

Fungal Contamination of Building Materials and the Aerosolization of Particles and Toxins in Indoor Air and their Associated Risks to Health: A Review

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Table S1. Fungal species detected on surfaces of materials in different types of buildings according to sampling method, material type, method used for analysis and location of the study.

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Damp and/or mouldy dwellings (no respiratory problems for occupants)					
30 mouldy homes *	Swab on a 25 cm ² area	Gypsum, wallpaper	DNA sequencing (ITS)	<i>Alternaria alternata</i>	France [75]
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
				<i>Stachybotrys chartarum</i>	
32 mouldy dwellings *	Swab on a 25 cm ² area	Wallpaper	Morphological identification after culturing	<i>Aspergillus versicolor</i>	France [76]
				<i>Aspergillus niger</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Cladosporium cladosporioides</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
34 mouldy dwellings	Swab on a 25 cm ² area	Wallpaper	Morphological identification after culturing	<i>Ulocladium chartarum</i>	Poland [77]
				<i>Aspergillus flavus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Penicillium chrysogenum</i>	
Mouldy buildings	Contact plates	Plaster, concrete, wallpaper, gypsum		<i>Stachybotrys Chartarum</i>	Denmark [78]
				<i>Alternaria tenuissima</i>	
				<i>Aspergillus fumigatus</i>	

		& wood	Morphological identification after culturing	<i>Aspergillus niger</i> <i>Aspergillus versicolor</i> <i>Aspergillus wentii</i> <i>Cladosporium sphaerospermum</i>	
22 mouldy dwellings	Scraping: 1.5 grams/ sample	Wallpaper	Morphological identification after culturing	<i>Acremonium charticola</i> <i>Aspergillus versicolor</i> <i>Cladosporium cladosporioides</i> <i>Penicillium chrysogenum</i>	Poland [79]
Mouldy storage room in a family house *	Swab on a 25 cm ² area	Wood	DNA sequencing (ITS)	<i>Aspergillus penicillioides</i> <i>Aspergillus subversicolor</i> <i>Stachybotrys echinata</i> <i>Sterigmatomyces halophilus</i>	USA [80]
60 mouldy dwellings	Swab on a 25 cm ² area	Wallpapers, Wood	DNA sequencing (ITS)	<i>Aspergillus unguis</i> <i>Cladosporium halotolerans</i> <i>Cyberlindnera jadinii</i>	USA [67]
32 mouldy homes *	Swab on a 25 cm ² area	Wallpaper, ceramic and wood	DNA sequencing (ITS)	<i>Alternaria soliaridae</i> <i>Aspergillus niger</i> <i>Aspergillus piperis</i> <i>Aspergillus versicolor</i> <i>Cladosporium halotolerans</i> <i>Cladosporium sphaerospermum</i> <i>Penicillium aurantiogriseum</i> <i>Penicillium oxalicum</i> <i>Stachybotrys echinata</i>	USA [81]
3 Mouldy homes	Swab on a 25 cm ² area	Brick walls	DNA sequencing (ITS) & morphological identification after culturing	<i>Acremonium charticola</i> <i>Aspergillus canadensis</i> <i>Aspergillus versicolor</i> <i>Cladosporium sphaerospermum</i> <i>Debaryomyces hansenii</i> <i>Monocillium tenue</i>	Denmark [82]

24 mouldy houses	Not mentioned	Wallpapers, plasters, wood	Morphological identification after culturing	<i>Penicillium roseopurpureum</i>	Germany [83]
				<i>Verrucocladosporium dirinae</i>	
				<i>Acremonium spp</i>	
				<i>Aspergillus calidoustus</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Chaetomium spp</i>	
				<i>Cladosporium spp</i>	
				<i>Fusarium spp</i>	
				<i>Penicillium spp</i>	
				<i>Stachybotrys spp</i>	

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Dwellings with respiratory problems for occupants (no visible mould development)					
100 dwellings with occupants with respiratory diseases	Contact plates	Wallpaper	Morphological identification after culturing	<i>Aspergillus glaucus</i>	France [73]
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Stachybotrys chartarum</i>	
27 dwellings with occupants with respiratory diseases *	Swab on a 25 cm ² area	Wallpaper	Morphological identification after culturing	<i>Aspergillus fumigatus</i>	France [76]
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium cladosporioides</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
25 homes with occupants with respiratory diseases *	Swab on a 25 cm ² area	Gypsum, wallpaper	DNA sequencing (ITS)	<i>Alternaria alternata</i>	France [75]
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
				<i>Stachybotrys chartarum</i>	
	Contact plate	Wallpaper		<i>Aspergillus flavus</i>	France [84]

90 dwellings with occupants with respiratory diseases *	Morphological identification after culturing	<i>Aspergillus fumigatus</i>
		<i>Aspergillus niger</i>
		<i>Aspergillus versicolor</i>

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Mouldy or damp dwellings where occupants suffer from respiratory problems					
One mouldy building with respiratory health problems for occupants *	Scraping (Stripping wallpaper)	Wallpaper	Morphological identification after culturing	Aspergillus niger	USA [85]
				Aspergillus sydowii	
				Stachybotrys chartarum	
				Ulocladium chartarum	
5 mouldy buildings with respiratory health problems for occupants	Swab on a 25 cm² area	Plaster, Wallpaper, wood.	Morphological identification after culturing	Aspergillus niger	USA [9]
				Aspergillus ustus	
				Penicillium aurantiogriseum	
				Stachybotrys chartarum	
12 mouldy dwellings with respiratory health problems for occupants	Swab on a 25 cm² area	Wallpaper, wood.	DNA sequencing (β-tubulin)	Acremonium strictum	Belgium [86]
				Aspergillus flavus	
				Aspergillus fumigatus	
				Aspergillus sydowii	
				Aspergillus versicolor	
				Chaetomium murarum	
				Cladosporium sphaerospermum	

1012 mouldy dwellings with respiratory health problems for occupants *	Swab on a 25 cm² area	Wallpaper	Morphological identification after culturing	<i>Ulocladium botrytis</i>	France [72]
				<i>Acremonium spp</i>	
				<i>Alternaria alternata</i>	
				<i>Aspergillus flavus</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus ochraceus</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium spp</i>	
				<i>Penicillium spp</i>	
				<i>Stachybotrys spp</i>	

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Normal buildings (no dampness, no visible mould and no respiratory problems for occupants)					
31 dwellings	Swab on a 25 cm ² area	Walls and ceilings	Morphological identification after culturing	<i>Aspergillus niger</i>	USA [87]
				<i>Aspergillus versicolor</i>	
				<i>Stachybotrys chartarum</i>	
59 dwellings *	Swab on a 25 cm ² area	Wallpaper	Morphological identification after culturing	<i>Aspergillus fumigatus</i>	France [76]
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium cladosporioides</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
55 control homes *	Swab on a 25 cm ² area	Gypsum, wallpaper	DNA sequencing (ITS)	<i>Ulocladium chartarum</i>	France [75]
				<i>Alternaria alternata</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium chrysogenum</i>	
10 buildings *	Scraping	Plasters, ceilings	Morphological identification after culturing	<i>Stachybotrys chartarum</i>	Slovakia [66]
				<i>Alternaria alternata</i>	
				<i>Aspergillus flavus</i>	
				<i>Aspergillus parasiticus</i>	
				<i>Cladosporium herbarum</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Fusarium verticillioides</i>	
				<i>Penicillium verrucosum</i>	

51 rooms in university	Passive petri plate gravitational dust settling method	Gypsum boards	DNA sequencing (ITS) & morphological identification after sampling	<i>Alternaria alternata</i>	Canada [88]
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium</i> spp	
				<i>Penicillium</i> spp	
				<i>Stachybotrys chartarum</i>	
35 homes *	Swab on a 25 cm² area	Wallpaper, ceramic and wood	DNA sequencing (ITS)	<i>Alternaria soliaridae</i>	USA [81]
				<i>Aspergillus niger</i>	
				<i>Aspergillus piperis</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium halotolerans</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Penicillium aurantiogriseum</i>	
				<i>Penicillium oxalicum</i>	
				<i>Stachybotrys echinata</i>	
9 homes	Swab on a 25 cm² area	Wood	DNA sequencing (ITS) & Morphological identification after culturing	<i>Acremonium charticola</i>	Denmark [82]
				<i>Aspergillus domesticus</i>	
				<i>Aspergillus glaucus</i>	
				<i>Aspergillus versicolor</i>	
				<i>Aspergillus vitricola</i>	
				<i>Cladosporium allicinum</i>	
10 higher-education institutes (HEI)	Swab on a 25 cm² area	Wallpapers, wood	Morphological identification after culturing	<i>Cladosporium cladosporioides</i>	Portugal [63]
				<i>Penicillium brevicompactum</i>	
				<i>Penicillium chrysogenum</i>	
				<i>Saccharomyces cerevisiae</i>	
				<i>Stachybotrys chartarum</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Chrysonilia sitophila</i>	
				<i>Cladosporium</i> spp	
<i>Penicillium</i> spp					

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Hospitals					
19 patient rooms in a hospital *	Swab on a 25 cm ² area	Wallpapers, bed-plastic,	Morphological identification after culturing	<i>Aspergillus flavus</i> <i>Aspergillus fumigatus</i> <i>Aspergillus niger</i>	France [89]
2420 patients' rooms in 3 hospitals *	Swab on a 25 cm ² area	Sinks, tables, wallpapers	Morphological identification after culturing	<i>Aspergillus flavus</i> <i>Aspergillus fumigatus</i> <i>Aspergillus niger</i> <i>Candida albicans</i>	Greece [90]
15 patient rooms in a hospital *	Contact plates (Bio contact applicator)	Wallpapers	Morphological identification after culturing	<i>Aspergillus flavus</i> <i>Aspergillus fumigatus</i> <i>Aspergillus glaucus</i> <i>Aspergillus hiratsukae</i> <i>Aspergillus niger</i> <i>Aspergillus terreus</i> <i>Aspergillus versicolor</i>	France [91]
4 elderly care centers *	Swab on a 25 cm ² area	Wallpaper	Morphological identification after culturing	<i>Aspergillus candidus</i> <i>Aspergillus fumigatus</i> <i>Aspergillus niger</i>	Portugal [64]

Type of building	Sampling method	Surface type	Analysis method	Species detected	Location [Ref]
Others					
36 wine cellars *	Swab on a 25 cm ² area	Walls (brick or concrete) and wine barrels	Morphological identification after culturing	<i>Absidia macrospora</i>	Austria [92]
				<i>Alternaria alternata</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus versicolor</i>	
				<i>Cladosporium cladosporioides</i>	
				<i>Cladosporium sphaerospermum</i>	
				<i>Fusarium solani</i>	
				<i>Penicillium chrysogenum</i>	
				<i>Penicillium olsonii</i>	
3 archives buildings *	Swab on a 25 cm ² area	Wallpaper, wood	Morphological identification after culturing	<i>Walleimia sebi</i>	Portugal [93]
				<i>Zasmidium cellare</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
6 museums *	Swabbing on a 25 cm ² area and by using contact plates samples	Shelves, walls and historical objects	Morphological identification after culturing	<i>Aspergillus versicolor</i>	Poland [94]
				<i>Stachybotrys chartarum</i>	
				<i>Aspergillus flavus</i>	
				<i>Aspergillus fumigatus</i>	
				<i>Aspergillus niger</i>	
				<i>Aspergillus ochraceus</i>	
				<i>Aspergillus parasiticus</i>	
				<i>Aspergillus versicolor</i>	

				<i>Cladosporium herbarum</i>	Slovakia [95]
				<i>Penicillium carheum</i>	
Museum *	Swab on a 25 cm ² area	Wood	Morphological identification after culturing	<i>Aspergillus ustus</i>	
				<i>Aspergillus versicolor</i>	
				<i>Chaetomium globosum</i>	
				<i>Penicillium citrinum</i>	
				<i>Penicillium copticola</i>	
				<i>Penicillium sclerotiorum</i>	
				<i>Penicillium spinulosum</i>	

*: Studies in which both air sampling and surface sampling were carried out