PERSPECTIVES

Clinical Utility of Probiotics Therapy in Managing Mycotoxin Illness

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For those dealing with a complex chronic illness—such as chronic fatigue syndrome, fibromyalgia, frequent infections, neuroendocrine disorders, and autoimmunity—mycotoxins are often overlooked, yet significant, silent killers that deteriorate various systems in the body. The symptoms caused by mycotoxins are often nonspecific and overlap many other health issues, and it's common for standard test results from screening labs to either be normal or borderline abnormal. The subsequent band-aid approach to managing these symptoms may cause delays in proper treatment, potentially resulting in worsened outcomes.

Mycotoxins are secondary metabolites of mold compounds that act as significant triggers of chronic immune activation. Mold toxicity—mycotoxin illness—reflects an immune response to mycotoxin exposure; this is different from mold allergy—immunoglobulin E (IgE)-mediated, immediate hypersensitivity reaction—and mycosis—mold infections.

Common and concerning sources of mycotoxins include Alternaria, Aspergillus, Claviceps, Fusarium, and Penicillium. Individuals become exposed to mycotoxins through dermal, inhalation, and ingestion routes, although exposure through water-damaged buildings, such as from flooding, can be particularly problematic.

It's postulated that the systemic chronic inflammation associated with mycotoxin exposure relates to abnormalities of pro-inflammatory cytokines, complement activation, and cellular immunity,[1] contributing to various negative health effects (Figure 1).[2]

Management of chronic inflammation, and the subsequent symptoms, is difficult to achieve with persistent mycotoxin exposure; hence, the primary goal is eliminating the source of exposure. In addition, it's imperative to use binders to reduce mycotoxin burden while supporting detoxification and redox capacity to promote immune tolerance.

Figure 1. Health Effects of Common Mycotoxins.[2] Laboratory investigation generally involves urine testing for levels of various mycotoxin exposures, such as mass spectrometry or enzyme-linked immunosorbent assay (ELISA).

Mycotoxin	Health effect
Aflatoxins	Hepatotoxic and immunosuppressive
Ochratoxin A	Carcinogenic, genotoxic, immunosuppressive, nephrotoxic and induction of upper urinary tract disease
Fumonisins	Carcinogenic, hepatotoxic, nephrotoxic, immunosuppressive
Deoxynivalenol	Nausea, vomiting, diarrhea, reproductive effects and toxicosis
Trichothecenes	Hepatotoxic, genotoxic, and immunosuppressive
Zearalenone	Carcinogenic, hormonal imbalance, and reproductive effects
Patulin	Neurologic and gastrointestinal

Signs/Symptoms of Mycotoxin Illness

Clinical presentation of mycotoxin illness can vary greatly from case-to-case, based on such factors as the nature of the exposure and genetic susceptibilities. These multisystem symptoms include but aren't limited to the following types:

General	Fatigue, night sweats, temperature dysregulation, electrical shocks
Musculoskeletal	Myalgia, arthralgia, arthritis
Neurological/psychiatric	Dysautonomia, cognitive impairment, multiple hypersensitivities, numbness/tingling, vertigo, mood swings
Head, ear, eyes, nose, throat:	Headache, chronic rhinosinusitis, conjunctivitis
Cardiorespiratory	Palpitations, shortness of breath, cough, asthma
Gastrointestinal	Abdominal pain, diarrhea, appetite changes, nausea
Genitourinary	Frequent urination

Mycotoxin Illness Management

Eliminate or Reduce Mold Exposure

Individuals should consider remediation of the affected space to whatever degree possible using experienced and trained professionals. Additionally, reducing the mycotoxin burden can be achieved with such methods as the use of a dehumidifier, with a relative humidity (RH) of 35-40%; use of a central air filter or portable air purifier; removal of all carpets; use of a high efficiency particulate air (HEPA) canister vacuum; and prevention of seasonal basement flooding.

Detox and Redox Support

Supporting phase 2 detoxification pathways, namely glutathione conjugation and glucuronidation, is important in promoting the elimination of mycotoxins, managing

oxidative damage, and enhancing the threshold to toxic load. This is achieved with nutrients such as *N*-acetyl cysteine (NAC), vitamins C and E, selenium, and calcium D-glucarate. In addition, silybins from milk thistle are an excellent hepato-protectant that facilitates glutathione conjugation of xenotoxins, via the upregulation of glutathione *S*-transferase (GST).[3]

Sequestering Agents (Binders)

Sequestering agents are used to bind mycotoxins in the digestive tract to aid in elimination by preventing enterohepatic recirculation.

Figure 2 shows the three primary mechanisms of action that appear to be involved in the binding and degradation of mycotoxins by lactic acid bacteria (LAB)[4]: (1) degradation by LAB enzymes, (2) adsorption by LAB cells, and (3) the interaction of mycotoxins with LAB metabolites.

Figure 2. Lactic Acid Bacteria (LAB) Mechanisms of Action[4]

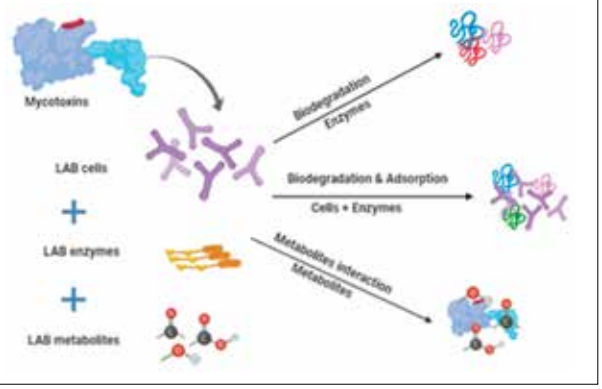

Figure 3. Application of Lactic Acid Bacteria (LAB) for Degradation of Mycotoxins[9]

Microorganism	Target Mycotoxin	Degradation%
Lactobacillus rhamnosus GG, *L. rhamnosus* LC-705	Aflatoxin B1	90%
L. amylovorus, *L. rhamnosus*	Aflatoxin B1	50%
L. casei LOCK 0920, *L. brevis* LOCK 0944, *L. plantarum* LOCK 0945	Aflatoxins (B1, B2, G1, G2)	~50%
L. plantarum, *Lactococcus lactis*	Aflatoxin B1	81%
Streptococcus thermophilus, *L. bulgaricus*, *L. plantarum*	Aflatoxin M1	11–74%
L. casei	Aflatoxin B1	49.2%
L. paracasei LOCK 0920, *L. brevis* LOCK 0944, *L. plantarum* LOCK 0945	Aflatoxin B1	36–55%
L. plantarum C88	Aflatoxin B1	60%
Lactic acid bacteria strains	Aflatoxins B1 and B2	NDI
L. casei LOCK 0920, *L. brevis* LOCK 0944, *L. plantarum* LOCK 0945	Ochratoxin A	~50%
L. acidophilus YM 20, *Rhodotorula mucosa* YM32	Ochratoxin A Patulin	95% 90%
Pediococcus parvulus	Ochratoxin A	90%
L. rhamnosus CRCT 2792	Ochratoxin A	92%
L. brevis 20023	Patulin	NDI
L. plantarum GT III	Deoxynivalenol	56–66%
Lactic acid bacteria strains	Deoxynivalenol, fumonisins B1, fumonisins B2	55%, 82%, and 100%
Lactic acid bacteria	Fumonisin B1 Zearalenone	36–67% 68–75%
L. rhamnosus GG (ATCC 53103), *L. plantarum* A1	Zearalenone	NDI
L. paracasei, *L. lactis*	Zearalenone	95%

LAB degrade mycotoxins by production of proteolytic enzymes and prevent their absorption through the digestive tract,[5] with several LAB strains being identified as having that capacity (Figure 3).[6-9]

Lactobacillus rhamnosus uses a variety of adsorption mechanisms, such as hydrogen bonding and ionic or hydrophobic interaction, to bind mycotoxins.[10-12]

Various LAB produce metabolites, such as acids; carbon dioxide (CO_2); hydrogen peroxide (H_2O_2); phenyllactic acid; fatty acids; reuterin; and bioactive, low-molecular-weight peptides, that mitigate growth of mold and subsequent mycotoxin production.[13,14]

An RCT examining the effects of *Lactobacillus rhamnosus* LC705 and *Propionibacterium freudenreichii* subsp. shermanii strains on liver-cancer risk, mediated by alfatoxin exposure, found that a five-week intervention led to a statistically significant reduction in alfatoxin exposure in the intervention group and a decreased the risk of liver cancer.[15]

In addition to LAB, *Saccharomyces boulardii* (*S. boulardii*) has demonstrated mycotoxin binding effects,[16] as well as the ability to reverse mycotoxin-induced injury by attenuating the "p38 mitogen-activated protein kinase (MAPK)" signaling pathway to modulate expression of inflammatory cytokines and apoptotic genes.[17]

Activated charcoal (AC) has also been found to bind several mycotoxins, including alfatoxin B_1, deoxynivalenol, ochratoxin, and zearalenone.[18-20] Due to possible concurrent adsorption of essential nutrients,[21] AC should be taken at least two hours after ingestion of food, medication, or supplements. Concomitant use of an oral multimineral formula or IV nutrient therapy can be considered based on the duration of the treatment.

Conclusions

With the growing awareness of the multisystem health risks associated with mycotoxin exposure, probiotic therapy offers practitioners a valuable therapeutic tool in the management of mycotoxin illness, to be used in concert with detox and redox support and general exposure-avoidance strategies.

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