60	100	6	500
20-50t		100	100	10	500
Batch weight (tonne)	**Sub-batch**	**Number of samples per sub-batch**	**Weight of each sample (g)**	**Bulk sample (kg)**	**Test sample (g)**
50-300	100t	100	100	10	500
300-1500	3 sub batch	100	100	10	500
>1500	500t	100	100	10	500

Table 1. Number of samples to collect as a function of the batch weight (regulation CE 401/2006).

The European legislation (Regulation CE 401/2006) has determined the right number of samples which have to be taken and, in the case of mycotoxin analysis, this number depends upon the weight of the initial batch of feed (see Table 1). This method gives a good representation of the final sample to be tested.

The method of sampling is primarily designed to reduce the total error during mycotoxin analysis. This is not the only source of error, but it is known to be the greatest one. Thus, it can be estimated that the method of sampling at port, feed mill or farm can represent 90% of the error (even in respect of the Recommendation CE 401/2006).

The method of sampling at the laboratory can equate to about 8% of these errors and imprecision due to the assay method seems to be only 2% of the total error. The regulation CE 401/2006 gives recommendations but, in the field, it can be very difficult to achieve these requirements. In addition, the number of samples required can be impractical. At the arrival in port CE 401/2006 recommends one analysis for every 100 tonnes up to a batch size of 500 tonnes, then one analysis every 250 tonnes until 1,000 tonnes and then one every 500 tonnes above 1,000 tonnes. For each analysis, the number of subsamples should be close to 100, of 100g each. This number of sampling is impossible to achieve in practice. Basically, the sampling for each truck loaded has to be done, and pooled together to constitute the bulk sample.

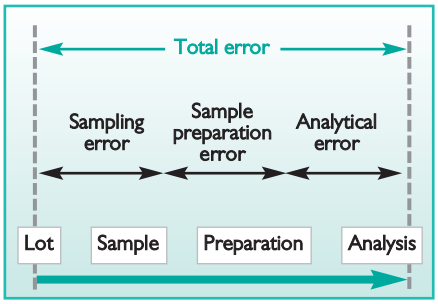


Fig. 2. The total error of a mycotoxins analysis.

On arrival at the farm/feed mill several methods of sampling can be used depending on the situation and the materials being sampled. If the raw material is delivered in bags (a full truck of around 25 tonnes contains some 500 bags), a sample of 100g each is taken every 50 bags.

In situations when more than four trucks were loaded with the same batch of raw material, material can be pooled together for analysis. In this case, a sampling is taken every 100 bags.

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If the raw material is delivered in bulk, the 'bulk sample' can be prepared by one of several methods.

- A trailer sampler can be used in order to withdraw from a minimum of 10 points in the truck (each of 100g), and these can be pooled to constitute the bulk sample.
- During the emptying of the trailer, when the doors are open, 10 subsamples (each of 100g) can be taken and pooled together.
- When a conveyor is used for transporting the raw material to a storage silo, a small hole (diameter of around 1.0cm) can be made in order to undertake a continuous sampling.

In the poultry house, feed samples can be taken directly from the feeder chains or feeders. Once again, several samples (at least 10) should be taken from the different chains/feeders in the house.

These can then be pooled together to make the 'bulk sample'. However, all these methods should be adaptable to every individual situation. Each case should be studied to decide which is the most efficient and representative method of sampling.

Complete understanding

It is important to have the maximum amount of information on the mycotoxin profile in order to be able to predict the effect of the mycotoxins at their respective levels on the birds.

To be as thorough as possible, 43 mycotoxins and metabolites (see inset) are analysed routinely by Neovia in each sample to be able to provide an accurate and specific diagnosis.

For each kind of mycotoxin contamination, their effects differ depending on the species,

Field mycotoxins

Family of trichothecenes type A
T-2 toxin
HT-2 toxin
T-2 tetraol
T-2 triol
DAS or Diacetoxyscirpenol
15 acetoxy scirpenol or MAS
Verrucarol

Family of trichothecenes type B
Deoxynivalenol or DON (or vomitoxin)
DOM-1 (metabolite of DON)
Nivalenol
Fusarenon X
15-O-acetyl 4-Deoxynivalenol (15 ac DON)
3-acetyl-Deoxynivalenol (3 ac DON)

Family of trichothecenes type D
Roridin A
Verrucarin A

Family of zearalenone and metabolites
Zearalenone
alpha zearalanol
beta zearalanol
alpha zearalenol
beta zearalenol

Family of fumonisins
Fumonisin B1
Fumonisin B2
Fumonisin B3

Other molecules produced by Fusarium
Moniliformin

Storage mycotoxins

Family of ochratoxins
Ochratoxin A
Ochratoxin B
Ochratoxin alpha

Family of aflatoxins
Aflatoxin B1(1)
Aflatoxin B2(1)
Aflatoxin G1(1)
Aflatoxin G2(1)

Family of tremorgenes toxins
Penitrem A
Verruculogen

Other molecules
Citrinin
Patulin
Cyclopiazonic acid
Sterigmatocystin

Field and storage mycotoxins
Family of alternaria toxins
Tenuazonic acid
Family of ergot alkaloids
Ergocornine
Ergocristine
Ergocryptine
Ergometrine
Ergosine
Ergotamine

age, sex and the general health status of the birds coupled to the duration of exposure and the level of contamination.

Moreover, most of the time, there is often more than one mycotoxin present in a raw material or feed and polycontamination does occur. Then, synergistic effects between mycotoxins can also be encountered.

For different geographical or climatic areas, local mycotoxin monitoring centres have been set up with local partners. These enable the local situation to be defined and better managed.

Action plan

For the raw material with the highest inclusion rate in the feed, batches have to be stored in relation to the mycotoxin risks identified by the different methods – either in dedicated silos or in well identified bags.

Then, the level of inclusion of contaminated raw materials in feed has to be adapted to the sensitivity to the mycotoxin linked to the target species, their age and sex, the duration of exposure and, finally, particular conditions, such as local hygiene standards and temperatures.

An integrated management of the formulation, taking mycotoxin contamination into account, should be set to maximise protection of the birds.

To give an example, with the LD50 data (lethal dosage for 50% of the animals) available in the scientific literature, it is possible to know the sensitivity of poultry to several mycotoxins.

Table 3. LD50 values for an aflatoxin B1 contamination.

Species	LD50 (ppm)
Duck (day-old)	0.46
Rabbit	0.50
Pig	0.56
Cat	0.78
Trout	0.81
Dog	1.00
Sheep	1.50
Guinea pig	2.00
Broiler chicken	6.65
Rat	7.00
Mouse	10.00

Thus, for the aflatoxin B1, the collected data in Table 3 shows big differences in sensitivity between species. As an example, ducks are about 15 times more sensitive than broilers.

In case of zearalenone contamination, the effects will be different in different sexes.

Even if an efficient management of the mycotoxin contamination of raw material reduces the risks, it does not give a full insurance to avoid adverse effects of mycotoxins.

Thus, the use of an adapted and validated antimycotoxins feed additive is recommended in sensitive situations. But what exactly is an adapted and validated antimycotoxins feed additive?

To fight against mycotoxins, there are different types of products: simple binders and complete anti-mycotoxins solution.

Simple binders

The products called 'binders' have mycotoxins adsorbent capacities able to eliminate the bound mycotoxins through the faeces. Some substances, such as silicate, charcoal and glucan derivatives are supposed to have binding ability.

However, the binding capacity of these products is highly variable.

Products have then to be evaluated on in

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vivo models that give a reliable response (as opposed to in vitro models that can only be used as first screening method but with a high number of false positive or false negative results).

Thus, Neovia has set up an original in vivo model, using young ducks, based on the protein plasmatic rate of these animals as biomarker of aflatoxin contamination to screen antimycotoxin products.

Highly efficient binders have been selected using this model, leading to theT5X range of commercial products. The efficiency of the T5X range has been validated by international references, such as the LAMIC in Brazil.

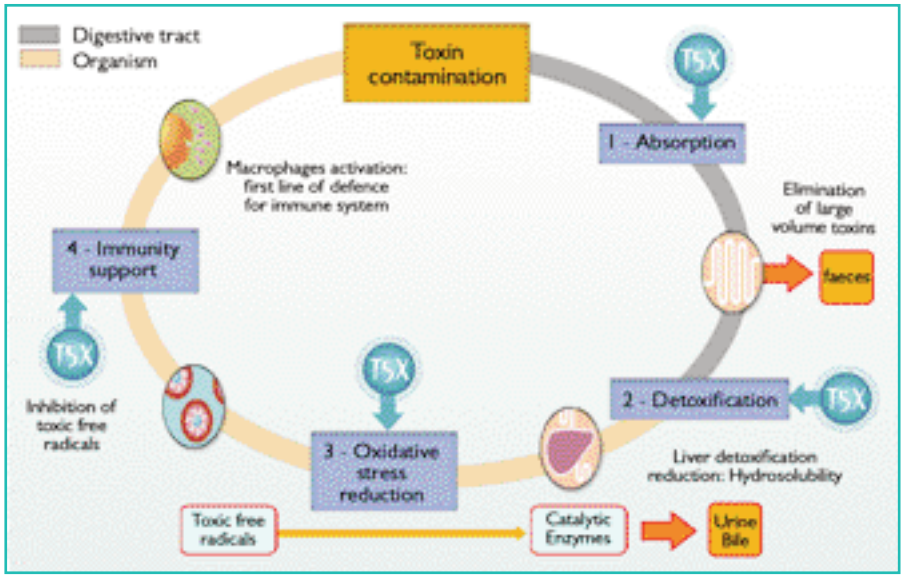
Complete solution

It is known that binders have only an action on the polar mycotoxins (such as aflatoxins). For the non-polar mycotoxins (such as trichothecenes) these products alone will not have any effect.

In addition to simple binding, other actions, either on the mycotoxin itself or on the bird, can help to counter the mycotoxin effect on the bird.

For example, Neovia has developed an original solution (based on a binder plus other components) able to support the bird's natural ways to detoxify the mycotoxin (stimulation of detoxification enzymes) in case of mycotoxin contaminations of the feed.

Boosting immunity and antioxidants complement the previous actions, in order to fight the well known immuno-depressive and pro-oxidant effects of almost all kind of mycotoxins.



Conclusion

The management of the risks from mycotoxins is a very large subject. It includes a dedicated management of the storage of the raw material, a dedicated sampling method before analysis, and a complete scientific knowledge of the mycotoxins' effects on the birds.

In addition, the use of a validated anti-mycotoxin solution will help, but without the right advice for incorporation into the feed, it will not give the expected effects to the birds. ■