

Company:
Project Name: Sample Report
Address:
Sample Type: Cotton Swab

Accession #:

Collected:
Received:
Completed:

Procedure Type:

Quantitative PCR (Polymerase Chain Reaction)

Code	Test	Value (Fungal Elements / ML)
AALT	<i>Alternaria alternata</i>	0
AFLAV	<i>Aspergillus flavus</i>	0
AFUMI	<i>Aspergillus fumigatus</i>	4,774
ANIG	<i>Aspergillus niger</i>	25,382
AOCHR	<i>Aspergillus ochraceus</i>	0
APENI	<i>Aspergillus penicillioides</i>	228,609
ASP25	<i>Aspergillus terreus</i>	8,190
AVERS	<i>Aspergillus versicolor</i>	4,218,070
CAU	<i>Candida auris</i>	0
CGLOB	<i>Chaetomium globosum</i>	0
FUS14	<i>Fusarium solani</i>	0
PBREV	<i>Penicillium brevicompactum</i>	651
PCHRY	<i>Penicillium chrysogenum</i>	21,800,000
STAC	<i>Stachybotrys chartarum</i>	63,313
WSEBI	<i>Wallemia sebi</i>	7,137

MOLD	MYCOTOXIN PRODUCED	POTENTIAL HEALTH ISSUES
<i>Alternaria alternata</i>	Alternariol	Spores can be found in damp, poorly ventilated homes, contributing to sick building syndrome [1]. Alternariol has been reported to be mutagenic [2].
<i>Aspergillus flavus</i>	Gliotoxin, Aflatoxin	<i>A. flavus</i> is the second leading cause of invasive aspergillosis in immunocompromised patients. Particularly common clinical syndromes associated with <i>A. flavus</i> include: chronic granulomatous sinusitis, keratitis, cutaneous aspergillosis, wound infections and osteomyelitis following trauma and inoculation [3, 4]. Can cause liver cancer in humans [5].
<i>Aspergillus fumigatus</i>	Gliotoxin, Aflatoxin	<i>A. fumigatus</i> is frequently found in homes and buildings [1]. It is considered to be an opportunistic pathogen, meaning it rarely infects healthy individuals, but is the leading cause of invasive aspergillosis (IA) in immunocompromised individuals such as cancer, HIV or transplant patients [2].
<i>Aspergillus niger</i>	Ochratoxin, Gliotoxin	<i>A. niger</i> produces gliotoxin, which has been identified in the sera of humans and mice with aspergillosis. Causes immunosuppression in patients [8].
<i>Aspergillus ochraceus</i>	Ochratoxin	Ochratoxin has been demonstrated to be Nephrotoxic, Hepatotoxic, and Carcinogenic and is a potent teratogen and immune-suppressant [8]. It has also been associated with urinary tract infections and bladder cancer [9].
<i>Aspergillus penicillioides</i>	Unknown	<i>A. penicillioides</i> is commonly found indoors [10]. Infection has been confirmed in pulmonary aspergillosis [11] and fungal aneurysm [12].
<i>Aspergillus terreus</i>	Gliotoxin, Citirin	Inhalation of fungal spores, which travel down along the respiratory tract, cause the typical respiratory infection [6].
<i>Aspergillus versicolor</i>	Sterigmatocystin	<i>A. versicolor</i> is one of the most frequently found molds in water-damaged buildings. <i>A. versicolor</i> is known to produce a mycotoxin called sterigmatocystin a potentially carcinogenic and hepatotoxic mycotoxin. It is primarily toxic to the liver and kidneys [7].
<i>Candida auris</i>	Unknown	<i>C. auris</i> can be found in healthcare facilities and can be spread through contact with infected patients and equipment. <i>C. auris</i> can cause blood stream infections, wound infections and ear infections [13].
<i>Chaetomium globosum</i>	Chaetoglobosins	<i>C. globosum</i> is a common indoor fungal contaminant of water damaged homes or buildings. Like <i>Stachybotrys</i> , <i>C. globosum</i> spores are relatively large and due to their mode of release are not as easily airborne as are some other molds [11].
<i>Fusarium species</i>	Fumonisin; Zearalenone	<i>Fusarium</i> can cause superficial infections such as keratitis or onychomycosis in healthy individuals and disseminated infections in immunocompromised patients [12].
<i>Penicillium brevicompactum</i>	Ochratoxin A	Producer of the toxin Ochratoxin A. Fungal particles depend on the relative humidity [14]. Can lead to chronic Rhinosinusitis if breathed in high concentrations [15].
<i>Penicillium chrysogenum</i>	Ochratoxin A	Producer of the toxin Ochratoxin A. Fungal particles depend on the relative humidity [14]. Can lead to chronic Rhinosinusitis if breathed in high concentrations [16]. High levels are correlated with the development of sick building syndrome [17].
<i>Stachybotrys chartarum</i>	Macrocytic Trichothecenes	<i>S. chartarum</i> , commonly known as black mold, is highly toxic to humans. Nausea, vomiting, diarrhea, burning erythema, ataxia, chills, fever, hypotension, hair loss and confusion are symptoms in individuals living or working inside <i>Stachybotrys</i> infested homes and buildings [10].
<i>Wallemia sebi</i>	Walleminol	Spores from <i>Wallemia</i> are significant allergens. Inhalation exposure of spores can lead to conditions such as asthma, hypersensitivity, or pulmonary fibrosis [23].

REFERENCES:

- Abel-Fernández, E., et al. (2023). Going over Fungal Allergy: *Alternaria alternata* and Its Allergens. *Journal of Fungi*, 9(5), 582.
- Ostry, V. (2008). *Alternaria* mycotoxins: an overview of chemical characterization, producers, toxicity, analysis and occurrence in foodstuffs. *World Mycotoxin Journal*, 1(2), 175-188.
- Deshazo, R. D. (2009). Syndromes of invasive fungal sinusitis. *Medical Mycology*, 47(s1), S309-S314.
- Hedayati, M. T., et al. (2007). *Aspergillus flavus*: human pathogen, allergen and mycotoxin producer. *Microbiology*, 153(6), 1677-1692.
- Nixon, M. W. (1990). Aflatoxin and liver cancer. *Lancet*, 335(8698).
- Vesper, S., et al. (2007). Quantitative PCR analysis of molds in the dust from homes of asthmatic children in North Carolina. *Journal of Environmental Monitoring*, 9(8), 826.
- Roohani, A. H., et al. (2018). Comparing the Profile of Respiratory Fungal Pathogens amongst immunocompetent and Immunocompromised Hosts, their Susceptibility Pattern and Correlation of Various Opportunistic Respiratory Fungal Infections and their Progression in Relation to the CD4+T-cell Counts. *Indian Journal of Medical Microbiology*, 35(3), 408-415.
- Buji-Klimke, T. R., & Wu, F. (2014). Ochratoxin A and human health risk: A Review of the evidence. *Critical Reviews in Food Science and Nutrition*, 55(13), 1860-1869.
- Sobel, J. D., & Vazquez, J. A. (1999). Fungal infections of the urinary tract. *World Journal of Urology*, 17(6), 410-414.
- Visagie, C., et al. (2014). *Aspergillus*, *Penicillium* and *Talaromyces* isolated from house dust samples collected around the world. *Studies in Mycology*, 78(1), 63-139.
- Santana, M. F., et al. (2020). Confirmed Invasive Pulmonary Aspergillosis and COVID-19: the value of postmortem findings to support antemortem management. *Revista Da Sociedade Brasileira De Medicina Tropical*, 53.
- Tambuzzi, S., et al. (2019). Fungal aneurism of the right posterior inferior cerebellar artery (PICA). *Medical Mycology Case Reports*, 26, 25-27.
- Shahandashti, R. V., & Lass-Flörl, C. (2019). Antifungal resistance in *Aspergillus terreus*: A current scenario. *Fungal Genetics and Biology*, 131, 103247.
- Reijula, K. (2003). Mycotoxins of Aspergilli exposure and health effects. *Frontiers in Bioscience*, 8(5), 232-235.
- Bradley, S. F. (2019). What Is Known About *Candida auris*. *JAMA*, 322(15), 1510.
- Kuhn, D. M., & Ghannoum, M. A. (2003). Indoor Mold, Toxigenic Fungi, and *Stachybotrys chartarum*: Infectious Disease Perspective. *Clinical Microbiology Reviews*, 16(1), 144-172.
- Cabrera-Aguas, M., et al. (2022). Infectious keratitis: A review. *Clinical & Experimental Ophthalmology*, 50(5), 543-562.
- Heutte, N., et al. (2016). Assessment of multi-contaminant exposure in a cancer treatment center: a 2-year monitoring of molds, mycotoxins, endotoxins, and glucans in bioaerosols. *Environmental Monitoring and Assessment*, 189(1).
- Murr, A. H., et al. (2012). Some chronic rhinosinusitis patients have elevated populations of fungi in their sinuses. *The Laryngoscope*, 122(7), 1438-1445.
- Bhavsar, S., et al. (2022). Invasive rhinosinusitis due to *Penicillium chrysogenum* in an adolescent man with new-onset leukaemia: a diagnostic dilemma. *BMJ Case Reports*, 15(12), e252265.
- Straus, D. C. (2009). Molds, mycotoxins, and sick building syndrome. *Toxicology and Industrial Health*, 25(9-10), 617-635.
- Straus, D. C. (2011). The possible role of fungal contamination in sick building syndrome. *Frontiers in Bioscience*, E3(2), 562-580.
- Zajc, J., & Gunde-Cimerman, N. (2018). The genus *Wallemia*—From contamination of food to health threat. *Microorganisms*, 6(2), 46.

Company:
Project Name: Sample Report
Address:
Sample Type: Cotton Swab

Accession #:

Collected:
Received:
Completed:

Test	Result	Value (ppb)	Reference Range
Ochratoxin A	Not Present	0.699	Not Present <1.8 Equivocal 1.8 - <2 Present >=2
Zearalenone	Not Present	0.240	Not Present <0.5 Equivocal 0.5 - <0.7 Present >=0.7
Glutoxin Derivative	Equivocal	0.524	Not Present <0.5 Equivocal 0.5 - <1 Present >=1
Trichothecene Group (Macrocyclic):	Present	0.132	Not Present <0.07 Equivocal 0.07 - <0.09 Present >=0.09
Roridin A			
Roridin E			
Roridin H			
Roridin L-2			
Verrucarin A			
Verrucarin J			
Satratoxin G			
Satratoxin H			
Isosatratoxin F			
Aflatoxin Group:	Present	1.502	Not Present <0.8 Equivocal 0.8 - <1 Present >=1
Aflatoxin B1			
Aflatoxin B2			
Aflatoxin G1			
Aflatoxin G2			

Released By: Wendy Watson, MLS(ASCP), M, MB, Technical Supervisor

RTL maintains liability limited to cost of analysis. Interpretation of the data contained in this report is the responsibility of the client. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by RTL. The above test report relates only to the items tested. RTL bears no responsibility for sample collection activities or analytical method limitations.

Mycotoxin	Cellular Activity of Mycotoxin	Symptoms/Other	Association with a "Disease State"
A FLA TOXIN FAMILY			
Organisms: <i>Aspergillus flavus</i>, <i>Aspergillus oryzae</i>, <i>Aspergillus fumigatus</i>, <i>Aspergillus parasiticus</i> Aflatoxins have been associated with liver cancer [2,3], cirrhosis [4,5], and other health issues			
1	Aflatoxin B1	Binds DNA and proteins [6,7]	Shortness of breath [8], weight loss [10], most potent and highly carcinogenic.
2	Aflatoxin B2	Inhibits DNA and RNA replication [12]	Impaired fetal growth [13,14]
3	Aflatoxin G1	Cytotoxic, induces apoptosis in cells, DNA damage [1]	A flavus is a leading cause of invasive aspergillus in immunocompromised patients [15]
4	Aflatoxin G2	Cancer, neonatal jaundice [2,3,16]	Aflatoxicosis in humans and animals [15]
OCHRATOXIN A			
Organisms: <i>Aspergillus ochraceus</i>, <i>Aspergillus niger</i>, <i>Penicillium species</i>			
5	Ochratoxin A	Inhibits mitochondrial ATP, potent teratogen, and immune suppressor [17-19]	Fatigue, dermatitis, irritated bowel [20-22]
MA CROCYCLIC TRICHOHECENES (Group D)			
Organism: <i>Stachybotrys chartarum</i>			
6	Satratoxin G	DNA, RNA, and protein synthesis inhibition [25]	Fatigue [26]
7	Satratoxin H	Inhibits protein synthesis [25]	Fatigue [26]
8	Isosatratoxin F	Immunosuppression [30]	Weakened immune system [30]
9	Roridin A	Immunosuppression [30]	Weakened immune system [30]
10	Roridin E	DNA, RNA, and protein synthesis disruption [25,32]	Weakened immune system [30]
11	Roridin H	Inhibits protein synthesis [25]	Weakened immune system [30]
12	Roridin L-2	Immunosuppression [30]	Weakened immune system [30]
13	Verrucaric acid	Immunosuppression [30]	
14	Verrucaric acid	Immunosuppression [30]	
GLIOTOXIN DERIVATIVE			
Organisms: <i>Aspergillus fumigatus</i>, <i>Aspergillus terreus</i>, <i>Aspergillus niger</i>, <i>Aspergillus flavus</i>			
15	Gliotoxin	Attacks intracellular function in immune system [34]	Memory and breathing issues [35,36]
ZEARALENONE			
Organisms: <i>Fusarium species</i>			
16	Zearalenone	Estrogen mimic [37,38]	Early puberty, low sperm counts, cancer [39-42]

REFERENCES:

- Zhang, Z., et al., *Cytochrome P450 2A13 is an efficient enzyme in metabolic activation of aflatoxin G1 in human bronchial epithelial cells*. Arch Toxicol, 2013. 87(9): p. 1697-707.
- Wang, S.H., S.H. Yeh, and P.J. Chen, *Androgen Enhances Aflatoxin-induced Genotoxicity and Inflammation to Liver Cancer in Male Hepatitis B Patients*. Cell Mol Gastroenterol Hepatol, 2023. 15(2): p. 507-508.
- Fan, J.H., et al., *Attributable causes of liver cancer mortality and incidence in china*. Asian Pac J Cancer Prev, 2013. 14(12): p. 7251-6.
- Seitz, H.K. and F. Stickel, *Risk factors and mechanisms of hepatocarcinogenesis with special emphasis on alcohol and oxidative stress*. Biol Chem, 2006. 387(4): p. 349-60.
- Chu, Y.J., et al., *Aflatoxin B(1) exposure increases the risk of cirrhosis and hepatocellular carcinoma in chronic hepatitis B virus carriers*. Int J Cancer, 2017. 141(4): p. 711-720.
- Lin, Y.C., et al., *DNA polymerase zeta limits chromosomal damage and promotes cell survival following aflatoxin exposure*. Proc Natl Acad Sci U S A, 2016. 113(48): p. 13774-13779.
- Poirier, M.C., *Chemical-induced DNA damage and human cancer risk*. Disadv Med, 2012. 14(77): p. 283-8.
- Le Pape, P., et al., *First case of Aspergillus caelatus airway colonization in a Chronic Obstructive Pulmonary Disease patient*. Int J Infect Dis, 2019. 81: p. 85-90.
- Hernandez-Martinez, R. and I. Navarro-Blasco, *Aflatoxin levels and exposure assessment of Spanish infant cereals*. Food Addit Contam Part B Surveill, 2010. 3(4): p. 275-88.
- Melaram, R., *Environmental Risk Factors Implicated in Liver Disease: A Mini-Review*. Front Public Health, 2021. 9: p. 683719.
- Pelkonen, O. and H. Raunio, *Metabolic activation of toxins: tissue-specific expression and metabolism in target organs*. Environ Health Perspect, 1997. 105 Suppl 4(Suppl 4): p. 767-74.
- Madrigal-Santillan, E., et al., *Antigenotoxic studies of different substances to reduce the DNA damage induced by aflatoxin B(1) and ochratoxin A*. Toxins (Basel), 2010. 2(4): p. 738-57.
- Tesfamariam, K., et al., *Chronic aflatoxin exposure during pregnancy is associated with lower fetal growth trajectories: a prospective cohort from the Butajira Nutrition, Mental Health, and Pregnancy (BUNMAP) Study in rural Ethiopia*. Am J Clin Nutr, 2022. 116(6): p. 1634-1641.
- Smith, L.E., et al., *Aflatoxin Exposure During Pregnancy, Maternal Anemia, and Adverse Birth Outcomes*. Am J Trop Med Hyg, 2017. 96(4): p. 770-776.
- Sugui, J.A., et al., *Aspergillus fumigatus and related species*. Cold Spring Harb Perspect Med, 2014. 5(2): p. a019786.
- Raafat, N., et al., *Assessment of serum aflatoxin B(1) levels in neonatal jaundice with glucose-6-phosphate dehydrogenase deficiency: a preliminary study*. Mycotoxin Res, 2021. 37(1): p. 109-116.
- Al-Anati, L. and E. Petzinger, *Immunotoxic activity of ochratoxin A*. J Vet Pharmacol Ther, 2006. 29(2): p. 79-90.
- Tao, Y., et al., *Ochratoxin A: Toxicity, oxidative stress and metabolism*. Food Chem Toxicol, 2018. 112: p. 320-331.
- Park, S., et al., *Ochratoxin A exerts neurotoxicity in human astrocytes through mitochondria-dependent apoptosis and intracellular calcium overload*. Toxicol Lett, 2019. 313: p. 42-49.
- Wu, T.Y., et al., *Prevalence of Aspergillus-Derived Mycotoxins (Ochratoxin, Aflatoxin, and Gliotoxin) and Their Distribution in the Urinalysis of ME/CFS Patients*. Int J Environ Res Public Health, 2022. 19(4): p. 1242-51.
- Akiyama, T., et al., *The human cathelicidin LL-37 host defense peptide upregulates tight junction-related proteins and increases human epidermal keratinocyte barrier function*. J Innate Immun, 2014. 6(6): p. 739-53.
- Gao, Y., et al., *The Compromised Intestinal Barrier Induced by Mycotoxins*. Toxins (Basel), 2020. 12(10): p. 739-53.
- Clark, H.A. and S.M. Snedeker, *Ochratoxin A: its cancer risk and potential for exposure*. J Toxicol Environ Health B Crit Rev, 2006. 9(3): p. 265-96.
- Fuchs, R. and M. Peraica, *Ochratoxin A in human kidney diseases*. Food Addit Contam, 2005. 22 Suppl 1: p. 53-7.
- Yang, G.H., et al., *Apoptosis induction by the satratoxins and other trichothecene mycotoxins: relationship to ERK, p38 MAPK, and SAPK/JNK activation*. Toxicol Appl Pharmacol, 2000. 164(2): p. 149-60.
- Johanning, E., et al., *Health and immunology study following exposure to toxigenic fungi (Stachybotrys chartarum) in a water-damaged office environment*. Int Arch Occup Environ Health, 1996. 68(4): p. 207-18.
- Islam, Z., et al., *Purification and comparative neurotoxicity of the trichothecenes satratoxin G and roridin L2 from Stachybotrys chartarum*. J Toxicol Environ Health A, 2009. 72(20): p. 1242-51.
- Jarvis, B.B., et al., *Study of toxin production by isolates of Stachybotrys chartarum and Memnoniella echinata isolated during a study of pulmonary hemosiderosis in infants*. Appl Environ Microbiol, 1998. 64(10): p. 3620-5.
- Yike, I., T.G. Rand, and D.G. Dearborn, *Acute inflammatory responses to Stachybotrys chartarum in the lungs of infant rats: time course and possible mechanisms*. Toxicol Sci, 2005. 84(2): p. 408-17.
- Lee, M.G., et al., *Effects of satratoxins and other macrocyclic trichothecenes on IL-2 production and viability of EL-4 thymoma cells*. J Toxicol Environ Health A, 1999. 57(7): p. 459-74.
- Thrasher, J.D. and S. Crawley, *The biotransformants and complexity of damp indoor spaces: more than what meets the eyes*. Toxicol Ind Health, 2009. 25(9-10): p. 583-615.
- Nagase, M., et al., *Apoptosis induction by T-2 toxin: activation of caspase-9, caspase-3, and DFF-40/CAD through cytosolic release of cytochrome c in HL-60 cells*. Biosci Biotechnol Biochem, 2001. 65(8): p. 1741-7.
- Wu, Q., et al., *Trichothecenes: immunomodulatory effects, mechanisms, and anti-cancer potential*. Arch Toxicol, 2017. 91(12): p. 3737-3785.
- Schlamm, D., et al., *Gliotoxin Suppresses Macrophage Immune Function by Subverting Phosphatidylinositol 3,4,5-Trisphosphate Homeostasis*. mBio, 2016. 7(2): p. e02242.
- Xiao, W., et al., *Sputum signatures for invasive pulmonary aspergillosis in patients with underlying respiratory diseases (SPARED): study protocol for a prospective diagnostic trial*. BMC Infect Dis, 2018. 18(1): p. 271.
- Kapoor, T., et al., *Forskolin, an Adenylcyclase/cAMP/CREB Signaling Activator Restoring Myelin-Associated Oligodendrocyte Destruction in Experimental Ethidium Bromide Model of Multiple Sclerosis*. Cells, 2022. 11(18): p. 1118.
- Kowalska, K., D.E. Habrowska-Gorczyńska, and A.W. Piastowska-Ciesielna, *Zearalenone as an endocrine disruptor in humans*. Environ Toxicol Pharmacol, 2016. 48: p. 141-149.
- Yan, W.K., et al., *Zearalenone affects the growth of endometriosis via estrogen signaling and inflammatory pathways*. Ecotoxicol Environ Saf, 2022. 241: p. 113826.
- Lo, E.K.K., et al., *Low dose of zearalenone elevated colon cancer cell growth through G protein-coupled estrogenic receptor*. Sci Rep, 2021. 11(1): p. 7403.
- Kowalska, K., et al., *ERbeta and NFKappaB-Modulators of Zearalenone-Induced Oxidative Stress in Human Prostate Cancer Cells*. Toxins (Basel), 2020. 12(3): p. 1242-51.
- Lee, R., et al., *Zearalenone Induces Apoptosis and Autophagy in a Spermatogonia Cell Line*. Toxins (Basel), 2022. 14(2): p. 1242-51.
- Masart, F. and G. Saggese, *Oestrogenic mycotoxin exposures and precocious pubertal development*. Int J Androl, 2010. 33(2): p. 369-76.