Fungi in indoor air – sources, exposure and health effects

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Understanding the sources and characteristics of indoor microbial impurities is a prerequisite for evaluating and managing good indoor air quality. Indoor fungal spores can originate from outdoors or from indoor sources, such as moisture-damaged materials.

When sampling fungal spores, the choice of a sampling method depends on the purpose of the sampling: is sampling conducted for verification of the presence of microbial problems, identification of the source, monitoring the efficiency of control methods or assessment of the human exposure. When choosing a sampling method, one also has to consider which analysis method would give most relevant measures for the question asked. This in turn may limit the choice of sampling methods available

A wide variety of sampling methods are available for assessing fungal contamination in indoor environments. These can be categorized in four main groups: air sampling, vacuum dust sampling, surface wipe sampling and building material sampling. This presentation will review the traditional and modern sampling techniques available and will discuss the advantages and disadvantages of the choices available.

Additional consideration for sampling fungi compared to other aerosol sampling is the ability to maintain the biological property that is used in the analysis, e.g., culturability of spores or integrity of genetic material. Particle size is an important consideration when selecting an air sampler. It has been shown that when fungi grow on damp materials, small fragments, consisting of both fungal material and material fragments, are released into the air (Mensah-Attipoe et al., 2016).

There are a few direct-reading instruments for airborne biological particles that are based on laser-induced autofluorescence of biological material. These have limitations in identifying the microorganisms. New techniques, such as laser-induced break-down are currently under development (Saari et al. 2015).

An alternative is a long-term collection of settled dust by placing dust sampling platforms at certain height in the indoor environment. Another approach is to use a specially-designed aerosolization chamber that releases biological particles from contaminated surfaces by air currents and vibration (e.g., Fungal Spore Source Strength Tester, FSSST and Particle-Field and Laboratory Emission Cell, P-FLEC). This approach can give the worst-case scenario for possible airborne concentration of biological particles that can be released or resuspended from the surface under investigation.

An emerging technique for the analysis of indoor fungal composition is based on the next generation sequencing (NGS) method. Studies that included analysis of indoor microorganisms by this technique have most often used vacuum sampling or surface wiping swabs. Comparison of several different sampling methods have shown that methods are based on analysis of larger samples (such as dust samples) reveal more diverse microbial communities than short-term air samples. This underlines the difficulty in comparing results of studies that used different sampling techniques.

Indoor microbial exposures have been linked to adverse respiratory health. The association between visible mold, cumulative exposures and asthma, especially in water-damaged buildings, is well-established. Recently, Dannemiller et al. (2014) have shown that low fungal diversity in house dust is associated with childhood asthma development.
In summary, each sampling and analysis technique has unique advantages and disadvantages. Therefore, it is often beneficial to use multiple techniques in each investigation. This way, the limitations of one technique can be are compensated by another one. Furthermore, results between different studies can be compared only if same sampling and analysis methods are used. More validation and reference data are needed with NGS methods before the method can be useful for routine use.

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