Air fungal contamination in ten hospitals' food units from Lisbon

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Abstract

A descriptive study was developed to monitor air fungal contamination in ten food units from hospitals. Fifty air samples of 250 litres were collected through impaction method. Samples were collected in food storage facilities, kitchen, food plating, canteen and also, outside premises, since this is the place regarded as reference. Simultaneously, environmental parameters were also monitored, including temperature and relative humidity through the equipment Babouc, LSI Sistems and according to the International Standard ISO 7726. Thirty two species of fungi were identified in air, being the 2 genera most commonly found *Penicillium sp.* (43, 6%) and *Cladosporium* sp. (23, 2%). Regarding yeasts, only *Rhodotorula* sp. (84,2%) and *Trichosporon* sp. (15,8%) were isolated. There was coincidence between prevailing genera in interior and outside premises, however all ten food units presented fungal species different from the ones isolated from outside. Nine from the ten food units presented *Aspergillus* species, such as *A. flavus*, *A. ochraceus*, *A. versicolor*, *A. candidus*, *A. fumigatus*, *A. niger* and *A. niveus*. There was no significant relation ($p>0,05$) between fungal contamination, temperature and relative humidity.
Keywords: air, fungal contamination, food units, hospitals.

1 Introduction

Hospital-wide surveillance studies have shown the presence of various potentially pathogenic fungal species in health care settings [1]. The microbial

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population of a given environment is influenced by many factors including the number of visitors and the amount of materials brought in from outside. In some hospital areas, such as the operating theater and intensive care unit, the microorganism number are usually extremely low. This is due to the high sanitary standards as compared to other hospital areas [2] like food units. Fungi presence requires ideal conditions of temperature, humidity, oxygen, carbon sources, nitrogen and minerals. Their biological activities of biodegradation and biodeterioration, depend on their enzymes activity, the environmental conditions, the competition phenomenon and the nature of the substrate. In situations where the fungal concentrations are high or when people suffer from respiratory problems or have a weak immune system, exposure to fungi can cause the onset of symptoms and disease. The effects are dependent on the species present, the metabolic products, the concentration and exposure duration and individual susceptibility [3].

Fungal exposure in hospitals is of particular interest due to the possible patient's susceptibility. Therefore, it is important to contribute to the increase of knowledge referring air fungal contamination in hospitals indoor spaces, such as food units, in order to identify most effective preventive measures to avoid such contamination. This investigation was designed to describe environmental air fungal contamination in ten hospitals food units from Lisbon.

2 Materials and methods

A descriptive study was developed to monitor air fungal contamination in ten food units from hospitals during a six-month period. Fifty air samples of 250 litres were collected through impaction method. Samples were collected in food storage facilities, kitchen, food plating, canteen and also, outside premises, since this is the place regarded as reference. Simultaneously, environmental parameters were also monitored, including temperature and relative humidity through the equipment Babouc, LSI Sistems and according to the International Standard ISO 7726.

Air samples were collected at 140 L/minute and at one meter tall on to malt extract agar with antibiotic chloramphenicol (MEA), in the facilities, and also, outside premises, since this is the place regarded as reference.

After samples incubation, quantitative (CFU/m^3) and qualitative results were obtained, with identification of isolated fungal species. Whenever possible, filamentous fungi were identified to the species level, since adverse health effects vary according to fungal species [4, 5]. Identification of filamentous fungi was carried out on material mounted in lactophenol blue and achieved through morphological characteristics listed in illustrated literature [5] and yeasts were identified by using ID 32C strips (Marcy é Etoile, France) [6].

Tables with frequency distribution of isolated fungal species were made with the obtained data. Correlation between fungal concentration and temperature and relative humidity was also analyzed.

3 Results

Thirty two species of fungi were identified in the collected samples from indoor air, being *Penicillium* and *Cladosporium* the two genera most commonly found, with 43,6% and 23,2% of frequency. Regarding yeasts, only *Rhodotorula* sp. (84,2%) and *Trichosporon* sp. (15,8%) were isolated (Table 1)

Table 1: Most frequent fungi identified in the food unit's air.

Filamentous fungi	**Frequency (%)**
Penicillium sp.	43,6
Cladosporium sp.	23,2
Chrysonilia sp.	7,3
Chrysosporium sp.	5,3
Aspergillus sp.	4,9
Others	15,7
Yeasts	**Frequency (%)**
Rhodotorula sp.	84,2
Trichosporon sp.	15,8

There was coincidence between prevailing genera in indoor and outside premises, however all ten food units presented fungal species different from the ones isolated from outside. Nine from the ten food units presented *Aspergillus* species, such as *A. flavus*, *A. ochraceus*, *A. versicolor*, *A. candidus*, *A. fumigatus*, *A. niger* and *A. niveus*.

Concerning 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 the influence of environmental variables monitored - temperature and relative humidity - no significant correlation ($p > 0,05$) was revealed.

4 Discussion

Concerning the predominant genus found in indoor air samples (*Penicillium*), there are different potential risks associated with their inhalation, due to the toxins release [7]. Regarding *Cladosporium* genus, is probably the fungus that occurs more frequently around world, especially in temperate climates [8] such as in Portugal. This genus is deeply connected to indoor condensation problems [9]. Both of the referred genus were also the more frequent in a study realized in a Portuguese poultry [10].

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 [3]. 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 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 this case, the prevailing genera, *Penicillium* sp. and *Cladosporium* sp., are the same in both these environments [11]. Nonetheless, all the monitored food units had one or more spaces with fungal species that differed from the ones isolated outside, and nine of them presented more CFU/m^3 in indoor than outdoor air, suggesting in both situations, fungal contamination from within [11].

With regard to qualitative assessment of fungal contamination in air, it is suggested that, among other species, *Aspergillus fumigatus* and *Penicillium, Trichoderma*, *Fusarium* and *Ulocladium* species, all of them isolated in the present study, are regarded as indicators of humidity problems or potential risk to health [3]. Moreover, according to American Industrial Hygiene Association (AIHA), in 1996, for determination of biological contamination in environmental samples, confirmed presence of the species *Aspergillus flavus* and *Aspergillus fumigatus*, both identified in this study, requires implementation of corrective measures [12].

Taking into account what is mentioned in Portuguese law, that 500 CFU/m^3 is the maximum reference concentration in indoor air, was exceeded in four indoor spaces 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. Moreover, *Aspergillus* species are frequently present on food and thus can be an indirect source of airway or digestive tract colonization of the patients [13].

Results related to environmental variables are not consistent with what is expected [14]. It was found that the relationship between the fungal air contamination and the temperature and relative humidity was not statistically significant (p>0,05). This may be justified by the effect of other environmental variables also influencing fungal spreading, namely workers and food, who may carry a great diversity of fungal species [15], as well the developed activities that may also affect fungal concentration [16].

5 Conclusions

With this study, was possible to observe that food units can be a source of fungal contamination to other hospital ward as well as for patients' food.

Unlike other studies, the monitored environmental variables (temperature and relative humidity) 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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