Use of mass spectrometry for determining microbial toxins in indoor environments

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Introduction

Many bacteria and fungi that thrive in damp indoor environments are prominent producers of cytotoxic and immunomodulating toxins. These toxins have attracted little attention largely due to lack of analytical methods of high enough sensitivity and selectivity. Tandem mass spectrometry (MSMS) represents a tool of unsurpassed performance. Here we report MSMS methods for determining some important toxins commonly produced by bacteria and moulds indoors.

Materials/Methods

Mycotoxins: Methanolic extracts of dusts and building materials are divided in two parts. One part is directly analyzed (by HPLC-MSMS) for sterigmatocystin, gliotoxin, and satratoxins, which are produced e.g. by *Aspergillus*, *Penicillium*, and *Stachybotrys* spp. The remaining part is hydrolyzed, processed, and analyzed (by GC-MSMS) for verrucarol and trichodermol, which are hydrolysis products of macrocyclic trichotecenes and of trichodermin (*Stachybotrys*) (1).

Endotoxins/peptidoglycans: Separate dust and material samples are hydrolyzed, processed, and analyzed (by GC-MSMS) for muramic acid (a marker of bacterial peptidoglycan), 3-hydroxy acids (3-OH FAs) (endotoxin markers), and ergosterol (fungal biomass marker) after sample purification and derivatization (2).

Results

With MSMS unequivocal detection at trace levels is possible. We have demonstrated that moulds that grow on building materials indoors regularly produce mycotoxins and that air-borne dusts from damp environments are frequently mycotoxin-contaminated. Patterns of markers for endotoxin, peptidoglycan, and fungal biomass differ with respect to the indoor environment studied e.g. damp v. non-damp buildings, schools in different geographical regions, empty v. occupied classrooms, and rooms with v. without ongoing smoking (3). Peptidoglycan in dust appears to be protective against symptoms of asthma whereas 3-OH FAs, reflecting endotoxin subpopulations, exhibit diverging effects according to carbon chain length: Endotoxins with 3-OH FAs of C10-C14 appear to be protective while those with 3-OH FAs of C16-C18 have the opposite effect.

Conclusions

Only MS (and MSMS) can determine peptidoglycan and differentiate between the various subpopulations of endotoxin that are ubiquitous in indoor environments (and obviously of different biological properties). MSMS is also excellent for definite identification of mycotoxins in building materials and dust. Developing and applying new analytical methods for the many potent toxins that may be produced by microorganisms indoors should be of high research priority.

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