DO PLANTS IN OFFICE HAVE ANY EFFECT ON INDOOR AIR MICROORGANISMS?

S Rautiala, S Haatainen, H Kallunki, L Kujanpää, S Laitinen, A Miihkinen, M Reiman and M Seuri

Kuopio Regional Institute of Occupational Health, Kuopio, Finland

ABSTRACT

The role of indoor plants as a source of microorganisms was studied in six office rooms. Concentrations of microorganisms (both fungi and actinomycetes) were determined from indoor air and settled dust before the plants were placed in the office rooms and afterwards with the plants in the rooms. Furthermore, samples of soil from the plant pots were analysed. Concentrations of airborne microorganisms were low during the whole study (< 100 cfu/cm^3). There was no increase in the concentration of indoor air microorganisms neither in the amount of microorganisms sampled from flat surfaces after the plants were placed in the office rooms. *Trichoderma* was the main fungal genus in the soil, while *Penicillium, Cladosporium,* non-sporing isolates and yeasts dominated in indoor air and surface samples. *Trichoderma* was not observed in indoor air or surface samples. The results indicate that indoor plants are not a significant source of microorganisms.

Key words: Indoor Air, Plants, Microorganisms

INTRODUCTION

The soil in the potted plants has been proved to be a potential source of certain *Aspergillus* species [1]. The role of potted plants as a source of airborne fungal spores has been studied in a few studies [2,3]. According to these studies, in very low ambient spore content e.g. in hospitals, potted plants may be a source of airborne fungal spores. Furthermore, under favourable greenhouse conditions, plants can harbour abundant fungal growth that may become airborne, especially when disturbed.

However, in several practical indoor air sampling situations the role of indoor plants as a source of microorganisms have also been questioned. Therefore we conducted a study, the aim of which was to find out if the plants have any effect on indoor air microorganisms in office environments and therefore on indoor air microbe analysis strategies.

METHODS

Six office rooms with no previous indoor plants and no known source of microorganisms were chosen. The number of potted plants was gradually increased from one plant to six in each room. The chosen plants included *Yucca elephantipes*, *Dieffenbachia maculata*, *Scindapsus aureus*, *Ficus elastica*, *Saintpaulia ionantha* and *Chlorophytum comosum,* which are common plants in Finnish homes and offices. All the plants were purchased from florist's shop and they were visible in good condition. Concentrations of microorganisms (both fungi and actinomyctes) were determined from indoor air and settled dust before the plants were

placed in the office rooms (15th Jan 1997) and afterwards seven times with the plants in the rooms (22nd Dec 1997-22nd April 1998). The soil from the plant pots was analysed four times during the study. This study was performed during the winter, when the baseline level of fungal and actinomycete spores in outdoor air is extremely low [4].

Samples for viable microorganisms were taken with six-stage cascade-impactor [5] calibrated at a flow rate of 28.3 l/min. Rose Bengal malt extract and dichloran glyserol (DG18) agars were used for fungi and tryptone-yeast extract agar (TYG) for actinomycetes. Sampling time was 15 min. The culture plates were incubated at 25° C for seven days. Settled dust samples (100 cm^2) were taken from surfaces of building materials with a wetted swab direct to the cultivation plates from two surfaces in each office room. The soil from the plant pots was analysed with cultivation method [6]. The incubation conditions of surface and soil samples were the same as for air samples.

After incubation, fungal colonies were identified to genus with a light microscope. From TYG plates only actinomycete colonies were counted. Concentrations of indoor air microorganisms are expressed as colony forming units/m^3 and microorganisms in the soil as colony forming units/g. The extent of the microbial growth in surface samples is expressed as follows: - = below detection limit, + = low (1-20 colonies/61 cm^2), ++ = moderate (21-50 colonies/61 cm^2), +++ = heavy (51-200 colonies/61 cm^2).

RESULTS

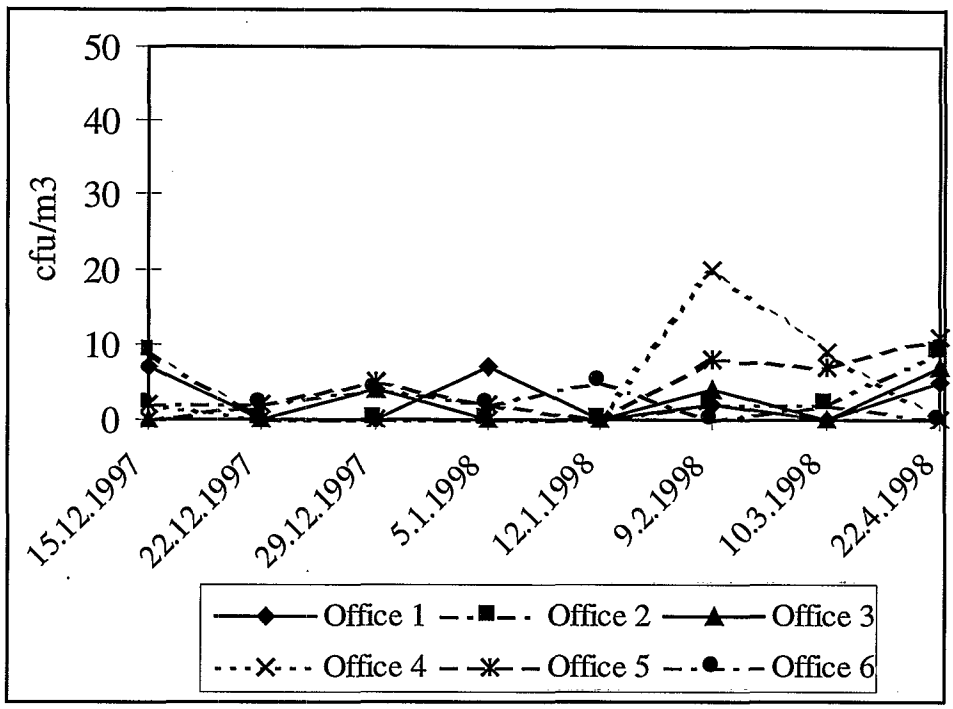
Concentrations of airborne fungi were < 10 cfu/m^3 before the plants were placed in the office rooms (Figure 1). No actinomycetes were found. After the plants were placed in the offices, concentrations of fungi were < 34 cfu/m^3. Small amount of actinomycetes (2 cfu/m^3) was once found in one office.

Before the plants were placed in the office rooms, the extent of microbial growth was low or below the detection limit in the settled dust samples (Table 1). After the plants were placed in the office rooms, the extent of the microbial growth was still at low level. Actinomycetes (moderate growth) were found only once after the plants were placed in the offices.

Concentrations of fungi varied between 10^4-10^7 cfu/g in the soil from the plant pots. No increase in concentrations was seen during this study. Actinomycetes (concentration 10^4-10^7 cfu/g) were found only in the beginning of the study (22.12.1997).

In indoor air samples, *Penicillium,* non-sporing isolates and yeasts were the most common fungi (Table 2). Actinomycetes were found in 2 % of the samples. In settled dust samples, *Cladosporium, Penicillium,* non-sporing isolates and yeasts dominated. *Trichoderma* was the main fungal genus in the soil samples during the whole study. *Trichoderma* was not observed in indoor air or surface samples.

A



B

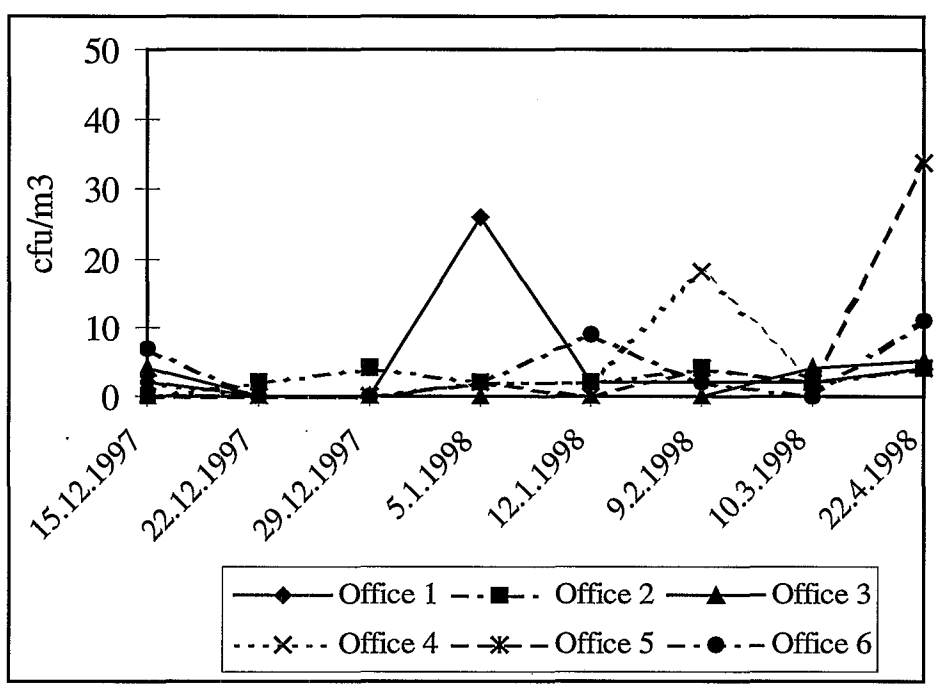


Figure 1. Concentrations of fungi in indoor air samples on rose bengal malt extract agar (A) and on DG18 agar (B).

Table 1. Prevalence of the extent of the fungal growth in settled dust samples (%).

The extent of the fungal growth	Rose bengal malt extract agar	DG18 agar
Before (n=12)		
- = below detection limit	58	33
+ = low	42	58
++ = moderate	0	8
+++ = heavy	0	0
Plants in offices (n=86)		
- = below detection limit	65	54
+ = low	31	46
++ = moderate	2	1
+++ = heavy	0	0

Table 2. Prevalence of the fungal genera and actinomycetes in air, settled dust and soil samples (%).

Fungi/ Actinomycetes	Air samples n = 144	Settled dust samples n = 96	Soil samples n = 24
Fungi			
Acremonium	2	-	3
Alternaria	-	0.5	-
Aspergillus fumigatus	-	0.5	-
Aspergillus niger	-	0.5	-
Aspergillus	5	0.5	6
Botrytis	1	1	-
Chrysosporium	-	0.5	-
Cladosporium	5	11	11
Eurotium	1	0.5	-
Fusarium	-	1	-
Geomyces	1	-	-
Monocillium	-	-	17
Oidiodendron	-	0.5	-
Olpitichum	1	-	-
Paecilomyces	8	-	-
Penicillium	34	19	36
Polyscytalum	1	-	-
Trichoderma	-	-	100
Wallemia	2	-	-
non-sporing isolates	13	8	6
yeasts	14	13	47
		0.5	30
Actinomycetes	2		

DISCUSSION

Concentrations of airborne fungi in office rooms during this study were lower than those previously measured in homes or schools during subarctic winter [7-10]. No significant increase in concentrations neither any changes in microbe genera were observed after the plants were placed in the office rooms. In indoor air samples, *Penicillium,* non-sporing isolates and yeasts were the most common fungi. These fungi have been reported to be the most common also in previous Finnish studies [9,10]. Actinomycetes occurred only occasionally and concentrations were low.

The extent of the fungal and actinomycete growth in settled dust samples remained in a low level during the whole study. No increase in concentrations was observed after the plants were placed in the office rooms. Fungal genera were the same as those previously reported in surface samples [9, 10].

Concentrations of microbes in pot samples remained the same throughout the study. High concentrations of actinomycetes were found in soil only in the beginning of the study. Although there were great number of actinomycetes in soil samples, no traces of them were found in air or surface samples. Furthermore, *Trichoderma* was present in every soil samples, but was not observed in indoor air or surface samples.

CONCLUSION

There was no increase in the concentration of indoor air microorganisms neither in the amount of microorganisms sampled from flat surfaces after the plants were placed in the office rooms. The results indicate that indoor plants did not have a significant effect on concentrations of indoor air microorganisms at least when not disturbed and when they were fairly new (6 months) and well cared.

REFERENCES

1. Staib, F, Tompak, B, Thiel, D, and Blisse, A. 1978. *Aspergillus fumigatus* and *Aspergillus niger* in two potted ornamental plants, cactus (*Epihyllum truncatum*) and clivia (*Clivia miniata*). Biological and epidemiological aspects. *Mycopathologia.* Vol. 66 (1-2), pp 27-30.

2. Burge, H A, Solomon, R S, and Muilenberg, M L. 1982. Evaluation of indoor plantings as allergen sources. *Journal of Allergy and Clinical Immunology.* Vol. 70 (2), pp 101-108.

3. Smith, V, Streifel, A, Rhame, F S, and Junl, B. 1988. Potted plant fungal spore shedding. Abstracts of Annual Meeting of American Society .... , Vol. 88, pp 414.

4. Pasanen A-L, Reponen T, Kalliokoski P, Nevalainen A. 1990. Seasonal variation of fungal spore counts and genera in indoor air in the subarctic climate. *Proceedings of the 5th International Conference on Indoor Air Quality and Climate- Indoor Air'90,* Vol 2, pp 39-44.

5. Andersen A A. 1958. New sampler for collection, sizing and enumeration of viable airborne particles. *Journal of Bacteriology*. Vol. 76, pp. 471-484.

6. Pasanen A-L, Juutinen T, Jantunen M J, Kalliokoski P. 1992. Occurrence and moisture requirements of microbial growth in building materials. *International Biodeterioration&Biodegradation*. Vol. 30, pp 273-283.

7. Nevalainen A, Pasanen A-L, Niininen M, Reponen T, Kalliokoski P, Jantunen MJ. 1991. The indoor air quality in Finnish homes with mold problems. *Environment International*. Vol. 17. pp 229-302.

8. Reponen T, Nevalainen A, Jantunen M, Pellikka M and Kalliokoski P. 1992. Normal range criteria for indoor air bacteria and fungal spores in a subarctic climate. *Indoor Air*. Vol. 2, pp. 26-31.

9. Hyvärinen A, Reponen T, Husman T, Ruuskanen J, Nevalainen A. 1993. Characterizing mold problem buildings-concentrations and flora of viable fungi. *Indoor Air*. Vol. 3. pp 337-343.

10. Meklin T, Taskinen T, Nevalainen A. 1996. Microbial characterization of four school buildings. *Proceedings of the 7th International Conference on Indoor Air Quality and Climate- Indoor Air'96*, Vol 2, pp 1083-1088.