Microfungal contaminants on the surface of the books and the atmosphere of the library of Health Services Vocational School in Marmaris, Turkey

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Keywords Microfungi, library atmosphere, microfungal flora, microfungal contamination.

Abstract

The aim of this study was to determine the microfungi which contaminated the surface of the books and the atmosphere of the library in Health Services Vocational School. The samples of the library air were taken by using open petri plate method and the samples from the surface of the books were taken by swabbing with the moistened sterile swab sticks. As a result of research, 14 different microfungal species were obtained belonging to Alternaria, Aspergillus, Chaetomium, Cladosporium and Penicillium genera. The genera of microfungi the most abundant in terms of the qualitative were Aspergillus, Penicillium and Cladosporium. Quantitatively, Aspergillus was found as the most abundant. Maximum colony was formed by Aspergillus niger in the microfungal species. The microfungal species which were obtained from the atmosphere of the library and from the surface of the books show great similarity.

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Introduction
Microfungi which produce too many spores and can be easily transported, form the significant part of the bioaerosols in the external and internal atmosphere of the surrounding and they can contaminate all kinds of surface. The air quality of indoor and common areas have an important effect on the human health. There are 20 thousand to 2 million fungus spores in 1 m³ of air and this is one of the significant causes of skin and respiratory diseases (Çeter and Pınar, 2009). One of the common areas that people use is the library where people take advantage of using it. Microfungi can be contaminated from visitors to books, other materials and other visitors. The microfungi in the library atmosphere also contaminate the books. They accelerate the corruption of the books, pages and aging process by increasing the acid formation. People, who contact the books which are contaminated by microfungi can suffer from allergy, itchy and irritated skin and if microfungi are inhalated, they can cause asthma and related diseases (Arslan and Ulaş, 2007). In some countries researches have been done about the microfungal contaminants which cause corruption on the artifacts that are kept in museums, archives and libraries and the microfungi in the internal atmosphere and the prevention methods of them (Shamsian et al., 2006, Mumcu et al., 2010, Temiz A, 2010, Borrego et al., 2012, Leite et al., 2012, Chadeganipour et al., 2013). The researches about this topic is not sufficient in our country (Yücel and Kantarcıoğlu, 1998, Arslan and Ulaş 2007, Mumcu et al., 2010). Considering the human circulation in libraries, these kind of studies, which have a great importance in terms of public and individual health, should be expanded. In this research it was aimed to identify the microfungal contaminants in the internal atmosphere of the Marmaris Health Services Vocational School library and on the surface of books.

Materials and Methods
Sampling
In this study, samples were taken from the Marmaris Health Services Vocational School library atmosphere and the surface of 20 books. Sampling from the library atmosphere was done by using petri dishes containing Rosebengal Chloramphenicol Agar (RbCA) and it was kept open for 30 minutes (Mumcu et al., 2010). The samples from the books were taken by using moistened sterile swab stick from the surface and they were transferred to petri dishes containing RbCA by using surface spreading technique (Shamsian et al., 2006, Mumcu et al., 2010, Temiz A, 2010, Borrego et al., 2012, Leite et al., 2012, Chadeganipour et al., 2013).

Incubation and identification
Sampling of the petri dishes were incubated for 15 days at 27 °C. The growing microfungi colonies were counted and transferred into the tubes containing Potato Dextrose Agar (PDA) and then they were incubated for 15 days at 27 °C. After incubation, inoculation was performed from each tube for diagnostic purposes on petri dishes containing Malt Extract Agar (MEA) and Czapek Dox Agar (CzDA). After 15 days of incubation at 27°C, developing microfungi colonies were identified by examining the cultural and microscopic features and by corresponding reference books (Domsch et al., 1980, Hasenekoğlu 1991, Samson and Pitt, 2000, Ellis et al., 2007).

Results and Discussion
The distribution of microfungi in the atmosphere of the library and on the surface of the books
In this research, 14 microfungi belonged to 5 genera were obtained. Aspergillus, Penicillium ve Cladosporium genera were found to be dominant in terms of qualitative aspect and Aspergillus was found to be dominant in terms of quantitative aspect (Table 1). Maximum colonies were formed by Aspergillus niger among the species of microfungi and this was followed by Alternaria alternata and Cladosporium herbarum (Table 1).
The microfungi which were found to be dominant in terms of the qualitative and quantitative aspects are widely distributed in nature. Because of spreading easily by the atmospheric movements, having a wide range of ecological tolerance and producing too many spores, they can be found in almost any environment and they can contaminate any surface (Domsch et al., 1980, Hasenekoğlu 1991, Asan et al., 2002, Yazıcıoğlu et al., 2002, Çeter and Pınar, 2009). Our findings are consistent with the relevant literature.

Table 1. Qualitative and quantitative distribution of microfungi.

<table>
<thead>
<tr>
<th>Microfungal species</th>
<th>Library atmosphere</th>
<th>Surface of books</th>
<th>Colony number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria alternata (Fr.) Keissler</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Aspergillus fumigatus Fresenius</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Aspergillus nidulans (Eidam) Winter</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Aspergillus niger van Tieghem</td>
<td>22</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>Aspergillus wentii Wehmer</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cladosporium cladosporioides (Fresen.) Viries</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Cladosporium herbarum (Pers.) Link ex Gray</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Cladosporium sphaerospermum Penz.</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Chaetomium Kunze ex Fries sp. I</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Chaetomium Kunze ex Fries sp. II</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Penicillium brevicipactum Dierckx</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Penicillium glabrum (Wehmer) Westling</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Penicillium italicum Wehmer</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Penicillium verrucosum Dierckx var. verrucosum Samson, Stolk &amp; Hadlok</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total colony number</td>
<td>42</td>
<td>29</td>
<td>71</td>
</tr>
</tbody>
</table>

There are not many studies in Turkey and other countries about the microfungi that contaminate the library air and the surface of the books. A number of these studies are about the protection against microbial originated corruption of the artifacts in the libraries, archives and museums. In a study conducted in Turkey, Alternaria, Penicillium, Cladosporium, Aspergillus, Fusarium and Rhizopus genera were isolated in the air of the library of Selimiye Mosque in Edirne (Mumcu et al., 2010). These findings are largely similar to the microfungi species derived from the library air in this research.

Leite Junior et al. (2012), have determined that the Aspergillus was found to be dominant in terms of quantitative and qualitative aspects in the atmosphere of the library. Borrrego et al. (2012), have obtained Aspergillus and Penicillium genera in high frequency from the air of the archives. Chadeganipour et al. (2013), have isolated Cladosporium, Penicillium, Aspergillus and Alternaria extensively from the library air and the bookshelves. The results obtained from the library air, support the findings of these literature.

Mumcu et al. (2010), have isolated Alternaria, Cladosporium, Aspergillus, Acremonium, Fusarium, Rhizopus and Chaetomium from the samples taken from the books in the library. In this research, the microfungi isolated from the books are largely similar to these findings. Shamsain et al. (2006), have isolated Aspergillus in high frequency and it was followed by Penicillium. Zotti et al. (2008), have obtained Penicillium and Aspergillus fungi extensively on the historical artifacts. Ebrahimi et al. (2011), have found the Aspergillus and Penicillium genera dominant. Borrrego et al. (2012), have isolated Aspergillus and Penicillium genera in high frequency from the historical documents. Chadeganipour et al. (2013), the Penicillium, Cladosporium, Aspergillus and Alternaria genera
were determined to be common. The microfungi genera we obtained from the books are largely relevant to these literature.

In this study, both the samples from the library air and the book surfaces, the Aspergillus niger has formed the maximum colony (Table 1). Leite et al. (2012) has also indicated that the most common species in their study is the Aspergillus niger. In this investigation, Aspergillus wentii, Chaetomium sp.II and Penicillium verrucosum var. verrucosum from the microfungi species were only isolated from the books (Table 1). These microfungi species could have been contaminated to the books by the readers. The microfungi isolated from the surface of the books and the air of the library are largely similar. This shows that the surface of the books are mostly contaminated by the air.

The microfungi isolated from the air and the surface of the books in the library have not been found in high levels in terms of the qualitative and quantitative aspects. The factors like the ventilation of the library, the cleaning of the floor and shelves with detergent and the surface of the books from time to time and less circulation of visitors, have a restricted effect on the microfungi species and numerical values.

In this research, it was found that the isolated microfungi like Alternaria species cause mycotic keratitis. Aspergillus species are important pathogens which can be effective on human and animals. Chaetomium species are rarely isolated in medical mycology laboratories. The pathogens of the Cladosporium species were transferred to Cladophialophora genus. Penicillium species may cause mycotic keratitis, otomycosis and endocarditis (Ellis et al., 2007). Besides, Alternia, Aspergillus and Penicillium species have an influence on the human health by producing mycotoxin (Tunail, 2000).

**Conclusion**

Microfungi isolated from the surface of the books and the library air can be hazardous to human health. On account of this, personal and environmental hygiene must be taken into consideration. Consequently, it would be beneficial for individual and environmental health to make further researches like this, to take measures for the improvement of air quality in the libraries and to clean the library materials steadily.

**References**


