

Comparison of fungal contamination between hospitals and companies food units

C. Viegas¹, M. Almeida¹, C. Ramos¹, R. Sabino²,
C. Veríssimo² & L. Rosado²

¹Higher School of Health Technologies of Lisbon,
Polytechnic Institute of Lisbon, Portugal

²National Institute of Health Dr Ricardo Jorge,
Mycology Laboratory, Portugal

Abstract

A descriptive study was developed to compare air and surfaces fungal contamination in ten hospitals' food units and two food units from companies. Fifty air samples of 250 litres through impaction method were collected from hospitals' food units and 41 swab samples from surfaces were also collected, using a 10 by 10 cm square stencil. Regarding the two companies, ten air samples and eight surface samples were collected. Air and surface samples were collected in food storage facilities, kitchen, food plating and canteen. Outdoor air was also collected since this is the place regarded as a reference. Simultaneously, temperature, relative humidity and meal numbers were registered.

Concerning air from hospitals' food units, 32 fungal species were identified, being the two most commonly isolated genera *Penicillium* sp. (43.6%) and *Cladosporium* sp. (23.2%). Regarding yeasts, only *Rhodotorula* sp. (84.2%) and *Trichosporon* sp. (15.8%) were isolated. Regarding the analyzed surfaces from the same places, 21 fungal species were identified, being also *Penicillium* sp. (69.1%) and *Cladosporium* sp. (8.25%) the genera most frequently found. *Candida parapsilosis* (36.3%) and *Rhodotorula* sp. (25.7%) were the most prevalent yeast species.

In the two companies, nine fungal species were identified in air, being *Cladosporium* sp. the most frequent genus (71.2%) followed by *Penicillium* sp. (13.0%). Only one yeast species, *Candida famata*, was identified. Eight filamentous fungi and three yeasts were identified in the analyzed surfaces, being



Penicillium sp the most frequently isolated mould (97.2%) and *Candida famata* the most frequent yeast (42.9 %).

Aspergillus species, such as *A. ochraceus*, *A. versicolor*, *A. candidus*, *A. fumigatus* and *A. niger* were also isolated in hospitals' food units, whereas companies' food units only *A. glaucus* was isolated. No positive association was observed ($p>0.05$) among fungal contamination and the following parameters: temperature, relative humidity and number of meals served in hospitals' and companies' food units.

Keywords: air, surfaces, fungal contamination, hospitals, companies.

1 Introduction

Fungal spores are complex agents that may contain multiple hazardous components. Health hazards may differ across species because fungi may produce different allergens and mycotoxins, and some species can infect humans [1]. Exposure effects to fungi are dependent on the species present, the metabolic products produced, concentration and duration of the exposure, and also individual susceptibility [2].

The main source of fungi in office environments is outdoor air. As outdoor air is often filtered before entering in the ventilation system and fungi settle due to lower air velocities in buildings than outdoors, common indoor fungal levels are expected to be lower than levels in outdoor air [1]. However, in hospital settings there are diverse possible sources of fungal contamination including ventilation or air-conditioning systems, decaying organic material, dust ornamental plants, food, water and, particularly, building works in and around hospitals [3, 4].

Despite the possibility of adverse health effects due to exposure to fungal products, no health-based exposure limits have yet been proposed. In part this is due to the difficulty of accurately characterizing cumulative fungal spore concentrations [5] and also because, epidemiological studies have failed to establish a causal relation of the extent of fungal presence, exposure time and specific effects on health or frequency and severity of symptoms reported. Studies tend to show only existence of a link between exposure to fungi and development of symptoms, especially respiratory ones [2]. Attempts have been made only to identify fungi responsible for specific symptoms attributed to mould exposure, such as allergenic [6], inflammatory [7] or mycotoxic [8] effects.

In Portugal, the prevalence of diseases such as asthma and rhinoconjunctivitis in the general population varies from 15% to 25% and from 10% to 15%, respectively, and in recent years has been increasing [9]. Various causes have been considered, including indoor air pollution caused by fungal contamination.

This investigation was designed to compare air and surfaces fungal contamination in ten hospitals' food units and two food units from companies and explore possible associations with independent variables.



2 Materials and methods

A descriptive study was developed to compare fungal contamination of air and surfaces analyzed from ten hospitals' food units and two food units from companies. Fifty air samples of 250 litres were collected through impaction method from hospitals' food units. Forty one swab samples from surfaces were also collected, using a 10 by 10 cm square stencil. Regarding the two companies, ten air samples and eight swab samples were collected using the methodology previously described. Air and swab samples were collected in food storage facilities, kitchen, food plating and canteen. Simultaneously, temperature and relative humidity were also monitored through the equipment Babouc, LSI Systems and according to the International Standard ISO 7726 – 1998. The number of meals served in each case was also registered.

Air samples were collected at one meter tall with a flow rate of 140 L/minute, onto malt extract agar supplemented with the antibiotic chloramphenicol (MEA), in the facilities, and also outdoor, since this is the place regarded as reference.

Concerning surfaces samples they were collected by swabbing the surfaces of the same indoor places, using a 10 by 10 cm square stencil disinfected with 70% alcohol solution between samples according to the International Standard ISO 18593 – 2004. Subsequently, all the collected samples were incubated at 27 °C for 5 to 7 days.

After laboratory processing and incubation of the collected samples, quantitative (CFU/m³ and CFU/m²) and qualitative results were obtained, with identification of the isolated fungal species. Whenever possible, filamentous fungi were identified to the species level, since adverse health effects vary according to fungal species [10, 11]. Identification of filamentous fungi was carried out on material mounted in lactophenol blue and achieved through morphological characteristics listed in illustrated literature [11] and yeasts were identified through biochemical API test [12].

Tables with frequency distribution of isolated fungal species were made with the obtained data. Fungal concentration dependence in the two monitored environmental parameters – temperature and relative humidity– and also number of meals served was analyzed.

3 Results

Concerning air from hospitals' food units, 32 species of fungi were identified, being the two most commonly isolated genera *Penicillium* sp. (43.6%) and *Cladosporium* sp. (23.2%). Regarding yeasts, only *Rhodotorula* sp. (84.2%) and *Trichosporon* sp. (15.8%) were isolated. Considering surfaces from the same places, twenty one fungal species were identified, being also *Penicillium* sp. (69.1%) and *Cladosporium* sp. (8.25%) the genera most frequently found. *Candida parapsilosis* (36.3%) and *Rhodotorula* sp. (25.7%) were the most prevalent yeasts species.

In the two companies, nine fungal species were identified in air, being *Cladosporium* sp. the most frequent genus (71.2%) followed by *Penicillium* sp.



(13.0%). Concerning yeasts only *Candida famata* was identified. Eight fungal species and three yeasts were identified in the analyzed surfaces, being moulds and yeasts most frequently found *Penicillium* sp. (97.2%) and *Candida famata* (42.9%), respectively.

Regarding hospitals' food units, there was coincidence between prevailing genera in indoor and outdoor air/environment. Nevertheless, all ten food units presented fungal species different from the ones isolated from outdoor. Moreover, nine from the ten food units presented *Aspergillus* species. Regarding the comparison of concentrations found in air, for indoor and outdoor environments, nine of the ten food units showed higher levels of contamination in indoor air.

Concerning companies' food units, there was no coincidence between prevailing genera in indoor and outdoor and the two food units presented fungal species different from the ones isolated from outdoor. However, only one of them presented *Aspergillus* species and none showed higher levels of contamination in indoor air when compare with outdoor air levels.

Aspergillus species, such as *A. ochraceus*, *A. versicolor*, *A. candidus*, *A. fumigatus* and *A. niger* were isolated in hospitals' food units, whereas companies' food units only *A. glaucus* was isolated.

There was no significant relation ($p > 0,05$) between fungal contamination and temperature, relative humidity and number of meals served in hospitals' and companies' food units.

4 Discussion

The most predominant genus found in hospital air was *Penicillium*. Regarding this genus, there are different potential risks associated with their inhalation, due to the toxins release [13]. Regarding the most frequent genus in companies' air – *Cladosporium* – is probably the fungus that occurs more frequently around world, especially in temperate climates [14] such as in Portugal and is deeply connected to indoor condensation problems [15]. Both of the referred genus were also the more frequent in a study realized in a Portuguese poultry [16].

It is suggested that fungal levels found indoors should be compared, quantitatively and qualitatively, with those found outdoors, because the first are dependent on the last [2]. Nevertheless, when it comes to fungal levels, it should be taken into account that indoor and outdoor environments are quite different which, by itself, justifies diversity of species between different spaces. However, with regard to fungal contamination, there are no stipulated thresholds which makes essential to compare fungal levels indoors and outdoors.

Thus, indoor air quality that significantly differs from the outdoor could mean that there are infiltration problems and that exist a potential risk for health. It is worth mentioning that as outdoor air is a major source of the fungi found indoors, it is no coincidence that, in the case of hospitals' food units, the prevailing genera, *Penicillium* sp. and *Cladosporium* sp., are the same in both these environments [13]. Nonetheless, in the companies' case there was no coincidence between prevailing genera in indoor and outdoor air. Besides that,

all the monitored food units (hospitals and companies) had one or more spaces with fungal species that differed from the ones isolated outdoor, suggesting fungal contamination from within [13]. Moreover, according to American Industrial Hygiene Association (AIHA), in 1996, for determination of biological contamination in environmental samples, The confirmed presence of the species *Aspergillus flavus* and *Aspergillus fumigatus* (both identified in hospitals' food units), requires implementation of corrective measures [17]. Regarding comparison of spore concentrations found in air, for indoor and outdoor environments, nine of the ten hospitals' food units showed higher levels of contamination in indoor air, whereas all the companies' food units presented higher levels of fungal concentrations in outdoor air. This fact could be explained by the discrepancy of the number of institutions analyzed or maybe because possible sources of fungal dissemination include hospitals' ventilation or air-conditioning systems [4, 18].

Taking into account what is mentioned in Portuguese law, this value was 500 CFU/m³ is the maximum reference concentration in indoor air, was exceeded only in four indoor spaces from the hospitals' food units analyzed in this study. Regarding what is mentioned in Portuguese Technician Norm NT-SCE-02, the presence of opportunistic fungi from *Aspergillus* genus, shows a lack of air quality in indoor space. *Aspergillus* species are frequently present on food and thus can be an indirect source of airway or digestive tract colonization of the patients and workers [19].

Results related to environmental variables are not consistent with what is expected [20]. It was found that the relation between the fungal air contamination and the temperature, relative humidity, and also number of meals served was not statistically significant ($p > 0,05$). This may be justified by the effect of other environmental variables also influencing fungal spreading, namely patients and workers, who may carry a great diversity of fungal species [21], as well the developed activities that may also affect fungal concentration [22].

5 Conclusions

With this study, it was possible to characterize fungal distribution in ten hospitals' food units and two food units from companies and evaluate the association of environmental variables and also number of meals served with this distribution. It was also possible to observe that hospitals' food units presented more evidence that fungal contamination comes from within than in the companies' case.

Unlike other studies, environmental variables monitored (temperature and relative humidity) and also number of meals served, did not show the expected association with fungal concentration, which may possibly have resulted from other variables not investigated in this study.



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