BIOTOXIN

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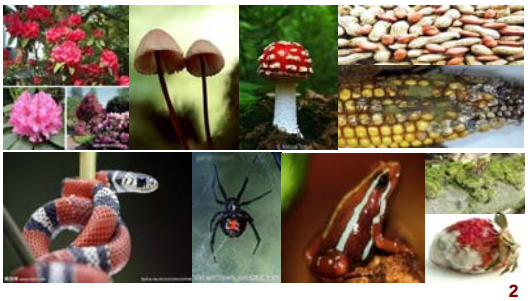
Biotoxin



Biotoxin

Identification of Biotoxin

- A biotoxin is a poisonous substance that is a specific product of the metabolic activities of a living organism (plant, animal, fungus, bacteria).
- Unlike most other biohazards, biotoxins do not replicate and, in some senses, are more analogous to chemical toxins.

Food Safety Effects

- Biotoxins are extremely common, and they can grow on a wide range of substrates under a wide range of environmental conditions.
- Biotoxins can enter the food chain in the field, during storage, or at later points.
- Ranks mycotoxins as the most important chronic dietary risk factor, higher than synthetic contaminants, food additives, or pesticide residues.

Human health effects

- Biotoxins have the potential for both acute and chronic health effects via ingestion, skin contact, and inhalation.
- These toxins can enter the blood stream and lymphatic system; they inhibit protein synthesis, damage macrophage systems, inhibit particle clearance of the lung, and increase sensitivity to bacterial endotoxin.
- Depending on specific substances and concentration, they are cancerogenic, mutagenic, teratogenic and immunosuppressive.

Classification of Biotoxin

- Microbial toxins
- Phytotoxin
- Animal toxins
- Marine toxins




Microbial toxins

- Microbial toxins are toxins produced by micro-organisms, including bacteria and fungi.
- Microbial toxins promote infection and disease by directly damaging host tissues and by disabling the immune system.
  - Mycotoxin
  - Bacterial toxin

Mycotoxin

- Mycotoxins are secondary metabolites produced by microfungi that are capable of causing disease and death in humans and other animals.
- With regard to the widespread distribution of fungi in the environment, mycotoxins are considered to be one of the most important natural contaminants in foods and feeds.
- According to an estimate of FAO, roughly 25 % of the world's food production contains mycotoxins. The main source for mycotoxins entering the food chain are cereals, but many other food items such as fruits and nuts may be contaminated with mycotoxins as well.
- Currently, more than 500 different mycotoxins are known; however, sufficient knowledge has been collected only for a limited number of them.

Types of Mycotoxins

- Aflatoxins (produced by Aspergillus) - includes Aflatoxin B1, B2, G1, G2, M1 and M2
- Ochratoxin - includes Ochratoxin A, B, and C
- Trichothecene (produced by Stachybotrys) - includes Satratoxin-H, Vomitoxin and T-2 mycotoxins
- Fumonisins - includes Fumonisin B1 and B2
- Zearalenone
- Citrinin
- Ergot Alkaloids
- Patulin
- Fusarium toxins

MRL of mycotoxins in food

- GB 2761—2011 MRL of mycotoxins in food


GB
中华人民共和国国家标准
GB 2761—2011
食品安全国家标准
食品中真菌毒素限量

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Fumonisins			
Fumonisins B1, A2, A3, B1, B2, B3, C1, C2, C3, P1, P2, P3	*Fusarium verticillioides, F. proliferatum, F. nygamai, F. napiforme, F. dlamini, F. anthophilum, F. subglutinans, Alternaria alternata*	Maize, maize based products, sorghum, sorghum, asparagus, rice	Sum of fumonisins B1 and B2: 200–4,000 µg/kg (infant foods, processed maize-based foods, unprocessed maize)
Hydrolyzed and partially hydro-lyzed fumonisins	Product of food processing		

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Trichothecenes			
Type A trichothecenes: T-2 toxin, HT-2 toxin, diacetoxyscirpenol, neosolaniol, verrucarol	*Fusarium sporotrichioides, F. poae, F. culmorum, F. equiseti, F. graminearum, F. moniliforme, Cephalosporium sp., Myrothecium sp., Trichoderma sp., Trichothecium sp., Phomopsis sp., Stachybotrys sp., Verticimonosporium sp.*	Cereals, cereal based products	In discussion for T-2 and HT-2 toxin

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Type B trichothecenes: nivalenol, deoxynivalenol, 3-acetylDON, 15-acetylDON, fusarenon-X	*Fusarium graminearum, F. culmorum, F. sporotrichioides, F. cerealis, F. lunulosporum*	Cereals, cereal based products	Deoxynivalenol: 200–1,750 µg/kg (infant food, processed cereal-based foods, unprocessed cereals)
Deoxynivalenol-3-glucoside	Metabolite of deoxynivalenol		

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Zearalenones			
Zearalenone	*F. graminearum, F. culmorum, F. crookwellense, F. equiseti, F. sporotrichioides*	Barley, oats, wheat, rice, sorghum, sesame, soy beans, cereal based products	20–400 µg/kg (maize based infant food, processed cereal-based and maize based foods, unprocessed maize, refined maize oil)
α- and β-zearalenol, α- and β-zearalanol	Metabolites of zearalenone		

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Ochratoxins			
Ochratoxins A, B, C	*Aspergillus ochraceus, A. niger, A. melleus, A. sulphureus, A. alliaceus, A. albertensis, A. sclerotiorum, A. citricus, Neopetromyces muricatus, Penicillium viridicatum, P. verrucosum, P. cyclopium, P. corbierense*	Cereals, dried fruit, raisins, wine, coffee, oats, spices, rye	Ochratoxin A: 0.5–10 µg/kg (infant foods, processed cereal-based foods, unprocessed cereals, dried vine fruits and instant coffee)
Ochratoxin α	Metabolite of ochratoxin A		

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Aflatoxins			
Aflatoxins B1, G1, B2, G2	*Aspergillus flavus, A. nomius, A. parasiticus, A. nomiticola, Emericella astellata, E. venezuelensis, E. olivicola*	Maize, wheat, rice, spices, almonds, oilseeds, dried fruits, cheese	Sum of aflatoxins B1, B2, G1 and G2: 4–15 µg/kg, aflatoxin B1 0.1–8 µg/kg: fruits, ground nuts, dried fruits, cereals, maize)
Aflatoxins M1 and M2	Metabolites of aflatoxin B1 and B2	Milk, eggs, meat	Aflatoxin M1: 0.025–0.05 µg/kg (infant and dietary foods, milk)

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Ergot alkaloids			
Ergocornine/inine, ergocryptine/inine, ergocryptine/inine, ergosine/inine, ergotamine/inine	*Claviceps purpurea, C. africanaum, C. fusiformis, C. fusiformis, C. paspali, Neotyphodium coenophialum*	Wheat, rye, hay, barley, millet, oats, sorghum, triticale	

MRL of mycotoxins in food

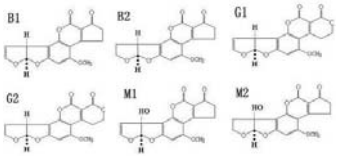
Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Alternaria toxins			
Alternariol; alternariol monomethyl ether; altertoxin I; altertoxin II; altertoxin III; tenuazonic acid	*A. alternata*, *A. dauci*, *A. cucumerina*, *A. solani*, *A. tenuissima*, *A. citri*	Wheat, rice, rye, olives, sorghum, tobacco, apples, peppers, sunflower seeds, oilseed rape, pecan nuts, tomatoes, mandarins	

MRL of mycotoxins in food

Mycotoxins	Main producers/origin	Food commodity	Maximum level (EC 1881/2006 amended by EC 1126/2007)
Fusarium			
Fumonisin A, fumonisin A1, fumonisin B, fumonisin B1	*Fusarium verticillioides*, *F. subglutinans*, *Alternaria*, *Alternaria alternata*, *Aspergillus niger*, *Verticillium* sp.	Wheat, corn, barley, bread mill, oat flour, rice	
Patulin	*Aspergillus clavatus*, *A. longivesica*, *A. terreus*, *P. expansum*, *Penicillium griseofulvum*, *Byssochlamys* sp.	Apples, apple sauce, churros, cereal grains, grapes, pears, bilberries	10–50 µg/kg (infant foods, apple juice, solid apple, spirit drinks derived from apples or containing apple juice, fruit juices)
Beauvericin	*F. bulbicola*, *F. dlamini*, *F. fredkrugii*, *F. proliferatum*, *F. succisae*	Wheat, corn, barley, bread mill, oat flour, rice	
Fusaproliferin	*Fusarium proliferatum*, *F. concentricum*, *F. anthophilum*, *F. begoniae*, *F. succisae*, *F. subglutinans*, *F. verticillioides*, *F. nygamai*, *F. sulawesi*, *F. subglutinans*	Wheat, corn, barley, bread mill, oat flour, rice	

Aflatoxins

- The four major aflatoxins are called B1, B2, G1, and G2.



- Aflatoxin B1 is the most potent natural carcinogen known and is usually the major aflatoxin produced by toxigenic strains..

Aflatoxins

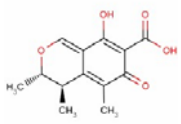
- Many substrates support growth and aflatoxin production by aflatoxigenic molds. Natural contamination of cereals, figs, oilseeds, nuts, tobacco, and other commodities.
- Crops-in the field before harvest
- Crops-in storage-moisture content
- Animals –use grains as an animal feed
- Milk products -When cows consume aflatoxin-contaminated feeds, they metabolically biotransform aflatoxin B1 into a hydroxylated form called aflatoxin M1.

Aflatoxins

- Aflatoxin is associated with both toxicity and carcinogenicity in human and animal populations.
- Acute aflatoxicosis results in death; chronic aflatoxicosis results in cancer, immune suppression, and other “slow” pathological conditions.

Citrinin

- Citrinin was identified in over a dozen species of *Penicillium* and several species of *Aspergillus*.
- More recently, citrinin has also been isolated from *Monascus ruber,* industrial species used to produce red pigments.

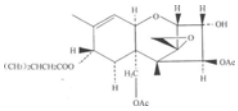


Citrinin

- Citrinin acts as a nephrotoxin in all animal species tested, but its acute toxicity varies in different species. The 50% lethal dose for ducks is 57 mg/kg; for chickens it is 95 mg/kg; and for rabbits it is 134 mg/kg.
- Citrinin can act synergistically with ochratoxin A to depress RNA synthesis in murine kidneys.
- Wheat, oats, rye, corn, barley, and rice have all been reported to contain citrinin.

Fumonisins

- Fumonisins were first described and characterized in 1988. The most abundantly produced member of the family is fumonisin B1.
- The major species of economic importance is Fusarium verticillioides

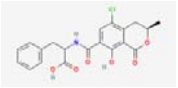


Fumonisins

- Fumonisins affect animals in different ways by interfering with sphingolipid metabolism. They cause leukoencephalomalacia in equines and rabbits; pulmonary edema and hydrothorax in swine; and hepatotoxic and carcinogenic effects and apoptosis in the liver of rats.
- In humans, there is a probable link with esophageal cancer.
- The occurrence of fumonisin B1 is correlated with the occurrence of a higher incidence of esophageal cancer in regions of Transkei (South Africa), China, and northeast Italy.

Ochratoxin

- Ochratoxin A was discovered as a metabolite of *Aspergillus ochraceus* in 1965.
- Members of the ochratoxin family have been found as metabolites of many different species of *Aspergillus*, including *Aspergillus alliaceus*, *Aspergillus auricomus*, *Aspergillus carbonarius*, *Aspergillus glaucus*, *Aspergillus melleus*, and *Aspergillus*.



Ochratoxin

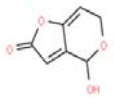
- Ochratoxin A is a nephrotoxin to all animal species studied to date and is most likely toxic to humans, who have the longest half-life for its elimination of any of the species examined.
- In addition to being a nephrotoxin, animal studies indicate that ochratoxin A is a liver toxin, an immune suppressant, a potent teratogen, and a carcinogen.

Ochratoxin

- Ochratoxin has been detected in blood and other animal tissues and in milk, including human milk. It is frequently found in pork intended for human consumption.
- Ochratoxin is associated with disease and death in poultry.

Patulin

- Patulin, 4-hydroxy-4H-furo[3,2c]pyran-2(6H)-one, is produced by many different molds but was first isolated as an antimicrobial active principle during the 1940s from *Penicillium patulum* (later called *Penicillium urticae,* now *Penicillium griseofulvum*).



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Patulin

- Patulin is regularly found in unfermented apple juice.
- Patulin is toxic at high concentration in laboratory settings, but evidence for natural poisoning is indirect and inconclusive.
- A provisional maximum tolerable daily intake for patulin of 0.4 mg/kg of body weight per day.

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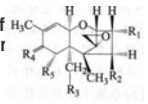
Trichothecenes

- The trichothecenes constitute a family of more than sixty sesquiterpenoid metabolites produced by a number of fungal genera, including *Fusarium, Myrothecium*, *Phomopsis, Stachybotrys*, *Trichoderma*, *Trichothecium*, and others.
- They are commonly found as food and feed contaminants, and consumption of these mycotoxins can result in alimentar hemorrhage and vomiting; direct contact causes dermatitis



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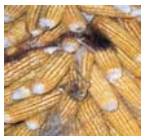
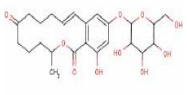
Zearalenone

- Zearalenone (6-[10-hydroxy-6-oxo-*trans*-1-undecenyl]-B-resorcyclic acid lactone), a secondary metabolite from *Fusarium graminearum* (teleomorph *Gibberella zeae*).





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Bacterial toxin

- Bacterial toxins are by-products produced by pathogenic microbes that have taken up residence in the body.
- Bacteria generate toxins which can be classified as either exotoxins or endotoxins.
- Some bacterial toxins can be used in the treatment of tumors.

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Bacterial toxin

- Most cases of food poisoning are infections caused by bacteria such as ***Salmonella*** and ***Campylobacter***.
- Only three bacterial species are considered important causes of the intoxication type of food poisoning.
  - *Bacillus cereus*
  - *Clostridium botulinum*
  - *Staphylococcus aureus*

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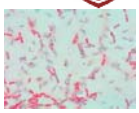
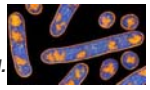
Bacillus cereus

- *Bacillus cereus* is a Gram-positive spore-forming bacterium, which can produce two different types of toxin.
- Foods involved in *B. cereus* emetic food poisoning cases are usually starchy, such as boiled or fried rice, potatoes, pasta and noodles. The toxin is extremely heat-stable and will withstand cooking.



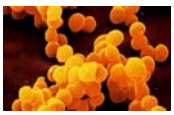
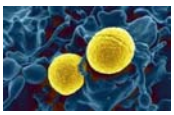
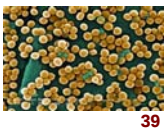
Clostridium botulinum

- The Gram-positive anaerobic bacterial species *Clostridium botulinum* is the causative organism for the very severe illness, botulism.
- Botulism is caused by highly potent neurotoxins, which can be pre-formed in food during growth of *Cl. botulinum* cells.
- There are at least seven different types of *Cl. botulinum* (A – G), each forming a different toxin. These can be divided into four groups, but only two, Groups I and II, are important in food safety.


Staphylococcus aureus

- *Staphylococcus* spp. are Gram-positive, non-sporeforming cocci. The most important toxigenic species in food microbiology is *Staph. Aureus.*
- Staphylococcal enterotoxins are heat-stable proteins and pre-formed in foods. Ingestion of food containing at least 0.1-1 μg of toxin can cause a mild form of food poisoning with a rapid onset of symptoms.

Staphylococcus aureus

- Foods associated with staphylococcal food poisoning include dairy-based products, such as cream and custard, cured and cooked meats and cheeses. Outbreaks have also been linked to pasta, sandwiches and sausages. Staphylococcal enterotoxins are heat resistant and will withstand cooking.

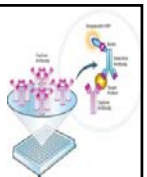





Web sites for biotoxin information

- www.cast-science.org
- www.mycotoxicology.org
- www.mycotoxin.de
- www.aocs.org
- www.fao.org
- www.iupac.org
- www.chujo-u.ac.jp/myco/index.html
- www.fda.gov

Analysis of Biotoxin



Analysis procudure

Methods for Mycotoxins Analysis

- Sampling
- Extraction of analytes from the matrix (usually with mixtures of water and polar organic solvents) possibly followed by an extract purification
- Final detection and quantitative determination.

Sampling

- Sampling - Your first step towards correct analytical results
- Sampling is the largest source of variability associated with the mycotoxins analysis procedure, and the most crucial step in obtaining reliable results.
- The European Commission issued the Commission Regulation ***(EC) 401/2006*** laying out the sampling methods.
- Generally, it is possible to recommend that the most effective way to reduce the overall variability of results is **to increase the size of the laboratory sample, ensure the proper milling, and homogenization.**

Sampling

- Two types of mistakes cause inconsistency among mycotoxin test results:
- First, good lots (in the range of regulatory limits) that may be rejected; the so-called sellers' risk (false-positives).
- Sec- ond, bad lots (over the regulatory limits) that may be accepted by the sampling program; the so-called buyers' risk (false-negatives).
- Increasing the size of a sample decreases both the buyers' and sellers' risks but it will be very expensive.

Extraction Method

- Extraction can be performed by liquid–liquid extraction (LLE) or solid phase extraction (SPE) using a solid and a liquid phase.
- liquid–liquid extraction (LLE)
  - Polar analytes favor polar solvents and pH plays a key role during extraction.
- solid phase extraction (SPE)
  - One of the most significant recent improvements in the purification step is the use of SPE. Test extracts are cleaned up before instrumental analysis to remove co-extracted materials that often interfere with the determination of target analytes.
- In some cases, multiple extractions are necessary for the analysis of mycotoxins.

Extraction Method

- *Accelerated solvent extraction (ASE).*
- In ASE, solvents are used at relatively high pressure and temperatures at or above the boiling point. In this case, parameters like temperature, pres- sure, static time, cell size, and solvent used are very important.

Clean-up methods

In mycotoxins analysis, purification of extracts is important, especially in case of their determination at trace levels.

- *Solid-phase extraction* (SPE)
- *Immuno- affinity columns* (IACs)
- Multifunctional columns

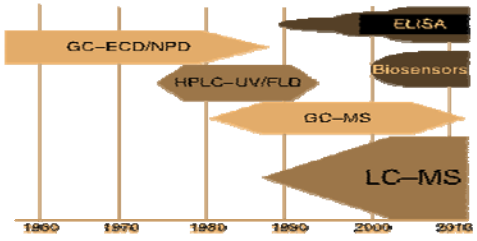
QuEChERS Approach

- QuEChERS approach (Quick, Easy, Cheap, Effective, Rugged, and Safe)
- Due to the acidic nature of some mycotoxins (e.g. fumonisins) and the risk of their binding on the sorbent, this approach is not recommended.

Instrumental analysis

- Thin layer chromatography（TLC）
- Gas chromatographic
- HPLC-systems incl. fluorescence and UV-detection
- HPLC-MS/MS systems
- Immunoaffinity Chromatography
- Enzyme-linked immunosorbent assays (ELISA)
- Biosencors

Instrumental analytical procedures



Trends in the analysis of mycotoxins from the time perspective years 1960–2010.

Methods of Biotoxin Analysis——TLC

- Thin Layer Chromatography (TLC)
- Thin-layer chromatography (TLC) is a technique that can be used for the separation, purity assessment, and iden- tification of organic compounds.
- Aflatoxin B1, B2, G1, G2，T-2 Toxin， Ochratoxin A，Zearalenone

Methods of Biotoxin Analysis——*GC*

- In the past, methods based on GC approach were routinely used for determination of trichothe- cenes, zearalenone, ochratoxin A, patulin, and citrinin.
- Draw- back：need to carry out derivatization of analytes prior to sample analysis.
  - GC–MS
  - GC–ECD
  - GC×GC–TOFMS

Methods of Biotoxin Analysis——HPLC

- HPLC has become the main method for mycotoxin analysis. Coupled with a variety of detectors, practically all mycotoxins have been separated and detected by HPLC.
  - Fluorescence detector (FLD)
  - UV detector
  - Diode-array detector (DAD)
  - Photodiode array detector (PDA).

Overview of latest analytical methods for mycotoxins determination employing liquid chromatography coupled with conventional detectors

References	[46]			[47]	[48]	[49]	[50]	[51]	[52]		[53]	[54]	[55]	[56]	[57]	[58]	[59]
Matrices	Cereals, cereal products			Rice	Medicinal plants	Red paprika, black pepper	Wheat flour	Milk	Paprika		Honey, natural sweetners, vinegars, apple juice	Rye, rye products	Dried apple rings	Apple juice	Oats, cereal foods	Green coffee, roasted coffee	Blue cheese
Analyte	FB1, FB2	OTA	ZEA	DON	Aflatoxins	OTA	OTA	DON	Aflatoxin M1	Aflatoxins	OTA	PAT	Ergot alkaloids	PAT	PAT	HT2, T2	OTA	OTA
LODs (μg/kg)	41 (FB1); 51 (FB2)	0.004	5.5	20–65	0.3–0.16	0.3	5	0.005	0.01	0.25–0.45[b]	0.9[b]	0.009 (μg/L)	up-to-3.3	n.p.	0.25 (μg/L)	8 (HT2); 8 (T2)	0.012	0.02
Extraction solvent	MeCN: MeOH: water	MeCN: water	MeCN: water	MeCN: water	MeOH: water	MeOH: water	MeCN: water	MeCN: water/ water/ MeOH: water	None	MeOH: water	MeOH: NaHCO$_3$	Water: MeCN: perchloric acid	Ethyl acetate: MeOH: aqueous ammonia	Water	Ethyl acetate: Na_2CO_3 solution	MeOH: water	MeOH:water containing sodium hydrogen carbonate and PEG	$CHCl_3$, NaCl, H_3PO_4
Purification	LAC	LAC	LAC	LAC	LAC	LAC	Mycosep	Mycosep/ LAC/Oasis HLB	LAC	LAC	LAC	no	SPE with basic alumina	Silica gel SPE	no	LAC	LAC	LAC
Detection method	FLD[c]	FLD	FLD	DAD	FLD	FLD	FLD	PDA	FLD	FLD	FLD	DAD	FLD	DAD	DAD	FLD[c]	FLD	FLD

Abbreviations of analytes: *FB1* fumonisin B1, *FB2* fumonisin B2, *OTA* ochratoxin A, *ZEA* zearalenone, *DON* deoxynivalenol, *PAT* patulin, *HT2* HT-2 toxin, *T2* T-2 toxin
n.p. – information not provided
[a] LOD presented in μg/L
[b] LOQ (limit of quantification)
[c] Pre-column derivatization employed

Methods of Biotoxin Analysis——HPLC–MS

HPLC–MS/MS has become the most rising analytical tool for the determination of mycotoxins and their metabolites.

- without the need of derivatization
- low detection limits
- the ability to generate structural information of the analytes
- the minimal requirement of sample treatment
- mass spectrometers are general detectors that are not so dependent on chemical characteristics.

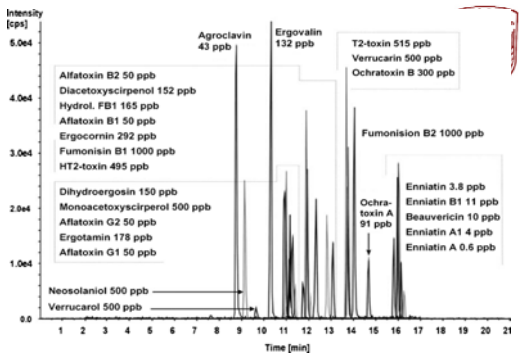


Fig. 3. The LC–ESI(+)-MS/MS total ion current chromatogram (sum of all MRM transitions) of a mixture of mycotoxins. The diluted wheat extract was spiked with a multi-mycotoxin standard and injected directly (reproduced from (73) with permission from Springer).

Overview of recent LC–MS based methods for multi-mycotoxin analysis with none of minimal sample clean-up

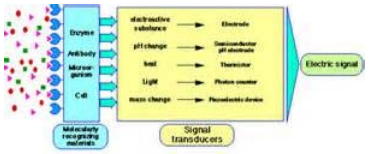
Reference	(74)	(75)	(76)	(77)		(27)	(78)	(79)	(35)	(80)	(81)
Matrices, which is method validated for	Wheat, maize, bread-crumbs	Maize, meet, eggs, milk, honey, horse feed	Peanut slurry, pistachio slurry, wheat slurry, maize slurry, dry-miller cornflakes, raisin slurry, fig slurry	Wheat, maize	Wheat, maize	Wheat, barley, oats	Maize, walnuts, biscuits, breakfast cereals	Maca, soy isoflavones, garlic, black radish, St John's wort, ginkgo biloba	Wheat, barley, maize	Beer	Beer
Example of LOD (μg/kg) for particular analyte/ matrix combination[a]	Bread-crumbs	Horse feed	Maize slurry	Wheat	Wheat	Wheat	Maize	Maca	Wheat	Beer[b]	Beer[b]
DON	20	>250	50	10	2,000	35	1.1	6	25	0.14	3
HT2	20	50	25	8	100	100	1	1	12.5	0.06	4
T2	2	20	25	1	20	15	0.1	3	5	0.07	2
ZEA	0.4	250	10	4	100	20	1.5	6	5	0.1	1
FB1	8	50	100	35	80	20	0.1	1	10	0.07	n.d.
FB2	7	20	100	30	80	15	0.2	0.3	5	0.09	n.d.
OTA	1	50	1	4	12	10	0.3	1	n.d.	0.02	60
AFB1	0.8	10	0.5	0.5	20	10	0.02	6	n.d.	0.04	2
AFB2	0.7	10	1.0	30	20	10	0.1	6	n.d.	0.05	0.5
AFG1	0.5	10	1.0	1	20	10	0.2	6	n.d.	0.03	3
AFG2	1	20	0.5	10	20	20	0.2	6	n.d.	0.08	2
PAT	100	n.d.	n.d.	800	2,000	15	n.d.	n.d.	n.d.	n.d.	n.d.

Extraction solvent (purification)	MeCN: water: acetic acid	MeCN: water: formic acid	MeCN:water	MeCN: water: acetic acid	MeCN: water: acetic acid	MeCN: water	MeCN: water	Ethyl acetate: formic acid	MeCN: water: formic acid (NaCl, $MgSO_4$)	Sonication (C18 clean-up)	Sonication, (MeCN precipitation)
Total number of targeted mycotoxins	87	23	33	80	32	31	12	23	11	12	32
Run time/no of chromatographic runs necessary for determination	21 min/2	22 min/2	35 min/1	33 min/2	33 min/1	35 min/2	8.5 min/1	25 min/1	18 min/2	6.5 min/1	18 min/1
Matrix equivalent per 1 mL of injected sample/matrix equivalent in the injected volume	0.125/ 0.000625 g	0.125/ 0.000625 g	0.0625/ 0.00125 g	0.25/ 0.00125 g	0.25/ 0.0025 g	5/0.05 g	0.5/ 0.0025 g	5/0.1 g	0.2/0.001 g	5/0.025 mL	1/0.005 mL
Number of steps within the sample preparation/timing estimate of the preparation of 1 sample	2/98 min	1/190 min	2/130 min	1/93 min	1/93 min	3/40 min	1/15 min	5/155 min	3/18 min	2/45 min	3/15 min
Type of MS detection	ESI-MS/MS (Qtrap)	ESI-MS/MS (triple quadrupole)	ESI-MS/MS (triple quadrupole)	ESI-MS/MS (triple quadrupole)	ESI-MS (orbitrap)	ESI-MS/ MS (triple quadru-pole)	ESI-MS/ MS (tandem quadru-pole)	ESI-MS/MS (triple quadrupole)	ESI-MS (time-of-flight)	MS/MS (tandem quadrupole)	APCI-MS (orbitrap)
MS detector	Qtrap 4000 (Applied Biosystems)	Quattro Premier XE (Waters)	Quattro Ultima (Waters Micromass)	TSQ Quantum Ultra AM (Thermo-Finnigan)	LTQ Orbitrap (Thermo Scientific)	Micromass Quattro Micro (Waters)	Acquity TQD (Waters)	Micromass Quattro Micro (Waters)	LCT Premier XE (Waters)	Acquity TQD (Waters)	Exactive (Thermo Fisher Scientific)

Abbreviations of analytes: *DON* deoxynivalenol, *HT2* HT-2 toxin, *T2* T-2 toxin, *ZEA* zearalenone, *FB1* fumonisin B1, *FB2* fumonisin B2, *OTA* ochratoxin A, *AFB1* aflatoxin B1, *AFB2* aflatoxin B2, *AFG1* aflatoxin G1, *AFG2* aflatoxin G2, *PAT* patulin
n.d. not determined
[a] Examples of LODs- limits of detection) for selected mycotoxins (mostly regulated, maximum limits established by (EC) No 1881/2006 implemented by (EC) No 1126/2007) in selected matrices
[b] LOD in beer in μg/L
[c] LOD in the solvent standard due to the lack of blank
[d] Operations considered as the sample preparation step: sonication, extraction, dilution, evaporation, liquid–liquid extraction, solid phase extraction, and partitioning

Methods of Biotoxin Analysis——Biosensor

- A biosensor is a device for the detection of an analyte that combines a biological component with a physicochemical detector component..

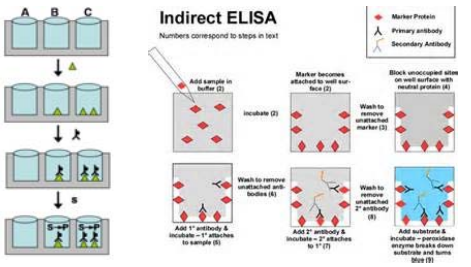


Principle of Biosensors

Methods of Biotoxin Analysis——ELISA

- **Enzyme-Linked Immunosorbent Assay (ELISA) Procedure**
- Nowadays, ELISA have also become widespread in biotoxin determination.
- ELISA techniques are based on a coupling reaction between a specific mycotoxin and antibodies specific for those biotoxins.
- ELISA tests can be performed in shorter time periods and provides relatively accurate screening results.
- Aflatoxins, Fumonisins, Ochratoxin, T-2 Toxin, Vomitoxin, Zearelenone (F-2 Toxin)

Methods of Biotoxin Analysis——ELISA



Recommendations

Following recommendations should always be considered within multi-mycotoxin analysis:

1. ***Blank matrix***

- In mycotoxins analysis, matrix-matched standards should be used whenever possible.
- Higher background mycotoxin concentration tends to increase the analytical bias of the results.

Recommendations

2. ***Internal standards***

- As a general rule, internal standard employed for mycotoxins analysis must not be present in the sample, and should combine physiochemical properties chromatographically similar to those of target mycotoxins.

Recommendations

3. ***Clean-up***

- When immunoaffinity columns are used for purification of sample extract and/or pre-concentration of analytes, exceeding of the column capacity has to be avoided. **Breakthrough** of analytes may occur when antibodies binding sites are saturated.

Recommendations

4. LC determinative steps

- For checking the signal stability during the sequence, running of **analytical standards** at the beginning and the end of each (longer) sequence is recom- mended.
- Analyses have to be performed **within the linear range.**
- In case of highly contaminated samples possibly exceeding the calibration range, they have to be **diluted** before the analysis.

Recommendations

5. Instrument's maintenance

- When a significant decrease in signal of analytes is observed, instrument's maintenance including **cleaning of the ion source and ion optic** is required.
- **Replacing of a pre-column** or the LC column is recommended.
- Filtration of the final extract by a **syringe filt**er (0.22 or 0.45 mm for U-HPLC or HPLC, respectively).

Analysis Method

- AOAC Official Method 993.06: Staphylococcal Enterotoxins in Selected Foods

Analyte(s)	Agent Category	CAS RN / Description
Staphylococcal enterotoxins (SEA, SEC)	Protein	37337-57-8 (SEA) 39424-54-9 (SEC) Monomeric proteins of ~ 27-27.5 kDa
Staphylococcal enterotoxins (SEB)	Protein	39424-53-8 Monomeric protein of ~ 28 kDa

Analysis Method

- Literature Reference for Microcystins (Analyst. 1994. 119(7): 1525—1530)

Analyte(s)	Agent Category	CAS RN
Microcystins (Principal isoforms: LA, LR, LW, RR, YR)	Small Molecule	96180-79-9 (LA), 101043-37-2 (LR), 157622-02-1 (LW), 111755-37-4 (RR), 101064-48-6 (YR)

Analysis Method

Analyte(s)	Agent Category	CAS RN / Description
Abrin	Protein	1393-62-0 (Abrin) 526-31-8 (Abrine) Abrin: Glycoprotein consisting of a deadenylase (25-32 kDa A chain) and lectin (35 kDa B chain); an agglutinin (A2B2) may be present in crude preparations Abrine: Small molecule, abrin marker
Ricin (Ricinine)	Protein	9009-86-3 (Ricin) 5254-40-3 (Ricinine) Ricin: 60 kDa glycoprotein consisting of a deadenylase (~32 kDa A chain) and lectin (~34 kDa B chain); an agglutinin of MW 120 kDa may be present in crude preparations Ricinine: Small molecule, ricin marker

Analysis Method

- Analysis Purpose: Presumptive and confirmatory Analytical Technique: Immunoassay (column) and HPLC-FL
- Method Developed for: Aflatoxins (Type B1) in corn, raw peanuts and peanut butter Method Selected for: SAM lists this method for presumptive and confirmatory analyses in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: This method is for the detection of aflatoxins in agricultural products. The sample is extracted with methanol-water (7 + 3), filtered, diluted with water, and applied to an affinity column containing mAbs specific for aflatoxins B_1, B_2 (CAS RN 22040-96-6), G_1 (CAS RN 1385-95-1), and G_2 (CAS RN 7241-98-7). Antibody-bound aflatoxins are removed from the column with methanol. For detection and quantitation of total aflatoxins, fluorescence measurement after reaction with bromine solution is performed. For individual aflatoxins, fluorescence detection and postcolumn iodine derivatization are performed and quantitation is by LC. Method performance was characterized using various commodities (e.g., corn) at aflatoxin levels over a range of 10 to 30 ng/g. This method was originally designed for the analysis of aflatoxins (B_1, B_2, G_1, and G_2) in samples where cleanup was necessary to remove food components, such as fats and proteins; the cleanup procedure may not be necessary for analysis of water samples.
- Special Considerations: AOAC Official Method 994.08: Aflatoxin in Corn, Almonds, Brazil Nuts, Peanuts, and Pistachio Nuts, (AOAC International. 1998. *Official Methods of Analysis of AOAC International*, 16th Edition. 4th Revision, Vol. II. http://www.aoac.org/) may be used as a complementary HPLC-FL method in order to provide more flexibility for analyses.
- Source: AOAC International. 1994. "Method 991.31: Aflatoxins in Corn, Raw Peanuts, and Peanut Butter." *Official Methods of Analysis of AOAC International.* 16th Edition. 4th Revision; Vol. II. http://www.aoac.org/

Analysis Method

- Analysis Purpose: Confirmatory Analytical Technique: HPLC-PDA
- Method Developed for: Microcystins-LA, -LR, -LW, -RR, -YR in raw and treated waters Method Selected for: SAM lists these procedures for confirmatory analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types other than water. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: Procedures are discussed to test the presence of microcystin-LR, -LY, -LW, -LF (CAS RN 154037-70-4), and -RR in treated and untreated water samples. Cyanobacterial cells are separated from the water by filtration through 110-mm glass fiber grade C (GF/C) discs. The cellular components collected on the discs are extracted three times with methanol; the collected extraction fluids are combined and dried. The residue is resuspended in methanol and analyzed by HPLC-PDA. The liquid portion of the filtered water sample is subjected to trace enrichment using a C_{18} SPE cartridge, followed by identification and determination by HPLC-PDA. This procedure can detect microcystin concentrations as low as 250 ng/L and is the basis of the World Health Organization (WHO) method for the detection of microcystins.
- Source: Lawton, L.A., Edwards, C. and Codd, G.A. 1994. "Extraction and High-Performance Liquid Chromatographic Method for the Determination of Microcystins in Raw and Untreated Waters." Analyst. 119(7): 1525—1530. http://www.rsc.org/Publishing/Journals/AN/article.asp?doi=AN9941901525

Analysis Method

- Analysis Purpose: Confirmatory Analytical Technique: HPLC-FL (precolumn derivatization)
- Method Developed for: Anatoxin-a in potable water Method Selected for: SAM lists these procedures for confirmatory analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types other than water. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: Procedures are described for HPLC analysis with fluorimetric detection of anatoxin-a in water samples after derivatization with 7-fluoro-4-nitro-2,1,3-benzoxadiazole (NBD-F). Samples are extracted at pH 7 with SPE using a weak cation exchanger. The toxin is eluted with methanol containing 0.2% trifluoroacetic acid (TFA). Samples are evaporated, reconstituted with acetonitrile, and re-evaporated prior to derivatization. This procedure detects anatoxin-a at concentrations of 0.1 µg/L with a good linear calibration.
- Source: James, K.J. and Sherlock, I.R. 1996. "Determination of the Cyanobacterial Neurotoxin, Anatoxin-a, by Derivatisation Using 7-Fluoro-4-nitro-2,1,3-benzoxadiazole (NBD-F) and HPLC Analysis With Fluorimetric Detection." Biomedical Chromatography. 10(1): 46—47. http://www3.interscience.wiley.com/journal/18562/abstract

Analysis Method

- Analysis Purpose: Presumptive Analytical Technique: Immunoassay (ELISA)
- Method Developed for: Cylindrospermopsin in ground water, surface water and well water Method Selected for: SAM lists these procedures for presumptive analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types other than water. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: Cylindrospermopsin is detected using a colorimetric immunoassay (competitive ELISA) procedure. A sample (0.05 mL), enzyme conjugate (cylindrospermopsin-HRP), and an antibody solution containing rabbit anti-cylindrospermopsin antibodies are added to plate wells containing immobilized sheep anti-rabbit antibodies. Both the cylindrospermopsin (if present) in the sample and cylindrospermopsin-HRP conjugate compete in solution to bind to the rabbit anti-cylindrospermopsin antibodies in proportion to their respective concentrations. The anti-cylindrospermopsin antibody-target complexes are then bound to the immobilized sheep anti-rabbit antibodies on the plate. After incubation, the unbound molecules are washed and decanted. A specific substrate is then added which is converted from a colorless to a blue solution by the HRP enzyme conjugate solution. The reaction is terminated with the addition of a dilute acid. The concentration of cylindrospermopsin in the sample is determined photometrically by comparing sample absorbance to the absorbance of the calibrators (standards) at a specific wavelength (450 nm). The applicable concentration range is 0.4 - 2.0 µg/L, with a minimum detection level of 0.4 µg/L.
- Source: NEMI. 2006. http://infotrek.er.usgs.gov/pls/apex/f?p=119:38:7526698938332159::::P38_METHOD_ID:9507

Analysis Method

- Analysis Purpose: Confirmatory Analytical Technique: High performance liquid chromatography - Photodiode array detector (HPLC-PDA)
- Method Developed for: Cylindrospermopsin in eutrophic waters Method Selected for: SAM lists these procedures for confirmatory analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types other than water. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: Cylindrospermopsin is detected using HPLC with photodiode array detector (PDA) in environmental waters. The suggested solvent range for cylindrospermopsin is below 50% methanol and 30% acetonitrile. Complex samples (culture medium) are purified on a C_{18} column with a linear gradient of 1 to 12% (v/v) methanol/water over 24 minutes at 40° C, with monitoring at 262 nm. The use of C_{18} columns for environmental waters is suggested for removal of the large number of organic compounds that may be present. This method detects and recovers cylindrospermopsin from spiked environmental water samples at 1 µg/L.
- Source: Metcalf, J.S., Beattie, K.A., Saker, M.L. and Codd, G.A. 2002. "Effects of Organic Solvents on the High Performance Liquid Chromatographic Analysis of the Cyanobacterial Toxin Cylindrospermopsin and Its Recovery From Environmental Eutrophic Waters by Solid Phase Extraction." FEMS Microbiology Letters. 216(2): 159—164. http://cat.inist.fr/?aModele=afficheN&cpsidt=14002569

Analysis Method

- Analysis Purpose: Complementary presumptive for abrin Analytical Technique: LC-MS-MS
- Method Developed for: Abrine in beverages Method Selected for: SAM lists these procedures for complementary presumptive analysis of abrin by abrine detection in aerosol, solid, particulate, liquid and water samples. Abrine, an alkaloid present in equal concentrations with abrin in rosary peas (*Abrus precatorius* L.), is found in crude preparations of abrin and may be an indicator of abrin contamination. Further research is needed to adapt and verify the procedures for environmental sample types.
- Method Description: Procedures are described for sample extraction by SPE or liquid-liquid extraction, followed by tandem mass spectrometry. The method was verified in beverages (bottled water, cola, juice drink, 1% low fat milk, bottled tea) spiked with abrine at either 0.5 µg/mL or 0.05 µg/mL. These samples were prepared for LC-MS-MS by either an optimized SPE procedure or a liquid-liquid extraction procedure. For SPE, optimal abrine recoveries were achieved with sample pH adjusted to 2 - 6 with formic acid, inclusion of a water/methanol (95/5, v/v) washing step prior to elution, and use of a Strata-X SPE cartridge. Liquid-liquid extraction was with an equal volume (2 mL) of acetonitrile/water (75/25, v/v). Differences in recovery between the two extraction methods were determined using the two-sided Student's *t* test, assuming equal variance. At 0.5 µg/mL, recovery of abrine by SPE was significantly higher ($P < 0.01$) for water and juice drink as compared to liquid-liquid extraction, but no significant differences were observed for cola and tea. At 0.05 µg/mL, the differences in recovery of abrine in water, tea, cola, and juice drink were highly statistically different ($P < 0.001$), with better recoveries for the optimized SPE procedure. The method had a MDL of 0.025 µg/mL and LOQ of 0.05 µg/mL. Storage stability was also tested for abrine at 10 µg/mL in a water/methanol stock solution (90/10, V/V) at three temperatures (0 ° C, 4 ° C, and 23 ° C). Aliquots were analyzed in triplicate at 0, 1, 7 and 21 days after sample preparation. There was no statistically significant difference between abrine standards stored at the three temperatures at 21 days and no loss of abrine concentration.
- Special Considerations: The biotoxin methods points of contact listed in Section 4.0 of SAM should be consulted for additional information regarding water and drinking water analyses.
- Source: Owens, J. and Koester, C. 2008. "Quantitation of Abrine, an Indole Alkaloid Marker of the Toxic Glycoproteins Abrin, by Liquid Chromatography/Tandem Mass Spectrometry When Spiked into Various Beverages." Journal of Agriculture and Food Chemistry. 56(23): 11139-11143. http://pubs.acs.org/doi/pdf/10.1021/jf802471y

Analysis Method

- Analysis Purpose: Presumptive Analytical Technique: Immunoassay (ELISA)
- Method Developed for: ¢ -Amanitin, ricin and T-2 mycotoxin in food and beverages Method Selected for: SAM lists these procedures for presumptive analysis of ¢ -amanitin and T-2 toxin in aerosol, solid, particulate, liquid and water samples and for confirmatory analysis of ricin in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types. See Biotoxin Methods Query for additional methods that should be used for this analyte.
- Method Description: Commercially available ELISAs are described and assessed for detection of ricin, amanitin and T-2 toxin at levels below those described as a health concern in food samples. Solid food samples are prepared by washing the sample with sodium phosphate buffer followed by dilution with phosphate-buffered saline. Liquid beverage samples are prepared by dilution in sodium phosphate buffer. Amanitin samples are similarly prepared using water instead of buffer, and T-2 toxin samples are similarly prepared using 35% methanol in water instead of buffer. The prepared samples are used with commercially obtained ELISA kits according to the manufacturer's directions, except for the incorporation of an eight-point calibration curve and reading the plates at both 405 and 650 nm after 26 minutes of incubation at 37 ° C. This assay detects ricin in food products at 0.01 µg/mL with acceptable background levels. Amanitin can be detected in food products at 1 µg/g with the ELISA. Background responses occurred, but at less than the equivalent of 0.5 ppm for amanitin. The ELISA kit will successfully detect T-2 toxin at targeted levels of 0.2 µg/g. The ELISA kit successfully detects T-2 toxin at targeted levels of 0.2 µg/g; the immunoassay for T-2 toxin, however, shows significant background responses and varies up to 0.1 ppm.
- Source: Garber, E.A.E., Eppley, R.M., Stack, M.E., McLaughlin, M.A. and Park, D.L. 2005. "Feasibility of Immunodiagnostic Devices for the Detection of Ricin, Amanitin, and T-2 Toxin in Food." Journal of Food Protection. 68(6): 1294—1301. http://www.ingentaconnect.com/content/iafp/jfp/2005/00000068/00000006/art00027

Analysis Method

- **Analysis Purpose: Presumptive Analytical Technique: Immunoassay (ELISA, ECL-based)**
- **Method Developed for: Abrin in food Method Selected for: SAM lists these procedures for presumptive analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types other than water. See Biotoxin Methods Query for additional methods that should be used for this analyte.**
- **Method Description: Procedures are described for using mouse monoclonal antibodies (mAbs) and rabbit-derived polyclonal antibodies prepared against a mixture of abrin isozymes for three separate ELISA and ECL-based assays in food products. The three assays vary by use of antibody combination (e.g., assay configuration): (1) polyclonal (capture)/polyclonal (detection) ELISA, (2) polyclonal/monoclonal ELISA and (3) polyclonal/monoclonal ECL assay. The LODs, with purified Abrin C and various abrin extracts in buffer are between 0.1 and 0.5 ng/mL for all three assays. The LOD for abrin spiked into food products ranged from 0.1 to 0.5 ng/mL, using the ECL assay. The LOD for abrin spiked into food products for the ELISA assays ranged between 0.5 and 10 ng/mL depending on the antibody combination. In all cases, the LODs were less than the concentration at which abrin may pose a health concern.**
- **Special Considerations: Crude preparations of abrin may also contain agglutinins that are unique to rosary peas and that can cross-react in the immunoassays. Addition of non-fat milk powder to the sample buffer may eliminate false-positive results (Dayan-Kenigsberg, J., Bertocchi, A. and Garber, E.A.E. 2008. "Rapid Detection of Ricin in Cosmetics and Elimination of Artifacts Associated With Wheat Lectin." Journal of Immunological Methods. 336(2): 251—254). http://www.sciencedirect.com/science/journal/00221759**
- **Source: Garber, E.A.E., Walker, J.L. and O'Brien, T.W. 2008. "Detection of Abrin in Food Using Enzyme-Linked Immunosorbent Assay and Electrochemiluminescence Technologies." Journal of Food Protection. 71(9): 1868—1874. http://www.ingentaconnect.com/content/iafp/jfp/2008/00000071/00000009/art00015**

Analysis Method

- **Analysis Purpose: Confirmatory Analytical Technique: LC/APCI-MS**
- **Method Developed for: DAS and T-2 mycotoxin in food Method Selected for: SAM lists these procedures for confirmatory analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types. See Biotoxin Methods Query for additional methods that should be used for this analyte.**
- **Method Description: A LC/APCI-MS procedure based on TOF-MS, with a real-time reference mass correction, is used for simultaneous determination of *Fusarium* mycotoxins (to include DAS and T-2 mycotoxin) in foodstuffs. Mycotoxin samples are extracted with acetonitrile/water (85:15) and centrifuged, and the supernatant is applied to a column for cleanup. Prepared samples are separated by liquid chromatography with an aqueous mobile phase of ammonium acetate and methanol detection is provided in exact mass chromatograms with a mass window of 0.03 Th. The limits of detection range from 0.1 to 6.1 ng/g in analyzed foodstuffs.**
- **Source: Tanaka, H., Takino, M., Sugita-Konishi, Y. and Tanaka, T. 2006. "Development of Liquid Chromatography/Time-of-Flight Mass Spectrometric Method for the Simultaneous Determination of Trichothecenes, Zearalenone, and Aflatoxins in Foodstuffs." Rapid Communications in Mass Spectrometry. 20(9): 1422—1428. http://cat.inist.fr/?aModele=afficheN&cpsidt=17697070**

Analysis Method

- **Analysis Purpose: Confirmatory Analytical Technique: HPLC-MS-MS**
- **Method Developed for: Brevetoxins in shellfish Method Selected for: SAM lists these procedures for confirmatory analysis in aerosol, solid, particulate, liquid and water samples. Further research is needed to adapt and verify the procedures for environmental sample types. See Biotoxin Methods Query for additional methods that should be used for this analyte.**
- **Method Description: Shellfish sample homogenates are extracted with acetone, and centrifuged. The supernatants are combined, evaporated, and re-solubilized in 80% methanol. Following a wash with 95% n-hexane, the methanolic layer is evaporated, and the residue re-solubilized in 25% methanol and applied to a C_{18} SPE column. Analytes are eluted with 100% methanol, evaporated, and re-solubized in methanol for analysis. Analysis of prepared samples is performed using HPLC-MS-MS with a mobile phase of water and acetonitrile with acetic acid. Analytes are detected by an MS with ESI interface. Brevetoxins are extensively metabolized, with many sub-forms. This method describes multiple liquid chromatography/electrospray ionization mass spectrometry (LC-ESI-MS) profiles for metabolites of brevetoxins from oysters.**
- **Source: Wang, Z., Plakas, S.M., El Said, K.R., Jester, E.L., Granade, H.R. and Dickey, R.W. 2004. "LC/MS Analysis of Brevetoxin Metabolites in the Eastern Oyster (*Crassostrea virginica*)." Toxicon. 43(4): 455—465. http://cat.inist.fr/?aModele=afficheN&cpsidt=15668117**

Procedures for the Analysis of Biotoxins

- **Determination of aflatoxins B1, B2, G1 and G2 in food and feed prEN 14123, modified, 2007-05**
- **Determination of aflatoxins B1, B2, G1 and G2 in infant and dietary food AOAC 84, No . 4, 2001, modified, 2005-03**
- **Determination of aflatoxins M1 and M2 in milk and dairy products by HPLC ISO 14501, modified, 1998-11**
- **Determination of ochratoxin A in cereal products and coffee DIN EN 14132, modified, 2003-09**
- **Determination of ochratoxin A in beverages DIN EN 14133, modified, 2003-10**
- **Determination of ochratoxin A in baby food, AOAC 84, No. 5, 2001, modified, 2004-03**
- **Determination of ochratoxin A in dried fruits, AOAC 86, No. 6, 2003, modified, 2004-02**
- **Multitoxin methods: determination of about 60 different mycotoxins by LC-MS/MS, Food Addit. Contam. 2005, 22, 752-760**
- **Determination of fumonisins B1 and B2 in food and feed by HPLC, E DIN EN 14352, modified, 2002-02**
- **Determination of patulin in apple juice and other fruit preparations, Eurofins Method 2005-10**
- **Determination of ergot alkaloids in cereal products by HPLC-MS/MS, Eurofins Method 2009-06**

Table 1 – Multi mycotoxin detection.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Trichothecenes, aflatoxins(B1, B2, G1, and G2), OTA, ZEA, fumonisins and alternaria toxins	Liquid chromatography tandem mass spectrometry	Sweet pepper	Monbaliu and others	Development of a multi-mycotoxin liquid chromatography/tandem mass spectrometry method for sweet pepper analysis	Rapid Commun Mass Spectrom 23(11):3–11	2009
Aflatoxin B1	Indirect competitive ELISA	Rice	Reddy and others	Detection of Aspergillus spp. and aflatoxin B1 in rice in India	Food Microbiology 26:27–31	2009
Fumonisins	Liquid chromatography (LC) with fluorescence (FD) and mass spectrometry (MS) detectors	Corn-based food	Silva and others	Analysis of fumonisins in corn-based food by liquid chromatography with fluorescence and mass spectrometry detectors.	Food Chemistry 112:1031–37	2009
OTA		Dry sausages	Iacumin and others	Moulds and ochratoxin A on surfaces of artisanal and industrial dry sausages.	Food Microbiology 26:65–70	2009
Aflatoxin B1	Flow through quartz cristal microbalance (QCM) immunoessay	–	Wang and Gan	Biomolecule-functionalized magnetic nanoparticles for flow-through quartz crystal microbalance immunoassay of aflatoxin B(1)	Biopiocess Biosyst Eng 32(1):109–116	2009
Aflatoxins(B1, B2, G1, and G2), Alternaria toxins, cyclopiazonic acid, fumonisins, ochratoxin, patulin, trichothecenes, ZEA	Review paper on sampling and analysis of mycotoxins	–	Shephard and others	Developments in mycotoxin analysis: an update for 2007–2008	World Mycotoxin Journal 2(1):3–21	2009
OTA	HPLC-MS/MS	Cheese	Zhang and others	Direct monitoring of ochratoxin A in cheese with solid-phase microextraction coupled to liquid chromatography-tandem mass spectrometry	J chromatography A. in press	2009
Aflatoxins and OTA	Reversed-phase liquid chromatography	Dietary supplements	Trucksess and others	Sampling and Analytical Variability Associated with the Determination of Total Aflatoxins and Ochratoxin A in Powdered Ginger Sold As a Dietary Supplement in Capsules	Journal of agricultural and food chemistry 57(2):321–325	2009

Continued

Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxins B1, B2, G1, G2; OTA; ZEA and fumonisins FB1 and FB2, DON	HPLC - postcolumn photochemical derivatization	Corn	Offerenva and others	Multiresidue Mycotoxin Analysis in Corn Grain by Column High-Performance Liquid Chromatography with Postcolumn Photochemical and Chemical Derivatization: Single-Laboratory Validation	J AOAC Int 92(1): 15–25	2009
OTA	LC-FD LC-MS-MS	Dry pasta	NG and others	Survey of Dry Pasta for Ochratoxin A in Canada	J food Prot 72(4): 890–3	2009
Aflatoxins(B1, B2, G1, and G2)	LC	Peanut butter sesame paste	Li and others	Natural Occurrence of Aflatoxins in Chinese Peanut Butter and Sesame Paste	J. Agric. Food Chem., 57(9):3615–3624	2009
Aflatoxins (B1, B2, G1, and G2)	Liquid chromatography–mass spectrometry	Nuts, cereals, dried fruits, and spices	Nonaka and others	Determination of aflatoxins in food samples by automated on-line in-tube solid-phase microextraction coupled with liquid chromatography–mass spectrometry	Journal of Chromatography A 1216(20): 4416–4422	2009
Aflatoxins (B1, B2, G1, and G2), ochratoxin, ZEA DON, fumonisins, T-2, HT-2,	Ultra-high-pressure liquid chromatography coupled to triple quadrupole mass spectrometry (UHPLC/MS/MS)	Different cereal food	Beltran and others	Determination of mycotoxins in different food commodities by ultra-high-pressure liquid chromatography coupled to triple quadrupole mass spectrometry	Rapid Commun Mass Spectrom 23(12):1801–1809	2009
OTA	Solid-phase microextraction (SPME)-LC-FD	Green coffee	Vatinno and others	Determination of ochratoxin A in green coffee beans by solid-phase microextraction and liquid chromatography with fluorescence detection	J Chromatogr A 1187(1-2):145–50	2008
Aflatoxins B1, B2, G1, and G2 and ochratoxin A	Multitoxin immunoaffinity column cleanup with liquid chromatography (LC)	Ginseng and ginger	Trucksess and others	Determination of aflatoxins B1, B2, G1, and G2 and ochratoxin A in ginseng and ginger by multitoxin immunoaffinity column clean-up and liquid chromatographic quantitation: Collaborative study	Journal of AOAC International 91(3):511–523	2008

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
ZEA	Direct competitive enzyme-linked immunosorbent assay (DC-ELISA)	Cereal	Thorgrussamee and others	Monoclonal-based enzyme-linked immunosorbent assay for the detection of zearalenone in cereals	Food Addit Contam 25(8):997–1006	2008
OTA	HPLC-FD	Wine	Taluri and others	A rapid high-performance liquid chromatography with fluorescence detection method developed to analyze ochratoxin A in wine	J Food Prot 71(10):2133–7	2008
OTA	HPLC-FD	Grapes, dried vine fruits, and winery byproducts	Soliinzo and others	Determination of ochratoxin A in grapes, dried vine fruits, and winery byproducts by high-performance liquid chromatography with fluorometric detection (HPLC-FLD) and immunoaffinity cleanup	J Agric Food Chem 56(23):11081–6	2008
33 mycotoxins include of Aflatoxins (B1, B2, G1, and G2) OTA, DON, ZEA, T-2 toxin, HT-2 toxin and others	LC–MS/MS	Peanut, pistachio, wheat, maize, cornflakes, raisins, figs	Spanjer and others	LC–MS/MS multi-method for mycotoxins after single extraction, with validation data for peanut, pistachio, wheat, maize, cornflakes, raisins and figs	Food Addit Contam 25(4):472–89	2008
Fumonisin B2, HT-2 toxin, patulin, and ZEA	Liquid chromatography combined with time-of-flight mass spectrometry (LC-TOF-MS)	Dried figs	Senyuva and Gilbert	Identification of fumonisin B2, HT-2 toxin, patulin, and zearalenone in dried figs by liquid chromatography–time-of-flight mass spectrometry and liquid chromatography–mass spectrometry	J Food Prot 71(7):1500–4	2008
Macrocyclic lactone mycotoxins (zearalenone, ZON; alpha-zearalenol, alpha-ZOL; and beta-zearalenol, beta-ZOL)	Supercritical fluid extraction (SFE) and clean-up on Florisil adsorption cartridge before Chromatography	Maize flour	Zougagh and Rios	Supercritical fluid extraction of macrocyclic lactone mycotoxins in maize flour samples for rapid amperometric screening and alternative liquid chromatographic method for confirmation	J Chromatogr A 1177(1):56–7	2008
T-2 and HT-2 toxins	LC–FD	Cereals	Trebstein and others	Determination of T-2 and HT-2 toxins in cereals including oats after immunoaffinity cleanup by liquid chromatography and fluorescence detection	J Agric Food Chem 56(13):4968–4975	2008

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Fumonisins	LC-MS-MS	Maize	Zitomer and others	A single extraction method for the analysis by liquid chromatography/tandem mass spectrometry of fumonisins and biomarkers of disrupted sphingolipid metabolism in tissues of maize seedlings	Anal Bioanal Chem 391:2257–63	2008
Aflatoxins (B1, B2, G1, and G2), OTA, ZEA	HPLC-FD	Poultry house	Wang and others	Simultaneous detection of airborne aflatoxin, ochratoxin and zearalenone in a poultry house by immunoaffinity clean-up and high-performance liquid chromatography	Environ Res 107(2):139–44	2008
For 25 contaminants	ACQUITY UPLC separation and detection with a Waters Quattro Premier XE tandem quadrupole mass spectrometer	A variety of sample types	Kok and others	Rapid multi-mycotoxin analysis using ACQUITY UPLC and Quattro Premier XE	Waters Applications Note 2007 Volume: Page: 5 pp	2007
Aflatoxins, ochratoxin, fumonisins, trichothecenes		Tropical cereals	Magan and Aldred	Postharvest control strategies: Minimizing mycotoxins in the food chain.	Int J Food Microbiol 2007 Jul 31	2007
Aflatoxins, ochratoxin A, fumonisins, deoxynivalenol and zearalenone,		Cereal grains	Bullerman and Bianchini	Stability of mycotoxins during food processing	Int J Food Microbiol 2007 Jul 31	2007
Aflatoxins	HPLC aflatoxins were quantified by HPLC equipped with a C18 column, a photochemical reactor, and a fluorescence detector.	Agricultural commodities ground sample	Sobolev	Simple, rapid, and inexpensive cleanup method for quantitation of aflatoxins in important agricultural products by HPLC	J Agric Food Chem 2007; 55:2136–41	2007
Ochratoxin A (OTA) and 4-deoxynivalenol (DON)	Results of OTA and DON occurrence from the database gathered in Belgium	Beer	Harcz and others	Intake of ochratoxin A and deoxynivalenol through beer consumption in Belgium	Food Addit Contam, August 2007; 24(8):815–8	2007
Simultaneous estimation of aflatoxin B(1) [AFB(1)] and ochratoxin A (OA)	Membrane-based immunoassay consisting of a membrane with immobilized anti-AFB(1) and anti-OA antibodies and a filter paper attached to a polyethylene card below the membrane	Chili samples	Saha and others	Simultaneous enzyme immunoassay for the screening of aflatoxin B(1) and ochratoxin A in chili samples	Anal Chim Acta 2007 Feb 19; 584(2):343–9	2007
		Cereal	Berthiller and others	Chromatographic methods for the simultaneous determination of mycotoxins and their conjugates in cereals	Int J Food Microbiol 2007 Jul 31	2007

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Simultaneous aflatoxins (B(1), B(2), G(1), G(2)), ochratoxin A, fumonisins (B(1), B(2)), deoxynivalenol, zearalenone, T-2 and HT-2 toxins	Liquid chromatography/ tandem mass spectrometry -reversed-phase liquid chromatography coupled with electrospray ionization triple quadrupole mass spectrometry (LC/ESI-MS/MS) using, as chromatographic mobile phase,	Maize	Lattanzio and others	Simultaneous determination of aflatoxins, ochratoxin A and Fusarium toxins in maize by liquid chromatography/ tandem mass spectrometry after multitoxin immunoaffinity cleanup	Rapid Commun Mass Spectrom 2007 Sep 10; 21(20):3253–61	2007
Aflatoxins aflatoxins (B1, B2, G1, and G2)	Enzyme-linked immunosorbent assay (ELISA),	Rice artificially contaminated hull, bran, polished broken grains, and polished whole kernels)	Castells and others	Distribution of total aflatoxins in milled fractions of hulled rice	J Agric Food Chem 2007; 55:2760–4	2007
Simultaneously aflatoxins, type A trichothecenes, type B trichothecenes, OTA, zearalenone, fumonisins, and patulin	Comprehensive LC/MS/MS in a single run	Analysis of corn flake extracts	Rudolphatta and others	Multicomponent mycotoxin analysis by LC/MS/MS	The 10th annual meeting of the Israel Analytical Chemistry Society Conference & Exhibition, January 23–4	2007
Simultaneously measure mycotoxins (NIV), (DON), AFG1, AFG2, AFB1, AFB2, FB1, FB2, Diacetoxyscirpenol (DAS), T2-Toxine, Ochratoxin A, and ZEN	LC–MS/MS method HPLC (Thermo Scientific, San Jose, Calif),	Cattle Forages and Food Matrices	Huls and others	Analysis of mycotoxins in various cattle forages and food matrices with the TSQ Quantum Discovery MAX	30 Mass spectrometry advertising supplement the application notebook March 2007	2007
Reduced up to 88% aflatoxin B1, 44% zearalenone, and 29% for fumonisins ochratoxin, Standard Q/FB was ineffective in reducing DON uptake			Avantaggiato and others	Assessment of the multi-mycotoxin-binding efficacy of a carbon/ aluminosilicate-based product in an in vitro gastrointestinal model	J Agric Food Chem 2007 May 19	2007

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Af B1, B2, G1, G2, M1, trichothecenes, DON diacetoxyscirpenol, T-2 toxin and HT-2 toxin), FB1, B2, B3, agaric acid, ergot alkaloids, OTA, ZEA patulin, phomopsins, sterigmatocystin,	Review		van Egmond and others	Regulations relating to mycotoxins in food.: Perspectives in a global and European context	Anal Bioanal Chem 2007 May 17	2007
DON, ZEN, and fumonisins B1 and B2 (FB1, FB2)	HPLC system consisted of a P1000XR pump HPLC–MS/MS system,	Corn silage	Niderkorn and others	Screening of fermentative bacteria for their ability to bind and biotransform deoxynivalenol, zearalenone and fumonisins in an in vitro simulated corn silage model	Food Addit Contam, April 2007; 24(4):406–15	2007
Fumonisins (FB1 and FB2) also analyzed for aflatoxins (B1, B2, G1, and G2) one by one	FB1 FB2:HPLC/fluorescence following naphthalene-2,3 dicarboxaldehyde (NDA) derivatization AFs on TLC) plate under UV light	Different corn-based food products	Caldas and Silva	Mycotoxins in corn-based food products consumed in Brazil: an exposure assessment for fumonisins	J Agric Food Chem 55(19):7974–80	2007
Aflatoxin and ochratoxin	Optical waveguide lightmode spectroscopy (OWLS) technique in competitive and in direct immunoassays.	Barley and wheat flour	Adanyi and others	Development of immunosensor based on OWLS technique for determining aflatoxin B1 and ochratoxin A	Biosens Bioelectron 2007; 22:797–802	2007
Aflatoxin B1	HPLC CIM disk was coupled through a switching valve to a reversed-phase column, namely, Chromolith Performance RP-18e, A fully automated HPLC fluorescence detection		Calleri and others	Development and integration of an immunoaffinity monolithic disk for the online solid phase extraction and HPLC determination with fluorescence detection of aflatoxin B1 in aqueous solutions	J Pharma Biomed Anal 2007; 44:396–403	2007
Extended multi-mycotoxin method, for 25 contaminants	Separation and detection with a Waters Quattro Premier XE tandem quadrupole mass spectrometer	A variety of sample types	Kok and others	Rapid multi-mycotoxin analysis using ACQUITY UPLC and Quattro Premier XE	Waters Applications Note 2007, Page: 5 pp	2007
Aflatoxin Bi (AFBi)	HPLC isocratic reverse-phase liquid chromatography (HPLC) using a LiChrospher 100 RP-18 (5 mm column 25 × 4.6 mm i.d.) EcoPack (Merck, Portugal), with post column derivatisation confirm by TLC	Cattle feed collected from 7 dairy cow's farms from Portugal	Martins and others	Occurrence of aflatoxin Bi in dairy cow's feed over 10 y in Portugal (1995 to 2004)	Rev Iberoam Micol 2007; 24:69–71	2007

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxin B_1, citrinin, deoxynivalenol, fumonisin B_1, gliotoxin, ochratoxin *A*, and zearalenone	HPLC–MS, Zorbax SB-C18 column (Agilent Technologies, Palo Alto, USA) with a 1 mm Optiguard C18 precolumn. Mass spectrometry was performed on a quadrupole analyser equipped with electron spray ionization (ESI),	Corn silage	Richard and others	Toxigenic fungi and mycotoxins in mature corn silage	Available online 22 June 2007	2007
Ochratoxin A (OTA)	Immunoassay	High-colored matrices liquorice, ginger, nutmeg, black pepper, white pepper *Capsicum* spp. spices	Goryacheva and others	Rapid spot-one three-step immunoassay for non-instrumental detection of ochratoxin A in high-coloured herbs and spices	Talanta Volume 72, Issue 3, 15 May 2007, Pages 1230–34	2007
Fusarium toxins fumonisins (FBs), moniliformin (MON), zearalenone (ZEA), and type-A and -B trichothecenes	HPLC or GC in combination with a variety of detectors Screening mycotoxins is performed by (TLC) ELISA	Feeds	Krska and others	Analysis of Fusarium toxins in feed	Animal Feed Science and Technology 137(3-4):241–64	2007
Aflatoxin B_1, citrinin, deoxynivalenol, fumonisin B_1, gliotoxin, OTA and zearalenone	High-performance liquid chromatography coupled to mass spectrometry (HPLC–MS)	Corn silage		Toxigenic fungi and mycotoxins in mature corn silage		2007
Aflatoxins; ochratoxins; fumonisins, deoxynivalenol; zearalenone	Analyzed by HPLC ochratoxin A and aflatoxin B1 was performed using a reversed phase Symmetry C18 column (15 cm _ 4,6 mm, 5lm particles) preceded by a Rheodyne guard 0,5 lm filter, The fluorescence detector emission for ochratoxin A emission for aflatoxin B1,	A blend of naturally contaminated grains	Avantaggiato and others	Assessment of the multi-mycotoxin-binding efficacy of a carbon/ aluminosilicate-based product in an in vitro gastrointestinal model	J Agric Food Chem 2007; 55:4810–9	2007
Fusariotoxin analysis DON, ZEA, FB1, . . . ,	Liquid chromatogra- phy/electrospray ionization tandem mass spectrometry (LC/ESI-MS/MS),	Maize meal	Cavaliere and others	Mycotoxins produced by Fusarium genus in maize: determination by screening and confirmatory methods based on liquid chromatography tandem mass spectrometry	Food Chem 105(2):700–10	2007

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Table 1—Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Ochratoxin A (OTA)	Cleanup tandem immunoassay column	Ginger, nutmeg, black pepper, and white pepper		Rapid all-in-one 3-step immunoassay for non-instrumental detection of ochratoxin A in high-coloured herbs and spices	Talanta Vol. 72, Issue 3, 15 May 2007; 1234–4	2007
Simultaneous detection of aflatoxin B1 and ochratoxin A	Tandem immunoassay 1 mL column with 1-cleanup layer and two detection immunolayers ELISA Results confirmed byHPLC-fluorescence detection, LC–MS/MS with immunoaffinity column cleanup	Spices Ginger, pepper, chili	Goryacheva and others	Simultaneous noninstrumental detection of aflatoxin B1 and ochratoxin A using a cleanup tandem immunoassay column	Anal Chim Acta 2007; 590:118–24	2007
Aflatoxin B1 (AFB1), citrinin (CIT) and ochratoxin A (OTA)	HPLC with fluorimetry detection equipped with an injector 20 µL loop, a C18 spherisorb column (3 in C18, 0.46 × 25 cm), and a fluorescence detector (Spectra physic 2000), was used. Different excitation and emission fluorescence parameters	Rice	Nguyen and others	Occurrence of aflatoxin B1, citrinin and ochratoxin A in rice in-ve provinces of the central region of Vietnam	Food Chem 2007; 105:42–7	2007
	Contaminants with the highest level of evidence include aflatoxin, alcoholic beverages, 2,3,7,8-tetrachlordibenzo-p-dioxin	Abnet		Carcinogenic food contaminants	Cancer Invest 2007 Apr–May; 25(3):189–96.	2007
Aflatoxin M_1 (AFM_1) and ochratoxin A (OTA)		Raw bulk milk	Boudra and others	Aflatoxin M_1 and ochratoxin A in raw bulk milk from french dairy herds	J Dairy Sci 2007; 90:3197–201	2007
Simultaneou determination of trichothecenes (NIV, DON, F-X, T-2 Ric-A, Ver-A)	HPLC coupled to UV and mass spectrometric (MS) detection,	Plant material such as wheat, wheat	Stecher and others	Evaluation of extraction methods for the simultaneous analysis of simple and macrocyclic trichothecenes	Talanta 2007; 73:251–7	2007
Zearalenone, α- and b-zearalenols, fumonisin B1	High-performance liquid chromatography coupled with mass spectroscopy (HPLC/MS) LC analysis by Varian system, 2 pumps, polar modified RP-18 column	Maize	Adejumo and others	Survey of maize from south-western Nigeria for zearalenone, α- and β-zearalenols, fumonisin B1 and emirates produced by Fusarium species	Food Addit Contam, September 2007; 24(9):993–1000	2007

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxins and ochratoxin A.	were determined by TLC and HPLC methods	Poultry feeds	Fraiga and others	Potential Aflatoxin and Ochratoxin A production by Aspergillus species in poultry feed processing	Vet Res Commun,Volume 31, Number 3<943>3323 Dec 2006	2007
Simultaneous determination of aflatoxin B1 (AFB1) and ochratoxin A (OTA)	HPLC column was Bio-sil C18 HL 90-5 S (5 mm, 4.6 × 150 mm) 200 ng/g with a corresponding limit of detection	Olive oil	Ferracane and others	Simultaneous determination of aflatoxin B_1 and ochratoxin A and their natural occurrence in Mediterranean virgin olive oil	Food Addit Contam. Vol. 24: 2:173–80	2007
Simultaneous, aflatoxins (AFL), i.e., B1 (AFB1), B2 (AFB2), G1 (AFG1), and G2 (AFG2), and ochratoxin A (OTA)	AF reversed-phase liquid chromatography (RPLC) with fluorescence detection after postcolumn UV photochemical derivatization. OTA was separated and determined by RPLC with fluorescence detection.	Ginseng and ginger	Trucksess and others	Use of multitoxin immunoaffinity columns for determination of aflatoxins and ochratoxin A in ginseng and ginger.	J AOAC Int 2007 Jul to Aug; 90(4):1042–9	2007
Aflatoxins or ochratoxins	Review	Tree nuts (almonds, pistachios, and walnuts)	Molyneux and others	Mycotoxins in edible tree nuts	Int J Food Microbiol 2007 Jul 31	2007
Aflatoxins, deoxynivalenol, fumonisins, zearalenone, T-2 toxin, ochratoxin and certain ergot alkaloids	Review	Crop plants	Richard	Some major mycotoxins and their mycotoxicoses: an overview.	Int J Food Microbiol 2007 Jul 31	2007
Aflatoxin B1, citrinin, deoxynivalenol, fumonisin B1, gliotoxin, ochratoxin A and zearalenone	High-performance liquid chromatography coupled to mass spectrometry (HPLC–MS).	Corn silage mycotoxins on nutrient agar	Richard and others	Toxigenic fungi and mycotoxins in mature corn silage	Food Chem Toxicol (2007) Jun 22	2007
13 trichothecenes, (SCAHP), 15-monoacetoxyscirpenol, 4,15-diacetoxyscirpenol, T-2 toksol, HT-2 toxin, (DON), 15-, 3-acetyl DON, ZEA, α- and /-ZOL.	Gas chromatography/mass spectrometry, zearalenone (ZEA), α- and /-zearalenol (α- and /-ZOL) by high-performance liquid chromatography (HPLC) with fluorescence and UV-detection.	Whole beans, roasted soy nuts, flour and flakes, textured soy protein, tofu, proteinisolate including infant formulas and fermented products (soy sauce)	Schollenberger and others	Natural occurrence of Fusarium toxins in soy food marketed in Germany	Int J Food Microbiol 2007; 113:143–6	

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxins, type A trichothecenes, type B trichothecenes, Ochratoxin A, Zearalenone Fumonisins, and Patulin	LC/MS/MS	Corn flake		Multicomponent mycotoxin analysis by LC/MS/MS	The 10th annual meeting of the Israel analytical chemistry society 2007	2007
Mycotoxins within 12 minutes: (NIV), (DON), AX21, AP02, AFB1, AIB2, FB1, FB2, Diacetoxyscirpenol (DAS), T2- Toxins, OTA, and (ZEN)	HPLC LC–MS/MS method for the determination of mycotoxins	Various cattle forages.		Analysis of mycotoxins in various cattle	Mass spectrometry	2007
Zearalenone, glucosides, malonylglucosides, ß-hexose- and hexose–pentose disaccharides of zearalenone, and -, - and -,-zearalenol, were detected	LC coupled to tandem mass spectrometry (LC–MS/MS)- analysis by (HPLC)-MS/MS. Aquasil C18 column (100_4.6 mm, 3 mm)	Using the model plant rabidopsis thaliana- After treatment of plant seedlings	Berthiller and others	Liquid chromatography coupled to tandem mass spectrometry (LC–MS/MS) determination of phase II metabolites of the mycotoxin zearalenone in the model plant Arabidopsis thaliana	Food Additives and Contaminants, November 2006; 23(11):1194–1200	2006
Aflatoxins	HPLC-fluorescence detection (FLD) with postcolumn electrochemical derivatization in a Kobra cell.	Chili powder, green bean, and black sesame.	Hu and others	Determination of aflatoxins in high-pigment content samples by matrix solid phase dispersion and high-performance liquid chromatography	J Agric Food Chem 2006, 54, 4126–30	2006
Aflatoxin B1, fumonisin B1, ochratoxin A	Aflatoxin B1, fumonisin B1, zearalenone using immunoassays, and ochratoxin A using a validated HPLC method with fluorescence detector	Rice, maize and peanuts	Sangare-Tigori and others	Co-occurrence of aflatoxin B1, fumonisin B1, ochratoxin A and zearalenone in cereals and peanuts from Côte d'Ivoire	Food Additives and Contaminants, October 2006; 23(10):1003–1007	2006
Aflatoxins	ELISA HPLC All positive samples were also analyzed and confirmed by HPLC.	Red scaled, red and black pepper.	Colak and others	Determination of aflatoxin contamination in red-scaled, red and black pepper by ELISA and HPLC	Journal of Food and Drug Analysis, Vol. 14, No. 3, 2006, Pages 259–96	2006
Trichothecenes, ochratoxins, zearalenone, fumonisins, aflatoxins, enniatins, moniliformin	Atmospheric pressure ionisation (API) techniques in the late 80s. LC/MS has become a routine technique also in food analysis		Zöllner and Mayer-Helm		J Chromatogr A 2006 Nov 4	2006

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxin; Ochratoxin A; Patulin; *Fusarium* toxins	PCR review		Paterson	Identification and quantification of mycotoxigenic fungi by PCR	Process Biochemistry Volume 41, Issue 7, July 2006, Pages 1467–74	2006
Trichothecenes, ochratoxins, zearalenone, fumonisins, aflatoxins, enniatins, moniliformin	LC–(API)MS review			Trace mycotoxin analysis in complex biological and food matrices by liquid chromatography–atmospheric pressure ionisation mass spectrometry	Journal of Chromatography A Volume 1136, Issue 2, Pages 123–69	2006
Aflatoxin M1 in milk and B1 in feed	ELISA immunoassay, used as screening test, positive samples confirmed by HPLC	Milk and feed	Decastelli and others	Aflatoxins occurrence in milk and feed in Northern Italy during 2004 to 2005	Available online 27 October 2006	2006
Aflatoxins B1, G1, B2, G2 and ochratoxin A	Ultra-performance liquid chromatography/tandem mass spectrometry (UPLC/MS/MS), mass spectrometer used an electrospray ionization source operated in the positive mode to detect aflatoxins and in the negative mode to detect ochratoxin	Beer	Guillén and others	Ultra-performance liquid chromatography/tandem mass spectrometry for the simultaneous analysis of aflatoxins B1, G1, B2, G2 and ochratoxin A in beer	Rapid Communications in Mass Spectrometry Volume 20, Issue 21, Pages 3199–204	2006
Mycotoxins OTA, DON, AFB1, and FB were detected simultaneouly	ELISA	Food sample		Rapid detection of foodborne contaminants using an Array Biosensor	Sensors and Actuators B 113 (2006) 586–607	2006
	Review		Malir and others	Monitoring the mycotoxins in food and their biomarkers in the Czech Republic	Mol Nutr Food Res 2006 Jun; 50(6):513–8	2006
AFL and ochratoxin A (OTA)	Liquid chromatographic separation, and fluorescence detection	Ginseng and other selected botanical roots	Trucksess and others	Determination of aflatoxins and ochratoxin A in ginseng and other botanical roots by immunoaffinity column cleanup and liquid chromatography with fluorescence detection	J AOAC Int 2006 May-Jun; 89(3):624–30	2006

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Analysis of mycotoxins analysis of three mycotoxins, Aflatoxins (AFs): Aflatoxin G1	Aflatoxin G1 has been detected by liquid-liquid partitioning methods with HPLC detection as false-positive in some maize Fumonisins (FB); Compounds interfering with the FB's antibodies were also observed while analysing breakfast cereals leading to underestimation of FB. Ochratoxin A (OTA)	Maize	Castegnaro and others	Advantages and drawbacks of immunoaffinity columns in analysis of mycotoxins in food	Mol Nutr Food Res 2006 May; 50(5):480–7	2006
Ochratoxin (OT) and aflatoxin (AF)		Barley rootlets (BR)	Ribeiro and others	Influence of water activity, temperature, and time on mycotoxins production on barley rootlets.	Lett Appl Microbiol 2006 Feb; 42(2):179–84	2006
Trichothecenes, ochratoxins, zearalenone, fumonisins, aflatoxins, enniatins, moniliformin and several other mycotoxins	LC–(API)MS	Review		Trace mycotoxin analysis in complex biological and food matrices by liquid chromatography–atmospheric pressure ionisation mass spectrometry	Journal of Chromatography A Volume 1136, Issue 2, 15 December 2006, Pages 123–69	2006
Simultaneously NIV, DON, ZEN, diacetoxyscirpenol, T-2 toxin, verrucarol, verrucarin A, neosolaniol, sterigmatocystin, roridin A, OTA,AFB1, AFB2,AFG1, AFG2	HPLC fluorescence detector, injector, gradient and data handling capability is required, The fluorescence detector settings: excitation 315 nm, emission ~415 nm liquid chromatography/ tandem mass spectrometry (LC/MS/MS) method	Two fungal media were used as samples	Delhalle and others	Development of a liquid chromatography/tandem mass spectrometry method for the simultaneous determination of 16 mycotoxins on cellulose filters and in fungal cultures	Rapid Commun Mass Spectrom. 2006; 20(5):771–8	2006
Aflatoxin; Ochratoxin A; Patulin; *Fusarium* toxins	PCR	Food stuff review		Identification and quantification of mycotoxigenic fungi by PCR	Process Biochemistry Volume 41, Issue 7, July 2006, Pages 1467–74	2006

Continued

Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Ochratoxin A (OTA)	Extracts were subsequently analysed using reverse-phase high-performance liquid chromatography–fluorescence detection with post column ammoniation to improve the limit of detection.	Wine and beer	Varelis and others	Quantitative analysis of ochratoxin A in wine and beer using solid phase extraction and high-performance liquid chromatography–fluorescence detection	Food Additives and Contaminants, December 2006; 23(12):1309–15	2006
Aflatoxins (B1, B2, G1, and G2), patulin and ergosterol one by one	HPLC (Agilent, 1100 series, USA) equipped with a fluorescence detector (G1321A, Agilent, 1100 series, USA) after postcolumn bromination immunoaffinity column (Vicam, Watertown, MA, USA)	Dried figs	Karaca and Nas	Aflatoxins, patulin and ergosterol contents of dried figs in Turkey	Food Additives and Contaminants, May 2006; 23(5):502–08	2006
Trichothecenes, ochratoxins, zearalenone, fumonisins, aflatoxins, enniatins, moniliformin, and several other mycotoxins	Application of LC–(API)MS atmospheric pressure ionisation (API) techniques			Trace mycotoxin analysis in complex biological and food matrices by liquid chromatography–atmospheric pressure ionisation mass spectrometry	[b]Department of Clinical Pharmacology, Medical University of Vienna, Währinger Gürtel 18-20, A-1090 Wien, Austria	2006
AFM1	Thin-layer chromatography for determining AFM1,compared with HPLC fluorescence detection	Raw, pasteurized and ultrahigh treated temperature (UHT) milk	Shundo and Sabino	Aflatoxin M1 in milk by immunoaffinity column cleanup with TLC/HPLC determination	Brazilian Journal of Microbiology (2006) 37:164–67	2006
Ochratoxin A (OTA) and aflatoxin B1 (AFB1) one by one	Mediterranean shores, It has a rectangular shape with 10,452 km^2 area, OTA was detected and quantified by reversed-phase HPLC, autosampler (Agilent 1100, G1313A, ALS) and a fluorescence detector A selected RP–18 column HPLC method for aflatoxin B1 analysis both fluorescence and UV detector	Wine-grapes in Lebanon on Czapek yeast extract agar (CYA), culture medium	El Khoury and others	Occurrence of Ochratoxin A- and Aflatoxin B1-producing fungi in lebanese grapes and ochratoxin a content in musts and finished wines during 2004	J Agric Food Chem 2006, 54, 8977–82	2006

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
	ELISA		Mhadhbi and others	Generation and characterization of polyclonal antibodies against Microcystins Application to immunoassays and immunoaffinity sample preparation prior to analysis by liquid chromatography and UV detection	Toxicon 70 (2006) 225–35	2006
Aflatoxin B1	TLC silica gel as an adsorbent and 7% methanol in chloroform as the developing solvent. And fluorodensitometrically using HPTLC plates aluminium sheets, silicagel 60 F254 precoated, enzyme linked immunosorbent assays (ELISA), flow through membrane based immunoassays, chromatographic techniques nucleic acid amplification assays, biosensors, and microarrays for detection of molds and mycotoxins,	Rice	Toteja and others	Aflatoxin B1 contamination of parboiled rice samples collected from different states of India: a multicentre study	Food Additives and Contaminants, April 2006; (23)4:411–14	2006
			Foong-Cunningham and others	Rapid detection of mycotoxigenic molds and mycotoxins in fruit juice	ARI The Bulletin of the Istanbul Technical University VOLUME 54, NUMBER 4	2006
AFB1 and OTA one by one	Quantitated by HPLC using a fluorescence detector.	Black and green olives of Greek origin	Ghitakou and others	Study of aflatoxin B1 and ochratoxin A preseason by natural microorganisms and Aspergillus parasiticus in black and green olives of Greek origin	Food Microbiology 23 (2006) 612–21	2006
Aflatoxins	High-performance liquid chromatography (HPLC)-fluorescence detection (FD), confirmed using HPLC-electrospray ionization (ESI)-mass spectrometry (MS).	Polished rice	Park and others	Effect of pressure cooking on aflatoxin B1 in rice	J Agric Food Chem 2006, 54, 2431–35	2006

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxins (AFs) (B1, B2, G1, and G2), zearalenone (ZEA), and ochratoxin A (OTA)	high-performance liquid chromatography (HPLC) with fluorescence detection	Cereal grains	Li and others	[Simultaneous determination of aflatoxins, zearalenone and ochratoxin A in cereal grains by immunoaffinity column and high-performance liquid chromatography coupled with postcolumn photochemical derivatization]	Se Pu 2006 Nov; 24(6):581–4	2006
Aflatoxin B1 (AFB1)	Screen-printed carbon electrodes (SPCEs) bearing a surface-assorbed antibody ELISA	Real samples from grain extracts.	Pemberton and others	Studies toward the development of a screen-printed carbon electrochemical immunosensor array for mycotoxins: a sensor for aflatoxin B1	Analytical Letters, 39:1573–86, 2006	2006
Aflatoxin B1, ochratoxin A, deoxynivalenol and T-2 toxin), one by one	Aflatoxin and ochratoxin by HPLC fluorescence, T-2 toxin and deoxynivalenol by ELISA	Animal feeds.	Charoenpornsook and others	Mycotoxins in animal feedstuffs of Thailand	KMITL Sci. Tech. J. Vol. 6 No. 1 Jan.–Jun. 2006	2006
Aflatoxin B1-N7-guanine (AFB1-N7-Gua), major human aflatoxin-DNA	Stable isotope-labeled internal standard (AFB1-N7-15N5-Gua) HPLC C18 microbore HPLC column	Excreted in the urine.	Egner and others	Quantification of aflatoxin-B1-N7-guanine in human urine by high-performance liquid chromatography and isotope dilution tandem mass spectrometry.	Chem Res Toxicol. 2006, 19:1191–95	2006
Fusarium metabolits moniliformin, acetamide-butenolide, chlamydosporol,) antibiotic Y, chrysogine, fusarin C, enniatins, 2-AOD-3-ol, aurofusarin	In a rat hepatoma (H4IIE-W), porcine epithelial kidney (PK-15), foetal feline lung,fibroblast, dog lymphoblast (D3447), and a human hepatocarcinoma (Hep G2) cell line Alamar BlueTM assay, HPLC high-performance liquid chromatography with photodiode array and mass spectrometric detection.	Extracts from rice cultures	Uhlig and others	Multiple regression analysis as a tool for the identification of relations between semiquantitative LC–MS data and cytotoxicity of extracts of the fungus Fusarium avenaceum	Toxicon 48 (2006) 567–79	2006
4-deoxynivalenol (DON or vomitoxin), DON and nivalenol	ELISA	Maize, wheat, and barley.		Production and characterization of a monoclonal antibody that cross-reacts with the mycotoxins nivalenol and 4-deoxynivalenol.	Food Additives and Contaminants, August 2006; 23(8):816–25	2006

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxin B1, B2, G1, and G2, ochratoxin A, and fumonisin B1, B2, and B3 one by one	HPLC, LC_MS, or high-performance thin-layer chromatography	Peanut butter, corn, peanuts, buckwheat flour, dried buckwheat noodles, rice, sesame oil, oatmeal, wheat flour, rye, buckwheat, green and roasted coffee beans, raisins, beer, wine	Sugita-Konishi and others	Occurrence of aflatoxins, ochratoxin A, and fumonisins in retail foods in Japan	J Food Prot. 2006 Jan;69(1):152–9	2006
Simultaneous determination of 12 trichothecenes DON, NIV, 3-acetyldeoxy NIV, 15-acetyldeoxy NIV, fusarenon X, T-2 toxin, HT-2 toxin, neosolaniol, monoacetoxyscir-penol, diacetoxyscirpenol, T-2 triol, and T-2 tetraol	Liquid chromatography-electrospray ionization tandem mass spectrometry (LC-ESI-MS/MS)	Wheat and oat samples	Klötzel and others	Determination of 12 Type A and B trichothecenes in cereals by liquid chromatography-electrospray ionization tandem mass spectrometry	J Agric Food Chem 2005, 53:8904–10	2005
			Whitlow and others	Mycotoxins in dairy cattle: occurrence, toxicity, prevention and treatment	Whitlow and Hagler, 2005, Proc. Southwest Nutr. Conf., 124–38	2005
FUM1	LCMS		Yu and others	Developing a genetic system for functional manipulations of *FUM1*, a polyketide synthase gene for the biosynthesis of fumonisins in *Fusarium verticillioides*	FEMS Microbiology Letters Volume 248, Issue 2, 15 July 2005, Pages 257–64	2005
OTA, α-ZEA, β-ZEA zearalenol (alpha-zol), FB1, FB2, T-2 toxin, HT-2 toxin, T-2 triol, diacetoxyscirpenol (DAS), 15-monoacetoxyscirpenol (MAS), (DON), 3-acetyldeoxyNIV (3-AcDON), 15-acetyldeoxyNIV(15-AcDON), deepoxy-DON (DOM-1) and AFM1	LC_MS /MS Liquid chromatographic/tandem mass spectrometric methods using pneumatically assisted electrospray ionisation (LC–ESI-MS/MS)	Milk	Sørensen and Elbæk	Determination of mycotoxins in bovine milk by liquid chromatography tandem mass spectrometry	J Chromatogr B, 820 (2005) 183–96	2005

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Fusarium mycotoxins NIV, DON, fusarenon-X, 3-acetyldeoxynivalenol, 3-acetyl-DONand 15-acetyl-DON, diacetoxy-scirpenol, HT-2 toxin, T-2 toxin, ZEN	RP-LC with atmospheric pressure chemical ionization triple quadrupole mass spectrometry (LC–APCI-MS/MS). LC–MS/MS analysis was performed	Maize	Berthiller and others	Rapid simultaneous determination of major type A- and B-trichothecenes as well as zearalenone in maize by high-performance liquid chromatography–tandem mass spectrometry	Journal of Chromatography A, 1062 (2005) 209–16	2005
Co-occurrence of ochratoxin A and aflatoxin B1 one by one		Dried figs	Senyuva and others	Survey for co-occurrence of ochratoxin A and aflatoxin B1 in dried figs in Turkey using a single laboratory-validated alkaline extraction method for ochratoxin A.	J Food Prot 2005 Jul; 68(7):1512–5	2005
Aflatoxin M1	Enzyme immunoassay compared with a reference high-performance liquid chromatography method with a fluorescent detector,	Milk	Maglulo and others	Development and validation of an ultrasensitive chemiluminescent enzyme immunoassay for aflatoxin M1 in milk	J Agric Food Chem 2005, 53, 3300–05	2005
DON, Aflatoxins, Ochratoxin A, Zearalenone and Fumonisin	HPLC and postcolumn derivatization column: MYCOTOX™ reversed-phase C18, 4.6 × 250 mm	Aliquot of the beverage	Offserova and others	Multiresidue mycotoxin analysis single run analysis of deoxynivalenol, aflatoxins, ochratoxin a, zearalenone and fumonisin by HPLC and postcolumn derivatization	www.pickeringlabs.com	2005
Aflatoxin M1, aflatoxin B1, and ochratoxin A.	HPLC pump Model 2248 together with a Low Pressure Mixer Fluorescence detection;.	Analyze 123 samples of 24-h diets	Sizoo and Van Egmond	Analysis of duplicate 24-h diet samples for aflatoxin B1, aflatoxin M1 and ochratoxin A	Food Additives and Contaminants, February 2005; 22(2):163–72	2005
Aflatoxins B_1, B_2, G_1 and G_2 (AFB1, AFB2, AFG1, AFG2) and ochratoxin A (OTA) one by one	high-performance liquid chromatography (HPLC) fluorescence detector	Spice ground red pepper, 6 black pepper, 5 white pepper, 5 spice mix, and 5 chili	Fazekas and others	Aflatoxin and ochratoxin A content of spices in Hungary	Food Additives & Contaminants, Volume 22, Issue 9 September 2005, pages 856–63	2005

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Table 1 – Continued.

Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Simultaneous determination of T-2 and HT-2 toxins	HPLC– fluorescence quantified by reversed-phase HPLC with fluorometric detection (excitation wavelength 381 nm, emission wavelength 470 nm) after derivatization with 1-AN.	Cereal grains	Lattanzio and others	Analysis of T-2 and HT-2 toxins in cereal grains by immunoaffinity cleanup and liquid chromatography with fluorescence detection	Journal of Chromatography A, 1075 (2005) 151–58	2005
Ochratoxin A (OTA)	ELIZA	Roasted coffee	Lobeau and others	Development of a new cleanup tandem assay column for the detection of ochratoxin A in roasted coffee	Analytica Chimica Acta Volume 538, Issues 1–2, 4 May 2005, Pages 57–61	2005
Simultaneously aflatoxins B1, B2, G1, G2 and M1, ochratoxin A, mycophenolic acid, penicillic acid and roquefortine C simultaneously	HPLC_MS	Blue and white mold cheeses	Kokkonen and others	Determination of selected mycotoxins in mould cheeses with liquid chromatography coupled to tandem with mass spectrometry	Food Additives and Contaminants, May 2005; 22(5):449–56	2005
Ochratoxin A (OTA) analysis	(LC) with fluorescence detection (FD), (ELISA) kits, using anti-OTA antibodies (electrochemical immunosensors, fluorescence polarisation, lateral flow devices, enzyme-based flow through membranes, and surface plasmon resonance biosensors) Liquid chromatography–mass spectrometry represents an adequate alternative to LC-FD	Cereals, coffee, wine, and beer.	Visconti and De girolamo	Fitness for purpose—ochratoxin A analytical developments	Food Additives and Contaminants, Supplement 1 2005:37–44	2005
Aflatoxin M_1 (AFM_1) and ochratoxin A (OA)	Quantification by high-performance liquid chromatography (HPLC) with fluorescence detection.	Human Milk Bank	Navas and others	Aflatoxin M_1 and ochratoxin A in a human milk bank in the city of São Paulo, Brazil	Food Additives & Contaminants, Volume 22, Issue 5 May 2005, pages 457–62	2005
Ochratoxin A (OTA)	LC–MS system	Alcoholic beverages, wine and beer	Bacaloni and others	Automated online solid phase extraction-liquid chromatography-electrospray tandem mass spectrometry method for the determination of ochratoxin a in wine and beer	J Agric Food Chem 2005, 53, 5518–25	2005

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Mycotoxins	Quantification method	Type of food	Author	Article	Reference	Year
Aflatoxins in a number of commodities, ochratoxin A (OTA) in wheat, deoxynivalenol (DON) in maize and wheat, and ZEA in maize	Review article	Aflatoxins in a number of commodities, ochratoxin A (OTA) in wheat, deoxynivalenol (DON) in maize and wheat, and ZEA in maize	Kruska and others	Advances in the analysis of mycotoxins and its quality assurance	Food Additives and Contaminants, Volume 22, Number 4, April 2005, pp. 345–53(9)	2005
Aflatoxin (AF) or ochratoxin A (OTA) one by one	HPLC for AF OTA by (ELISA)	Seed-, pulses-, and cereal-flours and starches	Baydar and others	Aflatoxin and ochratoxin in various types of commonly consumed retail ground samples in Ankara, Turkey	Ann Agric Environ Med. 2005;12(2):193–7	2005
Aflatoxin, ochratoxin A,	Analyzed for the mycotoxins by RHM Technology, using high-performance liquid chromatography (HPLC),	Spices		Survey of spices for aflatoxins and ochratoxin A	Food Survey Information Sheets on the WWW http://www.food.gov.au/science/surveillance	2005
Fumonisin B1 and B2, T2 toxin, DON one by one	HPLC with fluorescence detector for fumonisins and with variable wavelength UV detector for T2 toxin and DON	161 cereal and cereal products 115 medicinal and herbal tea specimens 112 cereal and pulse products	Omurtag and others	A review on fumonisin and trichothecene mycotoxins in foods consumed in Turkey	ARI The Bulletin of the Istanbul Technical University Volume 54, Number 4	2005
Fumonisin B1, fumonisin B2, zearalenone and ochratoxin A one by one	HPLCsystem (Varian, USA) with fluorescence detection.	Maize	Domijan and others	Fumonisin B1, fumonisin B2, zearalenone and ochratoxin A contamination of maize in Croatia	Food Additives and Contaminants, July 2005; 22(7):677–86	2005
Ochratoxin A (OTA) and aflatoxins B1, B2, G1 and G2	TLC and confirmation by HPLC extracts by HPLC with fluorescent detection;.	Bee pollen	Gonzalez and others	Occurrence of mycotoxin producing fungi in bee pollen	Int J Food Microbiol 105 (2005) 1–9	2005
Fusarium mycotoxins (trichothecenes Type A and B, zearalenone) simultaneously	Liquid chromatography with tandem mass spectrometry (LC–ESI-MS/MS), HPLC	Cereals and cereal-based samples	Biselli and Hummert	Development of a multicomponent method for Fusarium toxins using LC–MS/MS and its application during a survey for the content of T-2toxin and deoxynivalenol in various feed and food samples	Food Additives and Contaminants, August 2005; 22(8): 752–60	2005

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