Food Safety AUTHORITY OF IRELAND

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Mycotoxins in Food

The aim of this document is to provide food business operators (FBOs), enforcement officers and other stakeholders with a concise overview of the health hazards of, and sources of dietary exposure to, mycotoxins in food. It gives information on methods of sampling and analysis for these contaminants and the legislative control measures in place to minimise their presence in food. Finally, it provides a short guidance for FBOs on the risk management measures that they should have in place to control mycotoxins in food and also a bibliography giving sources of further information. The summary below gives a short synopsis of the information, while the following pages provide more technical detail.

Summary

Mycotoxins are natural chemical substances produced by fungi (molds) growing as contaminants on some food crops (in field and in storage), in particular cereals, nuts and fruit. Their presence in crops and in foods and animal feeds produced from them is undesirable, as they are toxic and have a number of adverse effects on health, both in humans and animals. Mycotoxins can affect the immune system, nervous system, liver, kidneys, blood and blood, and some mycotoxins are known to be carcinogens (cancer-causing).

Mycotoxins vary widely in their toxicity and the toxic effects may be both acute (after a single exposure) and chronic (after repeated exposure). The most important mycotoxins in terms of effects on health are the aflatoxins, ochratoxin A, patulin and the Fusarium toxins (tricothecenes including DON, zearalenone and fumonisins). Aflatoxins, which occur particularly in nuts, are considered to be the most toxic of the mycotoxins and long-term low level exposure to aflatoxins has been associated with liver diseases such as cancer, cirrhosis, hepatitis and jaundice in humans and animals.

Maximum levels (MLs) for the major mycotoxins in affected food crops have been set by Commission Regulation 1881/2006/EC, the framework EU legislation which sets maximum levels for chemical contaminants in foodstuffs, as amended by Commission Regulation (EC) No 1126/2007. Levels are also regulated in animal feed. These MLs are set at a very low level (as low as reasonably achievable for the particular food/feed and mycotoxin in question), in order to ensure that consumers' health is not affected by consuming these products.

In order to ensure that these MLs are not exceeded, routine surveillance of food and feed must be carried out, involving the taking of samples of potentially contaminated produce, followed by laboratory analysis to determine the levels of mycotoxins in the product. The Food Safety Authority of Ireland (FSAI) in collaboration with its agencies, including the Public Analyst Laboratories (PALs), the Department of Agriculture, Fisheries and Food (DAFF) and Teagasc, carry out regular checks on levels of mycotoxins in the food chain. The results of these checks show that the levels in both Irish-produced and imported food and feed are generally very low, and are considered to present little risk to the health of the Irish consumer, although occasional instances of contamination are detected.

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In addition to the overall responsibility placed on FBOs by the General Food Law (Directive 178/2002) to supply safe food, FBOs must also ensure that their products comply with the legislative limits for mycotoxins as laid down in Commission Regulation (EC) No 1881/2006 as amended. It is important that FBOs identify critical control points (CCPs) in their processes that may result in mycotoxin contamination, such as mouldy grain or nut products, or storage conditions that may lead to the development of mould. Application of Good Agricultural Practice (GAP) is an important aspect. The identification of appropriate CCPs along the process chain will enable FBOs to develop and apply proper HACCP and GAP systems which will ensure that there are no unforeseen sources of mycotoxin contamination in their products.

1. Introduction

Mycotoxins are natural chemicals produced by certain fungi which occur as contaminants of some food crops, either in the field or during post-harvest storage. Cereals, nuts, fruits and foods derived from these crops are the most likely to contain mycotoxins. As the name suggests, mycotoxins are toxic to humans and animals, and consumption of food containing high levels of these contaminants may cause illness. Three types (genera) of fungi are the major producers of mycotoxins – *Fusarium*, *Pencillium*, *Aspergillus*. Within each type of fungus, particular species may be mycotoxigenic, or mycotoxin-producing. While hundreds of mycotoxins have been identified from a very large number of fungi, only 20-30 mycotoxins have been associated with potential toxicity to animals and humans. Table 1 shows some of the major species of fungus which produce mycotoxins and the foods and animal feeds affected.

Table 1: Some major species of fungus which produce mycotoxins in food and feed

FUNGUS	MYCOTOXIN	FOOD/FEED AFFECTED
Fusarium		
F. graminearum	Trichothecenes (Type A: DAS, T-2,	cereals (wheat, maize)
F. culmorum	HT-2; Type B: DON, NIV)	
F. langsethiae		
F. crookwellense	Zearalenone	cereals, rice, beer, silage
F. semetectum		
F. moniliforme		
F. proliferatum		
Penicillium		
P. verrucosum	Ochratoxin A, Citrinin	cereals (wheat, barley)
P. aurantiogriseum	Pencillic acid, Citreoviridin	
P. citrinum	Cyclopiazonic acid, Penitrem A	nuts, fruit
P. expansum	Patulin	fruit and vegetables, silage
Aspergillus		
A. flavus	Aflatoxins B_1, B_2, G_1, G_2	cereals, maize, nuts
A. parasiticus	Cyclopiazonic acid	
A. versicolor	Sterigmatocystin	
A. ochraceus	Ochratoxin A	cereals, coffee, fruit, nuts, beer

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2. Mycotoxin toxicity

Mycotoxin-related illnesses have been recognised for centuries, without knowing the cause. For example, "St. Anthonys Fire" was a recognised disease, caused by eating rye contaminated with ergot alkaloids produced by the fungus *Claviceps purpurea*, as far back as 1000 AD. Only in the last century were mycotoxins identified as being the causative agents of illness, both in humans and animals. Mycotoxins vary widely in their toxicity and the toxic effects may be both acute (after a single exposure) and chronic (after repeated exposure). The **Aflatoxins** are considered to be the most toxic of the mycotoxins, aflatoxins B1, B2, G1 and G2 being the principal aflatoxins of concern. Long-term low level exposure to aflatoxins has been associated with liver diseases such as cancer, cirrhosis, hepatitis and jaundice in humans and animals and they are regarded both as genotoxic (DNA-damaging) carcinogens and as immunosupressants. **Ochratoxin A** also has immunosuppressant, teratogenic (reproductive) and carcinogenic effects, and a clear connection has been shown between nephropathy (kidney disease) and exposure to Ochratoxin A in humans and animals. Other Penicillium mycotoxins such as Penicillic acid and Citrinin have been found to enhance the toxic effect (synergism) of Ochratoxin A on liver and kidney carcinogenesis in animals. **Patulin** is a potent protein synthesis inhibitor and is also regarded as genotoxic. In animal toxicity studies, the effects observed include reduced weight gain, impaired kidney function and intestinal effects. **Citreoviridin** is a neurotoxin in animals, resulting in paralysis and muscular atrophy. **Trichothecenes** at relatively high levels give rise to acute symptoms of vomiting, diarrhoea and allergic reactions in humans. These mycotoxins are also associated with reduced weight gain (failure to thrive) in animals and immune dysfunction. **Zearalenone** is an oestrogenic substance with relatively low overall toxicity but it has been shown to have uterotrophic (anti-reproductive) effects in pigs. The effects of this mycotoxin in humans are not clearly established. The **Fumonisins** may have neurotoxic effects in some animals, and carcinogenicity in humans has been proposed but not proven.

In assessing the toxicity of mycotoxins to humans, a number of considerations are important. The main issue is the potential carcinogenic effect of a number of the mycotoxins, which is considered to be mediated via a so-called genotoxic (DNA-damaging) mechanism, meaning that in theory no safe level can be established for this effect. This has implications for the setting of maximum levels for these contaminants in food and feed. For other effects of the mycotoxins, the level of exposure and the period of exposure may affect toxicity. Furthermore, since more than one mycotoxin may be present in a food, additive and/or synergistic effects (where one mycotoxin enhances the toxicity of another) may be important. Also, the immunosuppressant effect of a range of mycotoxins may impact on already immune-compromised individuals. Animals are likely to be exposed to much higher levels of mycotoxins, via contaminated animal feed, and have shown symptoms such as higher mortality, reproductive failures, reduced feed efficiency and reduced productive capacity, e.g. decreased liver weight, milk yield, etc., etc. The toxins can carry through into products from these animals.

3. Exposure to mycotoxins

The Food and Agriculture Organization (FAO) estimates that 25% of the world's food crops, overall, are affected by mycotoxins. Considering that these food crops include cereals, nuts, fruit and vegetables which comprise a significant part of the European consumer's diet, there is potentially a significant exposure to mycotoxins. Exposure of consumers to mycotoxins is mainly via plant foods. However, an additional potential exposure may be via foods of animal origin such as milk, cheese and meat, as a result of consumption of contaminated feed by food animals. This illustrates the need to control levels of mycotoxins in animal feed as well as food. Available data on the incidence of mycotoxins in various foodstuffs, for example from various EC SCOOP Reports (see Biobliography, *Human Exposure to Mycotoxins*), indicate that the situation is very different for different mycotoxins.

Aflatoxins occur mainly in commodities imported from the tropics and sub-tropics, in particular pistachio nuts, groundnuts (peanuts), other edible nuts such as Brazil nuts, dried figs, spices and maize, and products derived from these commodities. While individually none of these commodities may be major contributors to the diet, the range of commodities in which the aflatoxins are found means that there is a significant potential for exposure. The consumer may also be exposed indirectly to aflatoxin M1and M2, the hydroxylated metabolites of aflatoxin B1 and B2, through milk from cows fed aflatoxin-containing feed. The main contributor to the dietary intake of **ochratoxin A** seems to be cereals and cereal products, but the contaminant has been detected at relatively high levels in dried vine fruits such as raisins and has been also reported in coffee, beer, wine and nuts. Additionally, exposure may occur as a consequence of consumption of meat from pigs fed ochratoxin-containing feed. Human exposure to ochratoxin A has been demonstrated in several European countries in blood and human milk. Estimates of mean dietary intakes of ochratoxin A for average adult persons presented in the EC SCOOP Report were in the range from close to zero to a few ng/kg body weight/day. **Patulin** is found in a variety of mouldy fruits, vegetables and cereals. Major sources of exposure are products such as juice derived from apples and pears, and exposure of young children, for whom these food items may represent an important component of the diet, is of particular concern. However, it should be noted that mycotoxin contamination is rarely a problem with clear juices made from concentrate and when it occurs is mainly associated with fresh-pressed (cloudy) juices. The **Fusarium toxins** such as the trichothecenes, zearalenone and the fumonisins, occur mainly in cereals grown in more moderate climates including Ireland. Results for a total of 35,000 cereal samples from 12 countries showed a positive incidence of approximately 30% overall. 57%, 16%, 20% and 14% of samples tested for DON, NIV, T-2 and HT-2 toxins, respectively, were positive. While these contaminants may be of lower toxicity than the aflatoxins, ochratoxin A, etc., their occurrence in food commodities that are eaten more widely by consumers means that levels must also be rigorously controlled in food and feed.

Exposure to mycotoxins may be decreased or increased due to food processing, e.g. processes such as cleaning, sorting and grading of cereals and fruits may reduce mycotoxin content by a factor of two. Processing of cereals involving milling and refining to produce flour may also reduce some mycotoxin content of the food product. Thermal processing, such as heating, roasting, baking, may inactivate some mycotoxins. However, the effect of food processing on removal or inactivation of mycotoxins varies for the different mycotoxins. Conversely, processing activities that involve germination of cereals such as malting/mashing/fermentation of barley have the potential to increase mycotoxin release and/or production from mycotoxigenic fungi which may be present on the barley.

The FSAI and other bodies responsible for ensuring the safety of Irish food and animal feed, including PALs, DAFF and Teagasc, carry out regular checks on levels of mycotoxins in the food chain. The results of these checks show that the levels in Irish food and feed are generally very low, and are considered to present little risk to the health of the Irish consumer.

4. Sampling and analysis of mycotoxin-containing commodities

Mycotoxins in the field may occur on particular ears/grains of cereals and individual fruits or nuts. In storage, mycotoxins may occur in particular "hot" spots in the bulk stored material. Because mycotoxins usually occur in a non-uniform distribution in a food commodity, sampling is particularly important and it is difficult to obtain a representative sample for analysis. Sampling of bulk material therefore involves taking numerous samples throughout the material, at various locations and depths, according to a specified protocol. The individual (or incremental) samples are composited and this composite (or aggregate) sample is mixed by grinding and blending followed by sub-sampling to obtain a sample for analysis. The required minimum

sample size to obtain a single representative sample depends on the overall size of the lot to be sampled, the homogeneity of the foodstuff and the size of the individual particles or components contained in it, e.g. grain size, with larger samples being required with increasing particle size and heterogeneity.

The statutory sampling and analysis procedures for commodities likely to be contaminated by mycotoxins are laid down in EC Regulation 401/2006, which has been subsequently amended by Commission Regulation (EC) No 1126/2007, as detailed further in Section 5 of this information document. Additionally, the FSAI will publish a separate information document on sampling for aflatoxins in food in the near future, while a guidance document for competent authorities has also been published by the European Commission for the control of compliance with EU legislation on aflatoxins, which provides useful additional information on legislative controls, sampling and analysis. The procedures outlined in this guidance, while directed towards aflatoxins, are widely applicable to all foodstuffs potentially contaminated by mycotoxins.
(http://ec.europa.eu/food/food/chemicalsafety/contaminants/comm_dec_2006_504guidance_en.pdf)

Analysis for mycotoxins in food samples involves a wide variety of residue extraction, clean-up, concentration and determination techniques. The mycotoxin content in the purified, concentrated sample extracts is normally determined by chromatography using HPLC or GC. More recently, mass spectrometry, in the form of GC-MS and LC-MS/MS has been applied to determination of mycotoxins in food sample extracts. The analytical method chosen must be validated and must meet certain performance criteria as laid down in the individual EC Directives on sampling and analysis detailed in Section 5 below. Given that the analytical methodology for mycotoxins requires sophisticated equipment and experienced analysts, in recent years a number of rapid screening methods have been developed that can be applied, e.g. by FBOs or by authorities in developing countries, who do not always have access to the necessary analytical equipment. These include immunoassays, which are widely available as commercial kits for screening for the presence of mycotoxins in food samples. These kits may be provided in the form of enzyme linked immunosorbent (ELISA) microtitre plate assays, giving quantitative or semiquantitative results. Other formats, such as lateral flow membrane ("dipstick") or tube-based tests, are available for very rapid testing in a non-laboratory environment.

5. Legislative controls for mycotoxins

MLs for certain mycotoxins in foodstuffs have been set by Commission Regulation (EC) 1881/2006/EC, the framework EU legislation which sets maximum levels for chemical contaminants in foodstuffs, which has been subsequently amended by Commission Regulation (EC) No 1126/2007. The EU legislation on contaminants in food is transposed in national legislation by S.I. No. 400 of 2001. A summary of the maximum levels specified is given in Table 2 (Appendix).

In addition to the MLs set for certain mycotoxins in foodstuffs, a series of Commission Decisions (so-called Safeguard Decisions) have been issued which require control authorities in Member States to specifically monitor certain foodstuffs entering the European Union from a third country outside the European Union. These Decisions cover Brazil nuts from Brazil, peanuts from China, pistachios from Iran, figs, hazelnuts, pistachios from Turkey, peanuts from Egypt and almonds from the US, all of which have shown a high incidence of aflatoxin contamination during routine surveillance programmes and have been the subject of a large number of Rapid Alerts (that is, notifications to control authorities in member states through the European Commission's Rapid Alert System for Food and Feed, RASFF). These Decisions require, inter alia, that these commodities are sampled at a specified frequency by competent authorities at the point of entry into Europe, before the foodstuff is distributed further in the European market. The guidance document for competent authorities published by the European Commission for the control of compliance with EU legislation on aflatoxins mentioned above provides useful additional information.

The statutory sampling procedures for commodities likely to be contaminated by mycotoxins have been set out in Regulation 401/2006, laying down the methods of sampling and analysis for the official control of the levels of mycotoxins in foodstuffs, which is a consolidated version of previous sampling and analysis Directives for the individual mycotoxins. This EC Regulation is transposed in Irish legislation by the European Communities (Sampling Methods and Methods of Analysis for the Official Control of the Levels of Certain Contaminants in Foodstuffs) (No. 2) Regulations 2006, S.I. No. 412 of 2006.

6. HACCP and GAP for mycotoxin control and responsibilities of FBOs

In addition to the overall responsibility placed on FBOs by the General Food Law (Directive 178/2002) to supply safe food, FBOs must also ensure that their products comply with the legislative limits for mycotoxins as laid down in Commission Regulation (EC) No 1881/2006 as amended. It is important that FBOs identify CCPs in their processes that may result in mycotoxin contamination, such as mouldy grain or nut products, or storage conditions that may lead to the development of mould. The identification of appropriate CCPs along their process chain will enable them to develop and apply proper HACCP systems which will ensure that there are no unforeseen sources of mycotoxin contamination in their products.

While the crop is growing, in the field, adherence to GAP is most important in preventing fungal growth and mycotoxin formation. While GAP is designed to produce healthy, sound plants, rather than specifically to prevent the occurrence of mycotoxins, the controls involved by the application of GAP will normally have this beneficial side-effect. GAP will typically involve the proper preparation of the land, crop rotation, use of fungus and/or pest resistant cultivars, control of insect damage to the growing crop, control of fungal infection, prevention of stress to the growing crop, e.g. drought, weeds, harvesting at the appropriate time, and correct handling and storage after harvesting. While crops produced according to GAP may be expected to be free of mycotoxins, in some cases specific CCPs are appropriate at the field stage such as removal of visibly damaged material at harvest (which would be susceptible to fungal growth and mycotoxin production) or particular outdoor drying regimes for peanuts immediately post-harvest. Codex Alimentarius has produced a number of Codes of Practice covering GAP for food commodities likely to be contaminated by mycotoxins, while the European Commission has published a Code of Practice for the reduction and prevention of patulin contamination in apple juice and apple juice ingredients in other beverages, and is in the process of finalising a further Commission Recommendation on the prevention and reduction of *Fusarium* toxins in cereals and cereal products.

Storage conditions, such as temperature, water activity (a_w), storage time, aeration and pest infestation, contribute to mould growth and mycotoxin production. Moisture content or, more particularly water activity or "free" water, is critical to facilitating the growth of fungi (and potential production of mycotoxins). Since water activity is related to the equilibrium relative humidity, it is a function of temperature, so both moisture content and temperature must be controlled during storage. Pest damage may result in heating and moisture generation, leading to fungal growth and mycotoxin production in localised "hot spots". A properly developed and applied HACCP system in food production, together with GAP in crop production, will contribute significantly to the prevention of mycotoxins in food crops.

In the case of mycotoxin hazards, application of HACCP will involve development of a Commodity Flow Diagram (CFD) which shows clearly the various steps for the food crop - primary production, storage, transport and processing. From the CFD it is possible to identify the HACCP CCPs, including parameters such as moisture content, temperature, and visible damage that must be monitored. For each CCP identified, the parameter to be measured must be defined and critical limits established. Procedures for monitoring of the CCPs against their critical limits must be established and corrective actions defined to deal with situations

where the critical limits are not being achieved, e.g. if a moisture content of ≤ 15% is the critical limit for a cereal at a certain storage point (CCP), the corrective action for material exceeding 15% moisture might be removal and checking for mycotoxin content. An effective HACCP system requires verification that application of the CCPs is achieving the goal of appropriate mycotoxin levels in the commodity. The HACCP system must be documented and a system of recording developed for the monitoring of CCPs and corrective actions. It is the responsibility of the FBO to test his products for mycotoxin content at the point of sale. Sampling and analysis should be carried out in accordance with the principles outlined in this section, which refers both to official controls and to sampling and analysis carried out by FBOs. Laboratories selected by the FBO should be accredited and should be able to comply with the requirements of Regulation 401/2006.

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Appendix

Table 2. Summary of maximum levels specified for mycotoxins in foodstuffs

(NB: specific footnotes attached to entries in the Commission Regulation have not been included in this Table, and should be checked in the Regulation

ENTRY NO. (IN RELEVANT EC REG.)	FOOD PRODUCT	MYCOTOXIN	MAX. LEVEL (µg/kg)
2.1.1	Groundnuts to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	8.0 15.0
2.1.2	Nuts to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	5.0 10.0
2.1.3	Groundnuts, nuts and processed products thereof, intended for direct human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	2.0 4.0
2.1.4	Dried fruit to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	5.0 10.0
2.1.5	Dried fruit and processed products thereof, intended for direct human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	2.0 4.0
2.1.6	All cereals and all products derived from cereals, including processed cereal products, with the exception of foodstuffs listed in 2.1.7, 2.1.10 and 2.1.12	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	2.0 4.0
2.1.7	Maize to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	5.0 10.0
2.1.8	Raw milk, heat-treated milk and milk for the manufacture of milk-based products and as defined by Council Directive 92/46/EEC)	Aflatoxin M_1	0.05
2.1.9	Following species of spices: *Capsicum spp.* (dried fruits thereof, whole or ground, including chillies, chilli powder, cayenne, and paprika), *Piper spp.* (fruits thereof, including white and black pepper) *Myristica fragrans* (nutmeg) *Zingiber officinale* (ginger) *Curcuma longa* (turmeric)	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	5.0 10.0

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ENTRY NO. (IN RELEVANT EC REG.)	FOOD PRODUCT	MYCOTOXIN	MAX. LEVEL (µg/kg)
2.1.10	Processed cereal-based foods and baby foods for infants and young children	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$	0.1 –
2.1.11	Infant formulae and follow-on formulae, including infant milk and follow-on milk	Aflatoxin M_1	0.025
2.1.12	Dietary foods for special medical purposes intended specifically for infants	Aflatoxin B_1 Total $B_1+B_2+G_1+G_2$ Aflatoxin M_1	0.1 – 0.025
2.2.1	Unprocessed cereals	Ochratoxin A	5.0
2.2.2	All products derived from unprocessed cereals, including processed cereal products and cereals intended for direct human consumption with the exception of foodstuffs listed in 2.2.9 and 2.2.10	Ochratoxin A	3.0
2.2.3	Dried vine fruit (currants, raisins and sultanas)	Ochratoxin A	10.0
2.2.4	Roasted coffee beans and ground roasted coffee excluding soluble coffee	Ochratoxin A	5.0
2.2.5	Soluble coffee (instant coffee)	Ochratoxin A	10.0
2.2.6	Wine (including sparkling wine, excluding liqueur wine and wine with an alcoholic strength of not less than 15 % vol) and fruit wine	Ochratoxin A	2.0
2.2.7	Aromatised wine, aromatised wine-based drinks and aromatised wine-product cocktails	Ochratoxin A	2.0
2.2.8	Grape juice, concentrated grape juice as reconstituted, grape nectar, grape must and concentrated grape must as reconstituted, intended for direct human consumption	Ochratoxin A	2.0
2.2.9	Processed cereal-based foods and baby foods for infants and young children	Ochratoxin A	0.5
2.2.10	Dietary foods for special medical purposes intended specifically for infants	Ochratoxin A	0.5
2.2.11	Green coffee, dried fruit other than dried vine fruit, beer, cocoa and cocoa products, liqueur wines, meat products, spices and liquorice	Ochratoxin A	–
2.3.1	Fruit juices, concentrated fruit juice as reconstituted and fruit nectars	Patulin	50.0
2.3.2	Spirit drinks, cider and other fermented drinks derived from apples or containing apple juice	Patulin	50.0

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ENTRY NO. (IN RELEVANT EC REG.)	FOOD PRODUCT	MYCOTOXIN	MAX. LEVEL (µg/kg)
2.3.3	Solid apple products, including apple compote, apple puree intended for direct consumption with the exception of foodstuffs listed in 2.3.4 and 2.3.5	Patulin	25.0
2.3.4	Apple juice and solid apple products, including apple compote and apple puree, for infants and young children and labelled and sold as such	Patulin	10.0
2.3.5	Baby foods other than processed cereal-based foods for infants and young children	Patulin	10.0
2.4.1	Unprocessed cereals other than durum wheat, oats and maize	Deoxynivalenol	1250.0
2.4.2	Unprocessed durum wheat and oats	Deoxynivalenol	1750.0
2.4.3	Unprocessed maize, with the exception of unprocessed maize intended to be processed by wet milling	Deoxynivalenol	1750.0
2.4.4	Cereals intended for direct human consumption, cereal flour, bran and germ as end product marketed for direct human consumption, with the exception of foodstuffs listed in 2.4.7, 2.4.8 and 2.4.9	Deoxynivalenol	750.0
2.4.5	Pasta (dry)	Deoxynivalenol	750.0
2.4.6	Bread (including small bakery wares), pastries, biscuits, cereal snacks and breakfast cereals	Deoxynivalenol	500.0
2.4.7	Processed cereal-based foods and baby foods for infants and young children	Deoxynivalenol	200.0
2.4.8	Milling fractions of maize with particle size > 500 micron falling within CN code 1103 13 or 1103 20 40 and other maize milling products with particle size > 500 micron not used for direct human consumption falling within CN code 1904 10 10	Deoxynivalenol	750.0
2.4.9	Milling fractions of maize with particle size ≤ 500 micron falling within CN code 1102 20 and other maize milling products with particle size ≤ 500 micron not used for direct human consumption falling within CN code 1904 10 10	Deoxynivalenol	1250.0
2.5.1	Unprocessed cereals other than maize	Zearalenone	100.0

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ENTRY NO. (IN RELEVANT EC REG.)	FOOD PRODUCT	MYCOTOXIN	MAX. LEVEL (µg/kg)
2.5.2	Unprocessed maize with the exception of unprocessed maize intended to be processed by wet milling (*)	Zearalenone	350.0
2.5.3	Cereals intended for direct human consumption, cereal flour, bran and germ as end product marketed for direct human consumption, with the exception of foodstuffs listed in 2.5.6, 2.5.7, 2.5.8, 2.5.9 and 2.5.10	Zearalenone	75.0
2.5.4	Refined maize oil	Zearalenone	400.0
2.5.5	Bread (including small bakery wares), pastries, biscuits, cereal snacks and breakfast cereals, excluding maize-snacks and maize-based breakfast cereals	Zearalenone	50.0
2.5.6	Maize intended for direct human consumption, maize-based snacks and maize-based breakfast cereals	Zearalenone	100.0
2.5.7	Processed cereal-based foods (excluding maize-based foods) and baby foods for infants and young children	Zearalenone	20.0
2.5.8	Processed maize-based foods for infants and young children	Zearalenone	20.0
2.5.9	Milling fractions of maize with particle size > 500 micron falling within CN code 1103 13 or 1103 20 40 and other maize milling products with particle size > 500 micron not used for direct human consumption falling within CN code 1904 10 10	Zearalenone	200.0
2.5.10	Milling fractions of maize with particle size ≤ 500 micron falling within CN code 1102 20 and other maize milling products with particle size ≤ 500 micron not used for direct human consumption falling within CN code 1904 10 10	Zearalenone	300.0
2.6.1	Unprocessed maize with the exception of unprocessed maize intended to be processed by wet milling	Fumonisins (sum of B1 and B2)	4000
2.6.2	Maize intended for direct human consumption, maize-based snacks and maize-based breakfast cereals with the exception of foodstuffs listed in 2.6.3 and 2.6.4.	Fumonisins (sum of B1 and B2)	1000

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ENTRY NO. (IN RELEVANT EC REG.)	FOOD PRODUCT	MYCOTOXIN	MAX. LEVEL (µg/kg)
2.6.3	Maize-based breakfast cereals and maize-based snacks	Fumonisins (sum of B1 and B2)	800
2.6.4	Processed maize-based foods and baby foods for infants and young children	Fumonisins (sum of B1 and B2)	200
2.6.5	Milling fractions of maize with particle size > 500 micron falling within CN code 1103 13 or 1103 20 40 and other maize milling products with particle size > 500 micron not used for direct human consumption falling within CN code 1904 10 10	Fumonisins (sum of B1 and B2)	1400
2.6.6	Milling fractions of maize with particle size ≤ 500 micron falling within CN code 1102 20 and other maize milling products with particle size ≤ 500 micron not used for direct human consumption falling within CN code 1904 10 10	Fumonisins (sum of B1 and B2)	2000