

WHICH FOODS CAN CONTAIN MYCOTOXINS?

Cereals, flour, tree nuts, dried fruit, spices and coffee: mycotoxins can affect a wide range of foods. However, no food category is invariably contaminated, nor is there a universal ranking of the 'most dangerous' foods. Whether a particular mycotoxin is found depends on the fungal species, growing, harvesting, drying and storage conditions, and the controls undertaken throughout the supply chain.

The useful question therefore has two parts: which toxins may develop in a particular raw material, and under what circumstances? This relationship between substance and food matrix, rather than the mere presence of mould, guides scientific assessment and analytical testing programmes.

DIFFERENT FOODS, DIFFERENT CONTROLS

Indicative associations: they do not imply systematic contamination

CEREALS

DON, ZEN, fumonisins
T-2 and HT-2

TREE NUTS

Aflatoxins

DRIED VINE FRUIT AND COFFEE

Ochratoxin A

APPLES AND APPLE-BASED PRODUCTS

Patulin

MILK

Aflatoxin M1
via feed

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CEREALS AND FLOUR: ONE FOOD GROUP, DIFFERENT PROBLEMS

Wheat, maize, barley, oats, rye and rice may be affected by different mycotoxins. Certain metabolites of *Fusarium* fungi are particularly important in cereals grown in the field. Under particular conditions, deoxynivalenol (DON) and zearalenone are associated with wheat and other cereals; fumonisins are especially relevant to maize; and T-2 and HT-2 toxins can affect oats, among other cereals. Aflatoxins and ochratoxin A may also be relevant to certain commodities and environmental conditions.

A batch of durum wheat and a batch of maize therefore do not necessarily require the same testing profile. Weather during the growing season, variety, damage to grains and storage arrangements all influence the picture. Mycotoxin levels cannot reliably be inferred from a cereal's appearance alone.

Milling does not normally create new mycotoxins, but it may distribute existing toxins differently among the fractions of the grain. The mycotoxin content of flour therefore also depends on the raw material and the milling process. Bread, pasta, biscuits and other products may retain residues of toxins originally present, to varying degrees depending on the substance and process: cooking and processing cannot universally guarantee removal.

TREE NUTS, PEANUTS AND OILSEEDS

Pistachios, almonds, hazelnuts, walnuts and peanuts are frequently included in aflatoxin testing. Botanically, peanuts are legumes, but in terms of controls they share some issues with tree nuts and oilseeds. Conditions favouring the growth of certain *Aspergillus* fungi, together with inadequate harvesting, drying or storage, may increase contamination risk.

This does not mean every pistachio or peanut contains aflatoxins, or that the presence or absence of visible mould can certify a batch. Contaminants may be distributed very unevenly: a few highly contaminated nuts can substantially affect the overall result. Sorting, rejecting defective pieces and representative sampling are therefore particularly important.

MAIN MYCOTOXINS AND ASSOCIATED FOODS

Mycotoxin	Main associated foods	Fungus (genus)
Aflatoxins (B1, B2, G1, G2)	 Maize, peanuts, tree nuts, dried fruit, spices	<i>Aspergillus</i>
Ochratoxin A	 Cereals, coffee, cocoa, dried fruit, wine, spices	<i>Aspergillus</i> , <i>Penicillium</i>
Patulin	 Apples and apple-based products (juices, purées)	<i>Penicillium</i> , <i>Aspergillus</i> , <i>Byssoschlamys</i>
Fusarium toxins (DON, ZEN, fumonisins, T-2, HT-2)	 Wheat, maize, barley, oats, rye, other cereals	<i>Fusarium</i>
Citrinin	 Cereals, fermented rice (food supplements)	<i>Penicillium</i> , <i>Monascus</i>
Alternaria toxins	 Tomatoes, other vegetables and processed products	<i>Alternaria</i>

DRIED FRUIT, GRAPES AND APPLE PRODUCTS

Dried figs are an important matrix for aflatoxins. Raisins and other grape products may be affected by ochratoxin A, depending on supply-chain conditions. Correct drying reduces the water available for microbial growth; however, if contamination has already occurred, the fact that a product is dry does not establish that the toxin is absent.

Apples and apple products merit separate consideration because of patulin, which is particularly associated with damaged or spoiled fruit and may be relevant to juices and other processed products. Sorting fruit before pressing is therefore essential. These examples explain why speaking of 'fruit' in general is insufficient: apples, dried figs and raisins have different mycotoxin associations.

SPICES, COFFEE, COCOA AND OTHER PLANT PRODUCTS

Chilli, paprika, pepper and other spices may be contaminated with aflatoxins or ochratoxin A. Some spices travel through long supply chains involving successive stages of drying, transport and storage: geographical origin alone does not establish a

batch's quality. Controls should address both the raw material and actual production conditions.

In coffee, ochratoxin A is a substance to consider particularly during raw-material handling and bean storage. Cocoa and some cocoa products may also need targeted attention, depending on their origin and processing. Generalisations must nevertheless be avoided: products in the same category do not all have identical concentrations, and processing does not automatically render a non-compliant raw material compliant.

MILK AND FOODS OF ANIMAL ORIGIN: AN INDIRECT ROUTE

Mycotoxins do not reach consumers solely through plant products. The best-known example is aflatoxin M1, a metabolite that may occur in milk from animals fed feed containing aflatoxin B1. In this case, milk testing is closely linked to feed safety, particularly feed based on maize and other susceptible raw materials.

This does not mean that all mycotoxins pass into foods of animal origin in the same way. Transfer, metabolism and elimination depend on the particular substance and animal species. Assessments must therefore be specific rather than assuming that meat, eggs and milk all have the same risk profile.



ORGANIC, LOCAL AND ARTISAN FOODS: WHAT REALLY CHANGES?

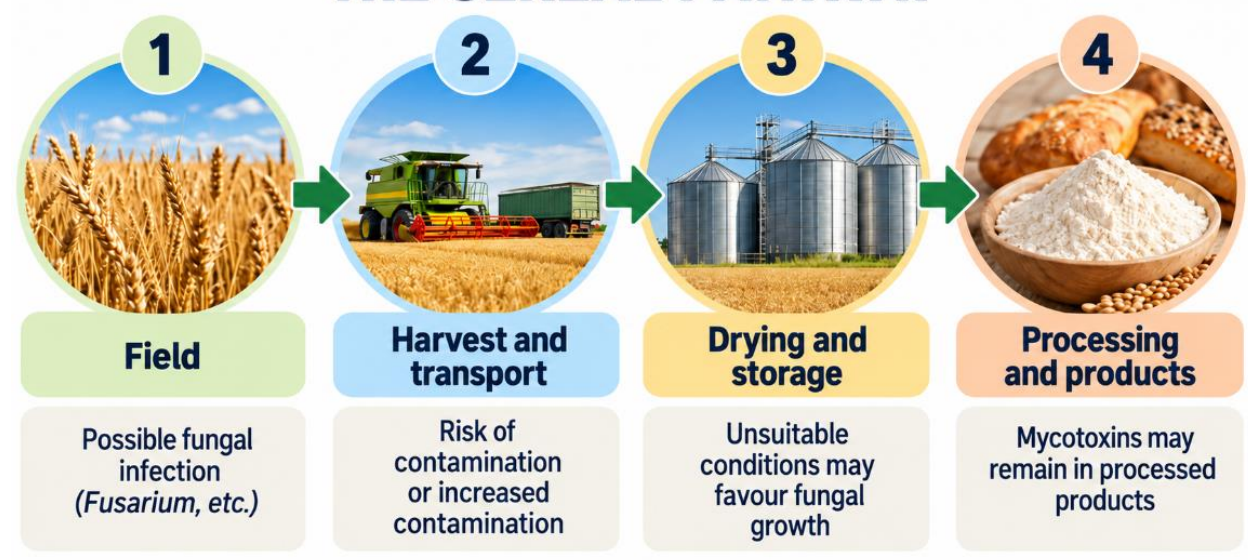
Mycotoxins are naturally occurring contaminants: they can develop in organic crops and in areas far from industrial pollution. An 'organic' label, mountain production or sourcing from a small farm does not itself guarantee the absence of mycotoxins. Equally, conventional production is not automatically more contaminated: outcomes depend on actual conditions and the preventive measures taken.

Origin and production method are useful for tracing the supply chain, but they do not replace representative analytical results where these are necessary. A key difference from many pollutants of human origin is that an environmentally unspoilt region can nevertheless produce contaminated crops in a season of unfavourable weather or as a result of poor storage.

WHY THE SAME FOOD CATEGORY CAN PRODUCE DIFFERENT RESULTS

Two batches of the same food may give very different results. Factors include temperature and humidity, rain close to harvest, drought stress, insect damage, the presence of toxigenic fungi, drying times and warehouse conditions. The link between climate and contamination is not the same for all toxins: conditions favouring one fungal group may not favour another.

FROM RAW MATERIAL TO PRODUCT: THE CEREAL PATHWAY



There is also an analytical difficulty: mycotoxins may be extremely unevenly distributed within a batch. A sample taken without an appropriate procedure may not represent the consignment. It is therefore wrong to treat a single positive or negative result as a definitive description of an entire harvest without considering the sampling plan.

PRESENCE, EXPOSURE AND RISK ARE DIFFERENT

Detecting a mycotoxin demonstrates its presence in the portion analysed, not automatically harm to health. Concentration matters when assessing exposure, but so do the amount consumed, frequency of consumption and individual circumstances. Children and people who consume large amounts of certain food categories may require a specific assessment.

Regulation (EU) 2023/915, as amended, lays down maximum levels for certain mycotoxins in specified food categories. There is no single value applying to all toxins and all foods. Exceeding a legal limit and assessing the toxicological implications of exposure are related but distinct issues. Even a compliant product is not necessarily free of every measurable trace.

FROM FOOD CATEGORIES TO TESTING INDIVIDUAL PRODUCTS

The conclusion is not to avoid cereals, nuts, spices or coffee, all of which may form part of a balanced diet. Rather, each food matrix calls for attention proportionate to the plausible mycotoxins and the history of its supply chain. Information about origin, agricultural practices, storage, sorting, traceability and testing are complementary. The next chapters examine the main mycotoxin groups, their effects and the principles of control in more detail.

SCIENTIFIC AND REGULATORY REFERENCES

- [1. EFSA – Mycotoxins: overview and occurrence in food.](#)
- [2. WHO \(2023\) – Mycotoxins: fact sheet.](#)

3. [European Commission – Legislation on contaminants in food.](#)
4. [European Commission – Regulation \(EU\) 2023/915, as amended, on maximum levels for certain contaminants in food.](#)
5. US Food and Drug Administration – <https://www.fda.gov/food/natural-toxins-food/mycotoxins>