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Airborne Bacteria and Fungi in Rural Houses in Finland

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ABSTRACT

Indoor air bacteria and fungal spore counts and flora were studied in six farmhouses and seven other rural houses of different ages. The lowest total microbial counts were detected in the new houses. Unlike in urban homes, spores of actinomycetes and thermophilic fungi were found to belong to normal indoor air microbial flora in all rural houses. The highest normal count for mesophilic fungal spores of urban homes in the winter was often exceeded in the old rural houses and less frequently in the new ones. This study indicates that, due to different sources, the criteria for indoor air microbes in urban homes do not apply to the rural environment.

INTRODUCTION

We previously developed the criteria for the normal range of indoor air microbial counts in urban homes in a subarctic climate (Reponen et al. 1990). The highest normal count for bacteria is 4500 cfu/m^3 during the whole year and for fungal spores, 500 cfu/m^3 in the winter. These levels are used as indicators of abnormal indoor microbial sources or insufficient ventilation. We have also noticed that the occurrence of mesophilic actinomycetes in the indoor air of urban homes in the winter may indicate exceptional microbial growth inside a building (Nevalainen et al. 1990). All these criteria have been limited to urban or suburban environments, where only minor sources are present in addition to outdoor air. However, airborne microbial counts and flora in farmhouses are different from urban homes because agriculture is a significant source of airborne microbes in rural environments (Gravesen 1972; Roby and Sneller 1979; Sneller and Roby 1979; Pasanen et al. 1989).

In this work, we studied airborne bacteria and fungal spore counts and flora both in farmhouses and in other rural houses, the occupants of which have no connection with agriculture, to find out possible differences between the rural and urban environment. The second aim was to clarify if the aging of rural houses affects the microbial quality of indoor air.

MATERIALS AND METHODS

Airborne microbes were sampled in the winter in 13 rural houses, six of which were farmhouses and the others were located in villages. In both groups, there was a mechanical ventilation system in only two houses. Three farmhouses and four other rural houses were built before the 1973 energy crisis (old houses) and the remaining ones were built in the 1980s (new houses). Moisture damage or building-related health problems were not identified in any of the houses.

The samples were collected with six-stage cascade impactors on tryptone-glucose-yeast extract agar for mesophilic bacteria, half-strength nutrient agar for thermotolerant bacteria, and malt extract agar for fungi. Samples were taken in two or three rooms (kitchen, bedroom, living room) in each house and outdoors. The samples for mesophilic microbes were incubated at 20°C-25°C for five or seven days and those for thermophilic fungi at 40°C and those for thermotolerant bacteria at 55°C for two or four days. Microbial concentrations were counted as colony-forming units (cfu) per m^3 by the positive hole correction method (Andersen 1958). Fungi were identified up to genus level and actinomycetes were recorded separately.

RESULTS AND DISCUSSION

The results of airborne bacteria counts are presented in Table 1. In all rural houses, mesophilic bacteria counts were below 4500 cfu/m^3, which we considered the highest normal bacteria count in Finnish urban homes (Reponen et al. 1990). Bacteria counts were of the same order of magnitude in the farmhouses and the other rural houses. Within both groups, the counts were higher in the old houses than in the new ones. Mesophilic actinomycetes were common in the old rural houses, and they were also occasionally found in the new farmhouses. The counts of mesophilic actinomycetes were below 100 cfu/m^3 in all cases. Thermotolerant bacteria, mostly actinomycetes, were sometimes detected in all rural houses. Unlike in urban homes (Nevalainen et al. 1990), actinomycetes seem to belong to the normal indoor air bacterial flora in the rural environment in the winter. Thus, the occurrence of actinomycetes does not indicate exceptional microbial growth in any rural houses.

Airborne fungal spore counts in the rural environment are presented in Table 2. Spore counts in the farmhouses were quite similar to those in our previous study (Pasanen et al. 1989). Both mesophilic and thermophilic fungal spore counts were usually higher in the farmhouses than in the other rural houses, indicating that fungal spores are carried from cow barns to farmers' homes (Pasanen et al. 1989). In addition, spore counts were usually higher in the old rural houses than in the new ones. The highest normal mesophilic fungal spore count of urban homes in the winter, 500 cfu/m^3 (Reponen et al. 1990), was exceeded in all houses other than the new nonagricultural rural houses. These results agree with the previously reported finding that

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TABLE 1
The Geometric Means (GM) and Ranges of Airborne Bacteria Counts in Rural Houses

		Mesophilic		Thermotolerant	
		Bacteria (cfu/m^3)			
Sampling Site	N	GM	Range	GM	Range
Farm Houses					
Old ones	20	1930	490-4530	10	<4-40
New ones	12	730	320-1850	4	<2-10
Other Rural Houses					
Old ones	16	1270	240-4290	3	<2-10
New ones	12	510	240-1480	3	<3-10
Outdoor Air	14	20	2-80	•	•

Note: The old houses were built before 1973 and the new ones in the 1980s.
N = Number of air samples
• = No sample was taken

TABLE 2
The Geometric Means (GM) and Ranges of Airborne Fungal Spore Counts in Rural Houses

		Mesophilic		Thermotolerant	
		Fungal Spores (cfu/m^3)			
Sampling Site	n	GM	Range	GM	Range
Farm Houses					
Old ones	20	1010	160-5730	80	10-490
New ones	12	340	140-1920	10	<4-30
Other Rural Houses					
Old ones	16	1020	100-4970	10	<3-250
New ones	12	80	20-410	5	<3-10
Outdoor Air	14	70	<2-370	•	•

Note: The old houses were built before 1973 and the new ones in the 1980s.
N = Number of air samples
• = No sample was taken

spore counts are usually higher in the rural than in the urban environment (Gravesen 1972). In addition, thermophilic fungal spores were common in all rural houses, whereas they have not been detected in the Finnish urban environment in the winter. The differences between rural and urban microbial counts and flora may be explained by the vicinity of agricultural sources and different life-styles and architecture in countryside.

Numerous fungal genera were identified from the indoor air of the rural houses, but the main genera, *Penicillium*, *Cladosporium*, and *Aspergillus*, were the same as in the urban environment (Pasanen et al. 1989; Pasanen et al. 1990). Other fungal genera detected in this study have been found previously in farmhouses (Gravesen 1972; Roby and Sneller 1979; Sneller and Roby 1979; Pasanen et al. 1989).

CONCLUSIONS AND RECOMMENDATIONS

Airborne fungal spore counts were remarkably higher in rural houses than in urban ones. Microbes, such as actinomycetes and thermophilic fungi, which are not normally detected in the urban environment in the winter, are common in the indoor air of all rural houses. Indoor air microbial counts and flora are quite similar in farmhouses and in other rural houses, indicating that microbes spread widely from agricultural sources. Thus, the criteria for indoor air microbes in urban homes as an indicator of abnormal microbial indoor sources do not apply for any rural building. The age of a building should also be considered when indoor microbial counts are evaluated because the counts seem to increase with time.

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