Original article

Allergenic fungi in deteriorating historic objects of Shahrekord Museum, in Iran

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Abstract

Introduction and objective: Presence of fungi in exhibition and storage spaces of museums may be dangerous to museum professionals and users. The aim of the present study was to assess the level of allergenic fungi in deteriorating historic objects of the Shahrekord Museum collection.

Materials and methods: In this investigation, samples of 115 deteriorating historic objects aged from 50 to 200 years were inoculated on Sabouraud dextrose agar and incubated up to two weeks at 28°C in order to isolate fungal contaminants.

Results: Samples of 105 items (91.3%) were positive for the presence of fungi. The most common isolated fungi were *Aspergillus* spp. (32.9%), *Penicillium* spp. (19.1%), and *Madurella* spp. (5.2%). The number for *Zygomycota* was 17.3%. Differences in contamination rates between fabrics, leather made and wooden objects for *Aspergillus* spp. and *Penicillium* spp. were statistically significant ($P<0.05$).

Conclusion: In fabrics *Aspergillus* spp. and *Zygomycota*, in leather made objects *Aspergillus* spp. and *Penicillium* spp. and in wooden objects *Zygomycota*, *Aspergillus* spp. were dominant moulds. Majority of isolated species were common allergens.

Significance and impact of the study: Most of the isolated fungi are allergenic and can cause adverse human health effects in both museum workers and users.

Keywords: Allergenic fungi; Museum; *Aspergillus*; *Penicillium*

Introduction

Presence of fungi in exhibition and storage spaces of museums, which majority of their species are common allergens and some of them are potential mycotoxin producers may be dangerous to museum professionals and users [1]. They enter the body via inhalation of toxicogenic spores and direct dermal contact, and can cause several diseases from which, airway infections, mycosis, immune system issues, and asthma are examples [2].

Cladosporium and *Penicillium* species are known as causal agents of asthma. The members of the genus *Aspergillus* are causative agents of large spectrum of diseases known as aspergillosis [3]. Exposure to *Alternaria alternata* spores presents a risk factor for asthma and causes significant respiratory problems [4]. Mould species usually attack materials such as paper, textile, wood, dyes and leather, forming well known symptoms on the objects. Dust and other air components can be potentional natural sources of fungi. Relative humidity over 70%, temperature over 15°C, a neutral to acid pH, and presence of organic nutritive sources are the optimal conditions for fast growth and reproduction of moulds, which attack museum objects [5]. The result is mycotic biodeterioration that is a significant problem resulting in a loss of ancient cultural objects of museums.

Some microscopic fungi on historic objects are strongly cellulolytic. Cellulose is the main component of paper, in books, archives, prints, maps and globes. Another class of substances commonly found in historic objects are protein and collagen that provide good conditions for the development of proteolytic fungi. All leather objects, such as book bindings, parchments, cordovans, garments and travel cases contain these substances [6].

The present investigation was undertaken to elucidate allergenic fungi making the mycoflora of the biodeteriorating historical objects, kept in cultural museum of Shahrekord, city in west centre of Iran.

Materials and methods

Through October 2009 to March 2010, samples of 115 ancient objects (aged from 50 to 200 years) most of them were fabrics, leather and wooden made items, that are kept in cultural museum of Shahrekord. Samples were transferred to mycological laboratory of this college to isolate the fungal agents. All sampled objects had biodeterioration signs such as colouring/ discolouring, or any other observable texture changes. Damaged areas were sampled using a scalpel to scratch the surface or to remove a small portion from the destroyed parts of the biodegraded item. 115 small samples (max. 0.5cm^2) were retrieved from different objects, and stored in sterile Petri dishes until further processing.

All sample manipulations were made aseptically with previously sterilized material, in order to prevent cross contaminations. Sample fragments were then inoculated on Sabouraud dextrose agar (SDA, Merck, Germany), supplemented with chloramphenicol (0.05g/l) and incubated up to two weeks at 28°C in order to isolate fungal contaminants. Complementary tests (slide culture) were performed for distinguishing the genera of the fungi [7]. The fungi were identified by their macro- and microscopic morphological characteristics [8]. Differences in contamination rates of three groups (fabrics, leather made and wooden objects) to more frequent isolated fungi were analyzed using chi squared test.

Results

Among 115 received samples, 105 (91.3%) were positive for the presence of fungi, details are summarized in table 1. *Aspergillus* spp., *Penicillium* spp., *Zygomycota* and *Madurella* spp. (32.9%, 19.1%, 17.3% and 5.2%, respectively) were the most frequent isolated fungi. Sixty items (out of 105) were contaminated by more than one kind of fungi. Differences in contamination rates between fabrics, leather made and wooden objects for *Aspergillus* spp. and *Penicillium* spp. are statistically significant, ($P<0.05$) while for *Zygomycota* only contamination rate of fabrics compared to other two groups (leather made and wooden objects) is significant ($P<0.05$).

Table 1: Frequency and percentages of different fungi isolated from biodeteriorated objects of Shahrekord Museum

Fungal agents	Fabric objects (39)	Leather objects (37)	Wooden objects (17)	Others (12)	Total (105)
	no (%)	no (%)	no (%)	no (%)	no (%)
Aspergillus spp.	19 (33.3)	26 (35.1)	7 (26.9)	5 (31.3)	57 (32.9)
Penicillium spp.	9 (15.8)	19 (20.7)	3 (11.6)	2 (12.6)	33 (19.1)
Madurella spp.	3 (5.3)	4 (5.4)	1 (3.8)	1 (6.2)	9 (5.2)
Alternaria spp.	1 (1.7)	1 (1.3)	2 (7.7)	1 (6.2)	5 (2.9)
Trichophyton spp.	1 (1.7)	4 (5.4)	0 (0.0)	0 (0.0)	5 (2.9)
Chrysosporium spp.	0 (0.0)	3 (4.1)	0 (0.0)	1 (6.2)	4 (2.3)
Epicoccum spp.	1 (1.7)	0 (0.0)	1 (3.8)	0 (0.0)	2 (1.2)
Zygomycota	14 (24.7)	7 (9.5)	8 (30.8)	1 (6.2)	30 (17.3)
Yeasts	4 (7.0)	1 (1.3)	1 (3.8)	2 (12.6)	8 (4.6)
Unidentified	5 (8.8)	9 (12.2)	3 (11.6)	3 (18.7)	20 (11.6)
Total	57 (100)	74 (100)	26 (100)	16 (100)	173 (100)

Discussion

Fungi were isolated from a great number of samples (91.3%), majority of isolated species are common allergens and some of them are potential mycotoxin producers [1]. High frequency of isolation of *Aspergillus* spp., *Penicillium* spp. and *Zygomycota* (collectively 69.3% of the isolated fungi) is in agreement with other works [9,10]. Since *Aspergillus* and *Penicillium* are found every-where, their presence as contamination agents on studied samples is not un-expected [11]. In parchment and leather, keratin is the most abundant structural protein together with collagen. Proteases like keratinases and collagenases from *Aspergillus* and *Penicillium* can be responsible for their dominant prevalent in the examined objects [12].

Regarding leather made objects, the majority of the species found were *Aspergillus* spp. (35.1%), *Penicillium* spp. (20.7%) and *Zygomycota* (9.5%) that are already reported by Zyska [9] support our data. The keratinophilic/dermatophilic fungi, *Trichophyton* spp. and *Chrysosporium* spp. (5.4% and 4.1% respectively), also were mostly isolated from leather made objects. Based on our previous report, the possibility of the presence of some zoonotic *Trichophyton* spp. in the historic objects with animal origin should be considered [13]. The latter two genera are responsible for various human cutaneous mycoses.

Sharma and Sharma [14] described the presence of *Alternaria* in leather, whereas we didn't find this fungus. In the case of

fabrics, *Aspergillus* spp. (33.3%), *Zygomycota* (24.7%) and *Penicillium* spp. (15.8%) were the dominant contaminants. Fabrics comprise the largest group of textile products which differ from one another in their composition. Our results are in agreement with Jadwiga [15] who stated, among all the microorganisms involved in the degradation of fabrics and wool. *Penicillium* and *Aspergillus* are very important genera. However, in the case wool, some dermatophytes and *Rhizopus* are also important.

For wooden objects the order were as *Zygomycota* (30.8%), *Aspergillus* spp. (26.9%) and *Penicillium* spp. (11.6%), The results are in line with investigations that indicate fungal strains such as *Aspergillus* spp., *Penicillium* spp. and *Zygomycota* genera have strong cellulolytic properties and can efficiently destroy historical objects such as books, manuscripts, textiles and wood sculptures [16]. Different physical, chemical and biological factors are involved in biodegradation of museum objects [15] and it is difficult to claim that the isolated fungal agents are solely involved in biodeterioration of the examined objects.

Preventing damage to museum collections and subsequent health hazards, environmental conditions should be adjusted in a way that fungi growth diminishes [17]. Nowadays, mechanical cleaning of contaminated museum objects with moulds and treatment with appropriate commercial fungicides are used with the aim of their prevention and protection. Apart from the degradation of the museum material, most of these organisms can also cause adverse human health effects in both workers and users.

Airborne pollen and fungal allergenic spores have been implicated as one of the main cause of allergic respiratory diseases in temperate regions [18]. The most common types of fungi that cause allergy belong to *Ascomycetes* such as *Aspergillus* spp., *Penicillium* spp, *Cladosporium* spp. and *Alternaria* spp. [18,19]. It is documented that some isolated fungal strains in the present study were identified to be the risk factors for allergic diseases in Isfahan (West centre of Iran) and are the dominant species of airborne fungi throughout the year [19]. So museum workers and users should be aware that adequate care should be taken when handling ancient objects.

Conclusion

In fabrics *Aspergillus* spp. and *Zygomycota*, in leather made objects *Aspergillus* spp. and *Penicillium* spp. and in wooden objects *Zygomycota, Aspergillus* spp. were dominant moulds. Majority of isolated species were common allergens.

Conflict of interest statement: All authors declare that they have no conflict of interest.

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