SciCom

Opinion 01-2022 of the Scientific Committee established at the FASFC on the evaluation of the FASFC analysis programme: Mycotoxins in food and feed

Background & Terms of reference

Within the framework of a periodic evaluation of the analysis programme of the Federal Agency for the Safety of the Food Chain (FASFC), the Scientific Committee has been asked to discuss the programming of the analyses with regard to mycotoxins (including the fungus *Claviceps purpurea*) in food and feed. In particular, it has been requested (i) to verify whether control results reported between 2010 and 2019 indicate possible trends, and (ii) to assess the implementation of the approach generally applied within the FASFC for the programming of analyses (i.e. the control efforts in terms of, inter alia, the chosen "matrix/hazard" combinations and the number of analyses programmed for these combinations) and to identify possible gaps within the analysis programme 2021.

Method

The programming of the analyses is evaluated on the basis of expert opinion in combination with information from scientific literature. The trend analysis was performed using the NADA ('Nondetects and Data Analysis') package for R version 3.5.0 (2018-04-23) and is based on a regression for left-censored (i.e. results below the reporting limit) log-normal data using the analytical result as dependent variable and the year of analysis as independent variable. For the trend analysis and observation, only the results obtained in the context of the control plan are considered.

Conclusions & Recommendations

Mycotoxins are toxic metabolites of fungi that may grow on crops or derived products under certain conditions in the field or during storage. These toxins are found as natural contaminants in many foodstuffs of plant origin, particularly in cereals, and in animal feed as well. Some mycotoxins may be partly transferred from contaminated feed to products of animal origin, such as milk, eggs, meat and offal.

Mycotoxins can have serious acute and chronic effects on human and animal health. Depending on their specific properties and concentration, they can cause hepatotoxic, oestrogenic, immunotoxic, dermonecrotic, nephrotoxic or neurotoxic effects when ingested. Some mycotoxins are known or suspected to be carcinogenic. Possible effects on animal production include reduced growth, reduced egg and milk production, reduced reproductive efficiency and increased susceptibility of animals to stress or disease.

The FASFC analysis programme includes analyses of aflatoxins, ochratoxin A, fumonisins, ergot alkaloids and ergot (*Claviceps purpurea*; visual check), T-2 and HT-2 toxins, deoxynivalenol, zearalenone, patulin and citrinin in food and feed.

The trend analysis of the control results reported for these mycotoxins between 2010 and 2019 is given in annex to the opinion. However, it should be noted that the trend analysis is subject to a number of uncertainties, which are discussed in the opinion. Moreover, the growth of fungi and the development of mycotoxins strongly depend on factors related to crop husbandry and on climatological factors, and therefore also on region-dependent factors, while the control programme contains results from matrices of different origin (Belgian, European and from third countries). It is therefore difficult to identify correlations with previous steps in the agri-food chains (e.g. with regard to an increase in occurrence on certain crops) on the basis of observed trends.

With regard to the programmed analyses of these mycotoxins in foodstuffs, the Scientific Committee recommends in general that, in the case of cereal products such as flour, bread, biscuits, etc., sampling should concentrate on wholemeal products. As mycotoxins are mostly located on the outer skin of the grain, cleaning, sorting, sieving and dehulling of cereals leads to an increase in these toxins in cereal by-products, such as bran. It is also recommended to cancel the analyses of maize starch. During the manufacture of maize starch, toxins possibly present in the raw material will be washed out of the starch after the separation process, rendering the analysis of mycotoxins in maize starch less pertinent.
With respect to the analyses of animal feed, no analyses of pet feed are included at the moment. Because these may also be contaminated with mycotoxins, it is recommended to include these matrices (possibly thematically) in the analysis programme for mycotoxins. Focus could be on pet feed containing grains or derivatives of grains.
The analysis programme for feed already includes the analysis of aflatoxin B_1 in silage. A multi-mycotoxin analysis method could be used to determine the presence of other relevant mycotoxins, such as deoxynivalenol, zearalenone, patulin and citrinin, but also nivalenol, enniatins and beauvericin, in these same samples.

In addition, the Committee formulates following, more specific recommendations:

The detection of **aflatoxins** in cereals, cereal products and cereal-based products intended as food or feed should focus as much as possible on maize-based products. Maize from Southern Europe or (sub)tropical countries has a higher risk of contamination due to climatic conditions. For the analyses of spices, preference should be given to ground spices (e.g. ground pepper or nutmeg instead of peppercorns or nuts) and spice mixtures. Although a European limit is available for white pepper, the analysis of this matrix is less relevant. The fungi are mainly located in the seed scales of the grains, which are removed during the preparation of white pepper. The analyses of bread are also of little relevance and can be discarded.
The Committee has no remarks on the programmed analyses of aflatoxin M_1 in particular foods for infants and young children. It is however recommended to pay sufficient attention to the sampling of short-chain dairy products.
With regard to animal feed, the Committee proposes to increase the proportion of analyses of 'Distiller's dried grains solubles' (DDGS) to one third of the total number of analyses programmed for maize and products derived from maize. DDGS is a by-product of the bioethanol industry from cereals. However, not all grain batches used in the distillation process are food or feed grade. The analysis of DDGS is included for all mycotoxins covered by the analysis programme. The remaining two thirds of the analyses of maize and maize derived products can be equally divided between other maize products and by-products, and maize.

Most analyses of **ochratoxin A** in foodstuffs are programmed for spices, followed by cereals. Regarding spices, it is recommended to give preference to ground spices and to programme analyses of chilli powder in addition to cayenne pepper. Both are *Capsicum* spp. and equally relevant to analyse. As mentioned for the aflatoxins, the analysis of ochratoxin A in white pepper is less relevant. For cereals, the number of analyses of buckwheat could be reduced, as this is rather a niche cereal. Likewise for wheat gluten, for which in case of contamination a much lower ochratoxin A content is expected compared to the outer layers of the wheat grain. The Committee also recommends to analyse ochratoxin A in industrially produced, freshly baked bread, which is, for example, typically sold in supermarkets.
As regard to feed, ochratoxin A is analysed in raw feed material, compound feed for pigs (pigs for fattening, sows and others) and compound feed for poultry. Given the higher susceptibility of pigs than poultry to ochratoxin A, it is recommended to programme proportionally more analyses of compound feed for pigs, without changing the total number of analyses.

The Scientific Committee is of the opinion that the relative proportion of the analyses of **fumonisins** in maize and maize products intended for food should be increased given that *Fusarium* fungi producing fumonisins mainly colonise this crop. The analyses of other cereals and products based on these other cereals can be deleted, with the exception of wheat that can still be monitored to a limited extent as the presence of fumonisins in wheat has been reported occasionally.
With regard to animal feed, fumonisin analyses are programmed for raw feed materials and compound feed specific intended for pigs and for horses. The Committee has no remarks on the approach followed in programming these analyses or on the distribution of the analyses among the various matrices.

The presence of sclerotia (i.e. small packages of fungal mycelium) of the fungus ***Claviceps purpurea*** **or rye ergot** is visually (microscopically) checked by the FASFC in unprocessed cereals intended for food and feed. The possible presence of **ergot alkaloids** formed by rye ergot is only monitored in foodstuffs, more specifically in cereal products and products intended for infants and young children. However, the visual control of sclerotia in cereals has become more difficult by the evolved harvesting techniques, as sclerotia are highly fragmented during the threshing process. It is therefore recommended to also provide analyses of ergot alkaloids in unprocessed cereals intended for food and feed.
Most of the ergot alkaloid analyses in foodstuffs are programmed for cereal flour, especially wheat flour followed by rye flour. Although rye is less consumed than wheat in Belgium, it is recommended to allocate a higher share of analyses to rye and to rye derivatives (rye flour, mixture of several types of flour containing rye) and rye based products (e.g. gingerbread), as rye is the most sensitive crop to ergot contamination.
Sampling of short-chain products is useful as well because it can be assumed that in this (sub)sector more often organically grown crops of older varieties are offered. There are no scientific indications that organically grown grain is more susceptible to ergot contamination than conventionally grown grain, but older grain varieties are generally more susceptible to *C. purpurea*.

Regarding the programmed analyses of **T-2 and HT-2 toxins** in foodstuffs, it is recommended to programme more analyses of oats and barley and products derived from these cereals such as, for example, oatmeal and flour, but also, in particular, vegetable drinks derived from oats and barley (liquid or powdered). The analyses of wheat, rye, maize and their derivatives are less relevant.
The analyses programmed for T-2 and HT-2 toxins in animal feed concern raw feed materials. As T-2 and HT-2 contamination appears to affect mainly oats, it is recommended to focus the analyses on this crop. The analyses of corn gluten can be deleted and the share of the analyses of wheat can be reduced.

The analyses of **deoxynivalenol** in cereals intended for food are carried out on wheat and maize. It is recommended to include also rye and oats analyses. As for ochratoxin A, analyses of deoxynivalenol should be performed in industrially produced, freshly baked bread, which is typically sold in supermarkets. In the context of new consumption patterns, sufficient attention should also be paid to the sampling of mill products offered via the short chain. This is not only a concern for food, but also for feed.
The programmed analyses of deoxynivalenol in feed, concern compound feed for poultry and for sows, and raw feed materials. The Scientific Committee recommends that not only compound feed for sows, but also compound feed for fattening pigs be analysed.

The Committee has no additional remarks concerning the programmed analyses of **zearalenone** in foodstuffs besides the previously formulated recommendations to focus on wholemeal products (wholemeal wheat flour) and to delete the analyses of maize starch.
The programmed zearalenone analyses of animal feed concern compound feed for pigs and sows, compound feed for dairy cattle and raw materials. It is recommended to programme one third of the analyses of raw materials for cereals, cereal products and by-products other than maize, one third for maize, maize products and by-products (including maize gluten) and one third for DDGS. With respect to the analyses of compound feeds, it is noted that the population of dairy cattle should include milk-producing animals in general (i.e. including sheep, for example).

The FASFC analysis programme of **patulin** only includes foodstuffs. Although apples, the most relevant matrix for patulin contamination, are hardly used in animal feed, by-products from the juice industry, such as apple pulp, are. Patulin can also be found in silage. However, the occurrence of adverse effects on livestock are considered minor, making analysis of patulin in animal feed less of a priority.
Concerning the analysis of apple juice, it is recommended to sample particularly cloudy apple juice (with pulp), which in case of contamination may contain higher amounts of patulin compared to clear juices (without pulp). As far as other fruit juices are concerned, it is noted that the analysis of pear juice (or nectar) and possibly peach and grape juice (or nectar) is mostly relevant. It is also recommended to not only analyse baby food based on apples but also baby food based on fruit other than apples (possibly thematically).

The FASFC only checks the **citrinin** content in food supplements based on red yeast rice, which is the most relevant matrix and only matrix regulated for citrinin. Although citrinin can contaminate other foodstuffs, this is often at very low concentrations. The Committee therefore has no remarks on the programmed analyses of citrinin in foodstuffs.
The analysis of citrinin in feed is considered less of a priority.

The mycotoxins included in the analysis programme are mycotoxins for which limits (European maximum levels, guide values or action limits) are available. However, new analytical methods allowing, among other things, for lower detection limits, higher analytical speed and the ability to determine multiple compounds, are contributing greatly to increased knowledge of new mycotoxins, the so-called 'emerging' mycotoxins, and of modified forms of known mycotoxins.

A number of **'emerging' mycotoxins** are briefly discussed in the advisory report. These 'emerging' mycotoxins have so far not been sufficiently characterised. The follow-up of most of these 'emerging' mycotoxins in the context of food and feed safety does not allow for risk assessment, since both occurrence and toxicity have to be taken into account and these data are currently not sufficiently available. Nevertheless, in the context of changing climatic conditions, it may be considered to include some of these 'emerging' mycotoxins thematically or by applying multi-mycotoxin analytical methods in the analytical programme. For example, the Scientific Committee proposes to investigate the occurrence of nivalenol and enniatins in cereals, the main substrates for mycotoxin producing fungal growth, the *Alternaria* toxin tenuazonic acid in tomato products and nivalenol, enniatins and beauvericin in silage (see above).

Modified or hidden forms of mycotoxins may occur in contaminated food or feed, e.g. by biotransformation in the mould, crop or mammal, or by non-enzymatic reactions in the food or feed matrix.
Modified mycotoxins are usually not monitored in food or feed, but may contribute to the risk of exposure to the original mycotoxin. Indeed, modified mycotoxins may release the original mycotoxin through metabolisation in humans and animals or by further processing and thus increase the exposure and effects of the original mycotoxin. By analogy with the recommendation on 'emerging' mycotoxins, the thematic inclusion of specific modified forms of mycotoxins could be considered when multi-mycotoxin analytical methods are applied.

Another point of attention is the contamination of food and feed with multiple mycotoxins and their **combined toxicity**. The same mould can produce several mycotoxins and food and feed can be contaminated with different moulds. The simultaneous detection of several mycotoxins not only offers scientific added value, but can also offer pragmatic added value in terms of sampling and analytical capacity.

In addition, changing dietary habits and new or alternative protein sources of vegetable origin may also have an impact on future exposure to mycotoxins. Finally, it is noted that the occurrence of 'traditional' mycotoxins sometimes shifts to atypical products or matrices, or previously uncommon geographical regions, possibly partly as a result of global warming. In the future, this will have to be taken into account when programming the analyses of mycotoxins.

The full text is available on this website in dutch and in french.