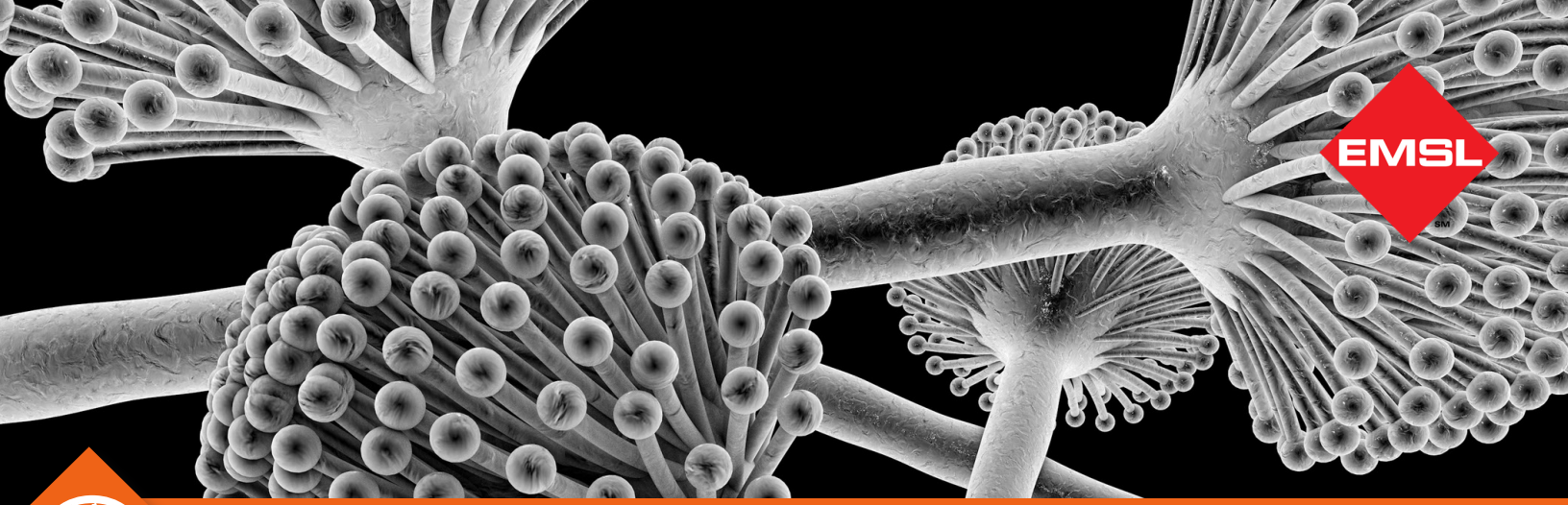

Environmental Mycotoxin Testing at EMSL

What are mycotoxins?

The name mycotoxin is derived from the Greek word 'mykes' meaning fungus and the Latin word 'toxicum' meaning poison. Mycotoxins are secondary metabolites produced by fungi (including molds) that cause illness or death in humans or animals, typically through ingestion. Some mycotoxins are also toxic to plants or other microorganisms (called antibiotics). Fungi produce many different secondary metabolites as a product of their metabolism. The reason why fungi produce mycotoxins for themselves is still not clear. It may be a mechanism to secure a food source from their competitors; chemical warfare at its most basic form!

Fungi are a natural part of the environment with most species living on dead organic matter that they help to decompose, while many others may cause diseases in plants. More than 300 mycotoxins have been detected from over 200 fungal species. For most, their toxicological characteristics have not been fully described. The Food and Agricultural Organization of the United Nations (FAO) has estimated that 25% of the world's crops are contaminated with mycotoxins, and certain diseases have been linked to ingestion of food and feed contaminated with mycotoxins. New evidence that indoor air pollution from toxigenic fungi may play a role in human illness has implicated that mycotoxins could have a much bigger role in chronic disease than was previously thought possible (CAST 2003).

Historically, the first fragmentary information of fungal poisoning was in ancient Greco-Roman times although it was not until the Renaissance that more precise descriptions are found. Modern mycotoxicology really began with the discovery of aflatoxin in the early 1960's as the chemical compound responsible for causing "Turkey X" disease. Over 10,000 turkeys were killed after consuming contaminated peanut meal.

What are the significant toxins?

Mycotoxins have traditionally been studied in the agricultural and food industries but in recent years their association with indoor mold contamination has been of great interest. The major classes of mycotoxins are aflatoxin, trichothecenes, fumonisins, zearalenone, ochratoxin A and ergot alkaloids. The mycotoxins found in indoor air are usually concentrated in the aerosolized fungal spores but may also be in mycelia and contaminated substrates. Table below lists toxigenic fungi commonly isolated from water-damaged buildings:

Fungus	Mycotoxins
Alternaria alternata	tenuazonic acid, alternatiol, alternatiol monomethyl ether, alterotoxins
Aspergillus fumigatus	**gliotoxin**, verrucologen, fumitremorgceusins, fumitoxins, tryptoquivalins, fumonisin B1, penicillic acid, fumagillin
A. niger	ochratoxin A, fumonisins, naphthopyrones, malformins, nigragillin, orlandin
A. nidulans	**sterigmatocystin**, nidulotoxin
A. ochraceus	ochratoxin A, citrinin, penicillic acid, xanthomegnin, viomellin
A. versicolor	**sterigmatocystin**, **5-methoxysterimatocystin**, versicolorins, cyclopiazonic acid, griseofulvin

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Fungus	Mycotoxins
Chaetomium globosum	**chaetoglobosins**, **chaetomin**, chaetoviridin A, chaetomugilin D, cochliodones
Memnoniella echinata	trichodermol, trichodermin, dechlorogriseofulvins, memnobotrins A and B, memnoconol, memnoconone
Penicillium aurantiogriseum	auranthine, penicillic acid, verrucosidin, **nephrotoxic glycopeptides**
P. brevicompactum	mycophenolic acid
P. chrysogenum	ochratoxin A, penitrem A
Stachybotrys chartarum	**satratoxins**, **verrucarins**, **isoratratoxins**, **roridins**
Wallemia sebi	**walleminols A and B**, wallimidione, walleminone, azasteroids

Toxins in boldface are of high potency.

How are Mycotoxins produced?

Mycotoxins can be produced by a variety of different fungal species and it is a generally accepted phenomenon that the occurrence of mycotoxins is unpredictable. Two important points need to be emphasized. First, the presence of a mold or evidence of prior fungal contamination does not in itself indicate the presence of mycotoxins. There is a possibility that the fungus is genetically incapable of toxin production or, if the organism is capable, the conditions may not be the right ones to trigger and stimulate toxin production.

Mycotoxin production is affected by a multitude of variables that are interactive and in a state of dynamic change. Environmental, genetic, and physiological factors play a key role. These factors include weather conditions, invertebrate vectors, strain type, and spore load. Physical factors for mycotoxin production are time of exposure, temperature, humidity, insect predation, and other damage. Chemical factors for production include nutrients, aeration (O_2 and CO_2 ratio), type of substrate, and pH.

Health considerations

Mycotoxins can be carcinogenic (causes cancer), teratogenic (causes birth defects), mutagenic (causes mutation or damage to genetic material), immunosuppressive (decreases the immune system), tremorgenic (causes tremors or damage to the central nervous system), hemorrhagic (causes bleeding), hepatotoxic (damages the liver), nephrotoxic (damages the kidneys) and neurotoxic (damages nerve tissue).

Human exposure to mycotoxins can occur by several ways, including ingestion, contact, and inhalation. Table below lists some human diseases in which analytic and/or epidemiological data suggest or implicate mycotoxin involvement from ingestion of contaminated substrates.

Disease	Species	Substrate	Etiologic agent
Akakabio-byo	Human	wheat, barley, oats, rice	*Fusarium* spp.
Alimentary toxic aleukia (ATA or septic angina)	Human	cereal grains (toxic bread)	*Fusarium* spp.
Balkan nephropathy	Human	cereal grains	*Penicillium* spp., *Aspergillus* spp.
Cardiac beriberi	Human	rice	*Aspergillus* spp., *Penicillium* spp.
Celery harvester's disease	Human	celery (pink rot)	*Sclerotinia*
Dendrodochiotoxicosis	Horse, human	fodder (skin contact, inhaled fodder particles)	*Dendrodochium toxicum*

Disease	Species	Substrate	Etiologic agent
Ergotism	Human	rye, cereal grains	*Claviceps purpurea*
Esophageal tumors	Human	corn	*Fusarium fujikuroi* (syn. *Fusarium verticillioides*)
Hepatocarcinoma (acute aflatoxicosis)	Human	cereal grains, peanuts	*Aspergillus flavus, A. parasiticus*
Kashin Beck disease, "Urov disease"	Human	cereal grains	*Fusarium* spp.
Kwashiorkor	Human	cereal grains	*Aspergillus flavus*, *A. parasiticus*
Onyalai	Human	millet	*Phoma sorghina*
Reye's syndrome	Human	cereal grains	*Aspergillus* spp.
Stachybotryotoxicosis	Human, horse, other livestock	hay, cereal grains, fodder (skin contact, inhaled haydust)	*Stachybotrys chartarum*

CAST (2003).

Dose-response relationships between exposure to mycotoxins in the indoor environment through inhalation and health effects to occupants have still not been established. We know that there are significant health effects when mycotoxins are ingested, we do not know what it takes to elicit any effect through breathing contaminated air.

Environmental Testing Approach

EMSL recommends testing the indoor environment for culturable fungi to determine whether fungal species are present in the environment with the potential to generate mycotoxins. This is a cost-efficient approach rather than unnecessarily testing for a wide range of mycotoxins that are not likely present. When you select test code M370, EMSL mycologists will perform a comprehensive culture for potential mycotoxin-producing fungi. Acceptable samples are air, dust, bulks, and food. After the completion of testing, our experts will provide personalized consulting on which mycotoxins are potentially present based on the culture results. If further testing is needed to confirm exposure, one of our targeted mycotoxin tests may be recommended.

Test Code: M370 – Comprehensive Culture for Potential Mycotoxin-producing Fungi

Turnaround Time: 2 weeks

Acceptable Matrices: Air (Andersen-type samplers, e.g. EMSL's VP-400 – Product ID # 8709001)
Dust (cassette sampler, e.g. EMSL Microvac Cassette – Product ID # 8715314)
Bulks (sheetrock, insulation, etc.), 1-2 in^2 of the bulk or 1-25g sample
Food (contaminated foods, e.g. peanuts and other nut products, corn products, etc.). 1-25g sample

Shipping Considerations: Ship overnight in a cooler with ice packs

Note: EMSL offers the following mycotoxin testing services on wipes in our Industrial Hygiene Laboratory:
Test Codes: IH302 – Aflatoxins, IH313 – Ochratoxin A, IH316 – Sterigmatocystin, IH318- Zearalenone

EMSL offers the following mycotoxin testing services on food sample in our Food Chemistry Laboratory:
Test Codes: F647 – Aflatoxins, Ochratoxin A, F648 – Zearalenone, Deoxynivalenol (DON), Sterigmatocystin