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A study on the fungi isolated from the carpeting, walls and prayer beads from the "New Mosque and Nuruosmaniye Mosque" situated in the province of Istanbul

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Mosques which are visited by many people every day, for both worship and touristic purposes, play an important role in the spread of infections in society. It is for this reason that research into the fungal concentrations found on the carpets, walls and prayer beads in mosques may prove instrumental in determining potential risks and in protecting the health of visitors. The sampling of fungus content from the carpeting, walls and prayer beads of two different mosques in the province of Istanbul was undertaken with the aim of determining fungi content and levels at two chosen stations in 2015 in the months of January, April, July and October. Samples were taken using dry sterile swabs. The samples brought to the laboratory were cultivated in Peptone-Dextrose Agar in appropriate conditions. The isolated fungi were spot cultivated in Malt Extract Agar (MEA) medium and pure colonies were detected. The preparations extracted from the pure culture of the fungi were examined using a microscope. In the sampling carried out for a duration of four months, 190 colonies were detected. As a result of the study undertaken, 18 different species from 8 genera were isolated. The genera identified were as follows; Alternaria, Aspergillus, Chaetomium, Cladosporium, Penicillium, Scopulariopsis, Trichoderma and Ulocladium. Amongst the genera, the 3 most commonly detected ones were; Aspergillus, 53.2% Penicillium 24.2% and Cladosporium, 14.2%. As a result of the study, the species most isolated, in order, are as follows: Aspergillus fumigatus at 25.8% Aspergillus flavus at 12.7%, Aspergillus parasiticus at 10%, Cladosporium sphaerospermum and Penicillium palitans at 8.4% respectively, Penicillium citreonigrum at 7.4%, Cladosporium cladosporioides at 6.3%, Penicillium citrinum at 5.8%, Chaetomium globosum at 4.2%, Aspergillus niger at 3.2%, Penicillium solitum and Trichoderma longibrachiatum at 1.6% respectively, Alternaria citri, Emericella nidulans and Penicillium chrysogenum at 1.05% respectively and Aspergillus sydowii, Scopulariopsis brevicaulis and Ulocladium alternariae at 0.5% respectively.

Key Words: Aspergillus, Penicillium, Fungus, Carpeting, Mosque, Indoor, Biology, Microbiology, Epidemiology, Istanbul

INTRODUCTION

Due to the characteristic of being able to develop in different habitats, fungi are widely dispersed across earth (Bavbek et al., 2006; Inal et al., 2008). Some of the fungi lead a symbiotic existence whilst others can be

saprophytic or parasitic (Öner, 2009). Due to the fact that fungi can be found in soil, air and water, they can be considered to be invaluable organisms of the natural environment (Lukaszuk et al., 2007). Despite the fact that up until today 120,000 species of fungi have been identified, it is known that in the region of 1.5 million fungi ensure their existence (Webster and Weber, 2007). It is known that the most common genera of the fungal community are *Cladosporium, Penicillium* and *Aspergillus* (Shelton et al., 2002).

The majority of fungus spores can ensure their existence for long periods. This can be considered to be very important from the perspective of the reproduction of fungi, allergic reaction and pathogenesis (Bavbek et al., 2006; Inal et al., 2008). Spores generally speaking enter the body through the respiratory system and on occasion rarely through the digestive tract or skin. Fungal spores also contribute to the cause of allergic diseases along with pollen, house dust, animal hair, medication, artificial colours, viruses, bacteria and parasites (Gelincik 2004). Fungi which possess the characteristic of wide dispersion can have a pathogenic and allergen effect on humans, animals and plants (Çeter and Pınar, 2009). The effect of fungal spores present in inhaled air on human health is dependent on the concentration, composition (genera and species) and quantity of the spores. Spores that are greater than 10 microns attach to the upper respiratory tract pathway (nose, pharynx) and can cause symptoms of high temperature (Hargreaves et al., 2003). The importance of fungi that are known to cause various diseases increase day by day (Çolakoğlu, 1983; Tümbay, 1983).

The concentration of fungal spores in the atmosphere differs from region to region. Concentration can vary depending on factors such as geographical regional characteristics, seasonal changes, altitude and vegetation type and biotic-abiotic factors. The meteorological factors that affect the quality and quantity of fungi in a particular region are climatic conditions such as sunlight, temperature, moisture, wind speed, precipitation and snowfall (Boyacioglu et al., 2007; Aríngoli et al., 2008; Aydogdu and Asan, 2008; Kilic et al., 2010; Morris et al., 2011).

Fungus studies carried out on mosques are considerably few. The aim of this study is to determine the concentration and distribution of fungus that originate from the carpets, walls and prayer beads in mosques, which are utilised for both worship and touristic related visits by people. Upon designation of species of fungi, changes in concentration and distribution which have an effect on community health according to seasons (summer-winter), would be determined. Therefore, this study will ensure that the effect on the human health of isolated fungi from material in mosques will be more easily determined. Social establishments play an important role in the transmission of fungal infections. The role of carpets, walls and prayer beads in mosques, which are institutions of vital importance from a societal perspective, in the transmission of fungal infections can be explained as follows: Closed footwear, synthetic socks and washed feet not drying sufficiently are factors in the spread of dermatophytosis of the feet. With regard to prayer beads, the fact that they are used repeatedly by more than one person is instrumental in the spread of fungal infections. The dermatophytes of infected individuals pass to the floor surface and are passed to non-infected individuals again through the floor surface. The moistness of the floor surface, worship performed in the mosque with damp feet, synthetic socks and the use of closed footwear, are effective in the spread of fungal infections. In this situation the following precautionary measures can be taken; the cleaning of the mosque carpets at regular intervals would ensure that the quantity of fungus in the carpets of mosques is reduced. The ideal frequency for the cleaning of the carpets should be determined.

The frequent washing of areas where ablution is performed would result in a positive result in terms of the reduction of fungus quantity. Also, ablution areas should be designed in a way that allows for the feet to dry sufficiently. It is also of importance that carpet producers add anti-fungal to the carpets to ensure that fungus quantities decrease (Raboobee et al., 1998). The cleaning and replacement of prayer beads at certain intervals using methods deemed appropriate would also go a long way to reducing fungus concentration. The wiping of mosque walls frequently and at regular intervals being washed with pressurised water would ensure that fungus intensity would be reduced.

MATERIALS AND METHODS

Sampling was undertaken from two different mosques in the province of Istanbul in 2015 during the months of January, April, July and October (Table 1). Samples were taken from the carpets, walls and prayer beads twice a month.

The samples taken were brought to the laboratory and cultivation in peptone-dextrose agar was undertaken. This agar medium was used for the first isolation of the fungi. In order to inhibit the excessive growth of the fungi in the culture medium prepared and to ensure limited growth, 30 mg/l of Rose-Bengal stain was added and sterilised at 120°C for 15 min. Following this, after being cooled to approximately 45 to 50°C to inhibit the reproduction of bacteria, 30 mg/l of streptomycin antibiotic was added (Sarıca et al., 2002).

Subsequent to the sterilisation process, distribution of 15 to 20 ml

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Table 1. Mosques in Istanbul chosen for sampling.

1	New Mosque
2	Nuruosmaniye Mosque

was undertaken into standard Petri dishes (Pitt, 1979; Klich, 2002). The samples under study were first cultivated into these mediums. Following an incubation period of approximately 7 to 10 days, and the monitoring of the reproduction of the isolated fungi, the fungi were spot cultivated in malt extract agar (MEA) medium and the Petri dishes were left to incubate at room temperature (22 to 26ºC) for an incubation period of 7 to 14 days at which point pure colonies were detected. The colonies detected were prepared in lactophenol solution (Çolakoğlu, 1996).

The identification of fungus colonies was carried out based on macroscopic (colony dimension, texture, shape, colouring from above and underneath, sporulation, zonation, exudation, pigmentation and existence of various macroscopic reproductive structures) and microscopic (examination of colony texture with stereo microscope, shape of conidia upon budding and measurement of various sections with light microscope, perimeter characteristics and such characteristics as colour (Tikveşli, 2013).

In order for the microscopic structures of the fungi to be examined under a microscope, lactophenol solution dyed in picric acid was used for the preparatory environment (Bilgehan, 2002). The use of this solution was important because it allowed the fungi structures to be more easily observed. A few drops of the lactophenol solution dyed in picric acid were added to the microscopic slide and the fungi drawn by the sterile pipette were added to the lactophenol solution and then sealed by lamella. After a while, the lamellae corners were sealed with the aid of a clear nail polish and the prepared slides were then incubated in the storage boxes (Çolakoğlu, 1983).

The slides prepared from the pure fungi cultures were examined using an Olympus Cx22 make microscope. An ocular disc was used to measure the fungi and photographs taken were added to the research. The identification of these fungi was based on both national and international literature (Çolakoğlu, 1983).

For the identification of general species, “Fungi and Indoor Fungi”, “Identification of common *Aspergillus* Species” and the publications of CBS-KNAW’ were utilised (Samson et al, 2010). In addition to this, “The Genus *Aspergillus*” was used for the identification of *Aspergillus* species (Raper and Fennell, 1965), “*Dematiaceous Hyphomycetes*” was utilised for the identification of the *Alternaria* and *Cladosporium* species (Ellis, 1971) and “A Manual of the *Penicillia*” was enlisted for the identification of the *Penicillium* species (Raper et al., 1949).

RESULTS

As a result of samples being taken and isolated from the carpets, wall and prayer beads of two different mosques in the province of Istanbul, 190 colonies detected from 8 genera and 18 different species were examined (Table 2).

An examination of the overall total reveals that the most isolated fungus was the *Aspergillus* genus at 53.2%. The following genus followed the above genus in terms of being the most isolated genus of fungus; *Penicillium* at 24.2%, *Cladosporium* at 14.2%, *Chaetomium* at 4.2%, *Trichoderma* at 1.6%, *Alternaria*, at 1.05%, *Scopulariopsis* and *Ulocladium* at 0.5% (Table 2).

Throughout the duration of the study the most isolated species was *Aspergillus fumigatus at 25.8%* and this was followed by *Aspergillus flavus at 12.7*%, *Aspergillus parasiticus* at 10%, *Cladosporium sphaerospermum* and *Penicillium palitans* at 8.4% , *Penicillium citreonigrum* at 7.4%, *Cladosporium cladosporioides* at 6.3%, *Penicillium citrinum* at *5.8%, Chaetomium globosum* at *4.2%, Aspergillus niger* at 3.2%, *Penicillium solitum* and *Trichoderma longibrachiatum*, at 1.6%, *Alternaria citri*, *Emericella nidulans* and *Penicillium chrysogenum* at 1.05% and *Aspergillus sydowii*, *Scopulariopsis brevicaulis* and *Ulocladium alternariae* at 0.5% (Table 2 and Figure 1).

According to the results of the research conducted, walls were the material that fungus were most isolated from, at a value of 39.5%. This was followed by carpets at 38.9% and prayer beads at 21.6% (Table 2).

Throughout the study the fungus most isolated from the New Mosque was at a rate of 52.1%. An evaluation of the fungus isolated from the New Mosque’s materials in terms of walls, carpets and prayer beads, reveals that its walls had the highest value of fungi isolated at 19.5%. This was followed by carpets at 18.4% and prayer beads at 14.2% (Table 2).

The species of fungus most isolated from the carpet of the New Mosque were *A. fumigatus* and *P. palitans* at 20%, whereas *A. flavus* was the species most isolated from the carpets of the mosque at 24.4% and *A. parasiticus* was the species most isolated at 18.6% (Table 3).

At the New Mosque in the month of January, *Cladosporium sphaerospermum* was the most isolated species from the carpets with 3 colonies, whereas in contrast, the species most isolated from the walls with 4 colonies was *A. flavus* and *P. citrinum* and *U. alternariae* from the prayer beads with 1 colony In the month of April, the most isolated species of fungus from the carpets was *P. palitans* with 4 colonies and for the walls this was *A. flavus* with 4 colonies. In contrast, the most isolated species from the prayer beads were *A. fumigatus* and *P. palitans* with 3 colonies. In the month of July, *A. fumigatus* was the most isolated species from the carpets with 4 colonies. This was followed by *A.* parasiticus being the most isolated species from the walls with 3 colonies and *A. fumigatus* was the most isolated species from the prayer beads with 6 colonies. However, in the month of October, the most isolated species of fungus from the carpets was *A. fumigatus* and *C. sphaerospermum* with 2 colonies, and for the walls this was *C. sphaerospermum* with 2 colonies and the most isolated species of fungus from the prayer beads was *A. parasiticus* (Table 3).

April was the month that witnessed the highest rate of fungi isolated from the carpets of the New Mosque at 34.2%. April was also the month that witnessed the highest rate of fungi isolated from the walls of the New Mosque at 35.1%. However, July was the month that witnessed the highest rate of fungus reproduction in

Table 2. The percentage distribution and occurrences of fungi genera and species isolated from the carpets, walls and prayer beads of the New and Nuruosmaniye Mosques.

Genera and species name	New mosque			Nuruosmaniye mosque			Colony quantity in total	%
	C	W	P	C	W	P		
Alternaria	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**1.05**
Alternaria citri	-	2	-	-	-	**-**	2	1.05
Aspergillus	**15**	**22**	**18**	**20**	**15**	**11**	**101**	**53.25**
Aspergillus flavus	3	9	3	3	3	3	24	12.7
Aspergillus fumigatus	7	4	10	13	8	7	49	25.8
Emericella nidulans	1	-	-	1	-	-	2	1.05
Aspergillus niger	1	4	-	1	-	-	6	3.2
Aspergillus parasiticus	3	5	5	1	4	1	19	10
Aspergillus sydowii	**-**	-	-	1	-	-	1	0.5
Chaetomium	**2**	**2**	-	**2**	**2**	-	**8**	**4.2**
Chaetomium globosum	2	2	**-**	2	2	-	8	4.2
Cladosporium	**6**	**4**	**-**	**9**	**9**	**-**	**28**	**14.7**
Cladosporium cladosporioides	1	-	-	6	5	-	12	6.3
Cladosporium sphaerospermum	5	4	-	3	4	-	16	8.4
Penicillium	**11**	**7**	**8**	**6**	**11**	**3**	**46**	**24.2**
Penicillium chrysogenum	1	-	-	1	-	-	2	1.05
Penicillium citreonigrum	-	1	3	1	7	2	14	7.4
Penicillium citrinum	2	3	1	2	3	-	11	5.8
Penicillium palitans	7	3	4	1	-	1	16	8.4
Penicillium solitum	1	-	-	1	1	-	3	1.6
Scopulariopsis	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**0.5**
Scopulariopsis brevicaulis	1	-	-	-	**-**	-	1	0.5
Trichoderma	**-**	-	-	**2**	**1**	**-**	**3**	**1.6**
Trichoderma longibrachiatum	-	**-**	**-**	2	1	-	3	1.6
Ulocladium	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**0.5**
Ulocladium alternariae	-	-	1	-	-	-	1	0.5
Total	**35**	**37**	**27**	**39**	**38**	**14**	**190**	
%	**18.4**	**19.5**	**14.2**	**20.5**	**20**	**7.4**		**100**
Total %		**52.1**			**47.9**			**100**

***H,** Carpet; ***D,** wall; ***T,** prayer beads.

terms of the prayer beads at the New Mosque at 44.4% (Table 3).

The concentration of the fungus isolated at the Nuruosmaniye Mosque was 47.9%. Among the materials sampled, the carpets revealed the highest rate of fungus isolation at 20.5%, followed by the walls at 20% and the prayer beads at 7.4% (Table 2).

The species most isolated from the Nuruosmaniye Mosque's carpets was *A. fumigatus,* at a rate of 33.3%, 21% from the walls and the highest concentration of isolated species at 50% from the prayer beads (Table 4).

During the month of January at the Nuruosmaniye Mosque, while *C. cladosporioides* was the most isolated species from the carpets with 3 colonies, *A. flavus* and *A. parasiticus,* were the most isolated species from the walls with 3 colonies and the species most isolated from the prayer beads was *A. flavus* with 3 colonies. During the month of April, *A. fumigatus*, was the most isolated species from the carpets with 4 colonies whereas for the walls, this was again *A. fumigatus*, but with 3 colonies. The species most isolated from the prayer beads was also *A. fumigatus* with 2 colonies. For the month of July, the following species were isolated from the carpets with 1 colony: *A. flavus*, *A. fumigatus*, *A. sydowii*, *C. cladosporioides*, *C. sphaerospermum* and *T. longibrachiatum.* Whereas *Penicillium citreonigrum* was the species most isolated from the walls with 3 colonies and *A. fumigatus* and *P. citreonigrum* were the species

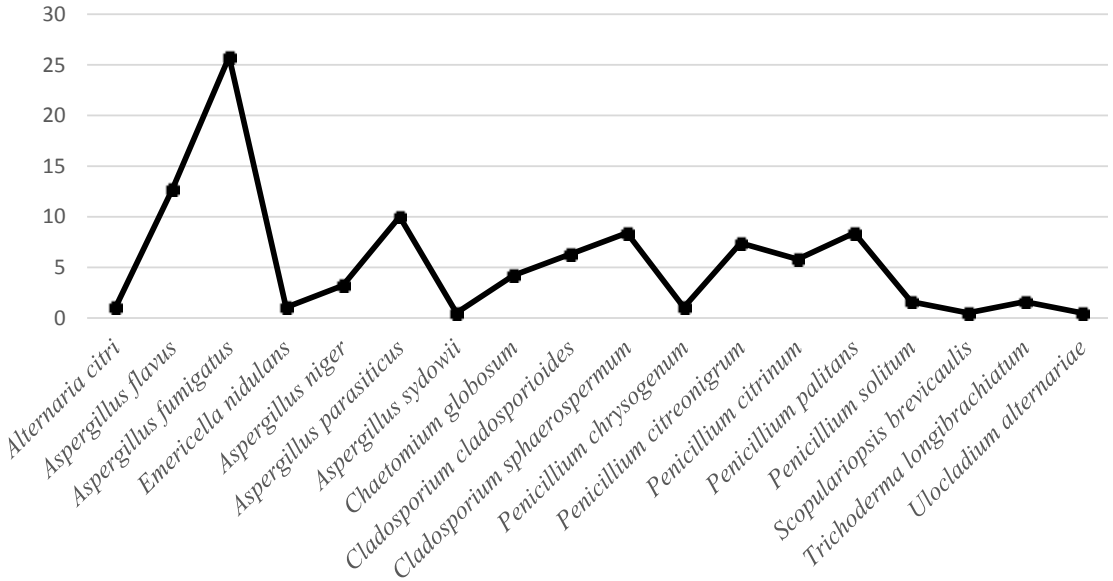

Figure 1. The percentage distribution and occurrences of fungus species isolated from the New and Nuruosmaniye mosques throughout the Study.

most isolated from the prayer beads with 2 colonies. For the month of October, *A. fumigatus* was the species most isolated from the carpets with 8 colonies and the again the species most isolated from the walls and prayer beads with 3 colonies and 2 colonies respectively (Table 4).

January was the month that witnessed the highest concentration of fungi isolated from the carpets of the Nuruosmaniye Mosque at a rate of 38.5%. The highest concentration of fungi isolated from the walls of the Nuruosmaniye Mosque at a rate of 36.9% and was also in January. Again, January was the month that witnessed the most fungus isolation from the prayer beads at a rate of 42.8% (Table 4).

As a result of the research carried out in the months of January, April, July and October in the year of 2015, a total of 57 colonies were detected during the month of January in the winter season. Whereas in contrast, 53 colonies were detected during the spring season in April, 43 colonies were detected in summer during July and 37 colonies were detected during autumn (Table 5).

The isolation of fungi according to season throughout the study in terms of percentages is as follows; January in winter came first with 30%, April in spring came second with 27.9%, July in summer is in third place with 22.6% and October in autumn is last with 19.5% (Figure 2).

Isolation of fungal species

A total of 18 fungal species namely

(indexfungorum)
Alternaria citri (Penz.) Mussat 1901
Aspergillus flavus Link 1809
Aspergillus fumigatus Fresen. 1863
Emericella nidulans (Eidam) Vuill. 1927
Aspergillus niger Tiegh. 1867
Aspergillus parasiticus Speare 1912
Aspergillus sydowii (Bainier & Sartory) Thom & Church 1926
Chaetomium globosum Kunze 1817
Cladosporium cladosporioides (Fresen.) G.A. de Vries 1952
Cladosporium sphaerospermum Penz. 1882
Penicillium chrysogenum Thom 1910
Penicillium citreonigrum Dierckx 1901
Penicillium citrinum Thom 1910
Penicillium palitans Westling 1911
Penicillium solitum Westling 1911
Scopulariopsis brevicaulis Bain. 1907
Trichoderma longibrachiatum Rifai 1969
Ulocladium alternariae (Cooke) E.G. Simmons 1967

DISCUSSION

Fungi are commonly found in the environment. The probability of airborne saprophytic fungi causing invasive disease in individuals who otherwise have a healthy immune system is low (Asan et al., 2004). However, for those with pre-existing conditions, the potential for a disease to arise is high (Asan et al., 2004; Latgé, 1999).

Almost all of the fungi that cause allergic disorders are saprophytic. The majority of such fungi fall within the Ascomycetes and Deuteromycetes category (Kurup et al., 2000; Li and Yang, 2004). It is known that the fungi that cause infections in humans are *Alternaria*,

Table 3. The percentage distribution and occurrences of fungi genera and species isolated from the carpets, walls and prayer beads of the New mosque according to month.

Genera and species name	Carpet						Wall						Prayer beads					
	Jan	Apr	Jul	Oct	Colony quantity	%	Jan	Apr	Jul	Oct	Colony quantity	%	Jan	Apr	Jul	Oct	Colony quantity	%
Alternaria	**-**	**-**	**-**	**-**	**-**	**-**	**2**	-	-	-	**2**	**5.4**	**-**	**-**	**-**	**-**	**-**	**-**
A. citri	-	-	-	-	-	-	2	-	-	-	2	5.4	**-**	**-**	-	-	-	**-**
Aspergillus	**1**	**5**	**6**	**3**	**15**	**42.8**	**7**	**8**	**5**	**2**	**22**	**59.5**	-	**5**	**9**	**4**	**18**	**66.7**
A. flavus	-	3	-	-	3	8.6	4	4	-	1	9	24.4	**-**	2	-	1	3	11.1
A. fumigatus	-	1	4	2	7	20	-	1	2	1	4	10.8	**-**	3	6	1	10	37
E. niduans	-	-	-	1	1	2.8	-	-	-	-	-	-	**-**	-	-	-	-	-
A. niger	-	1	-	-	1	2.8	1	3	-	-	4	10.8	**-**	-	-	-	-	-
A. parasiticus	1	-	2	-	3	8.6	2	-	3	-	5	13.5	**-**	-	3	2	5	18.6
Chaetomium	-	**2**	-	-	**2**	**5.8**	-	**2**	-	-	**2**	**5.4**	-	-	-	-	-	-
C. globosum	**-**	2	**-**	**-**	2	5.8	**-**	2	**-**	**-**	2	5.4	**-**	**-**	**-**	**-**	**-**	-
Cladosporium	**3**	**-**	**-**	**3**	**6**	**17.2**	**1**	**1**	**-**	**2**	**4**	**10.8**	**-**	**-**	**-**	**-**	**-**	-
C. cladosporioides	-	-	-	1	1	2.8	-	-	-	-	-	-	-	-	-	-	-	-
C. sphaerospermum	3	-	-	2	5	14.4	1	1	-	2	4	10.8	-	-	-	-	-	-
Penicillium	**3**	**5**	**1**	**2**	**11**	**31.4**	**2**	**2**	**2**	**1**	**7**	**18.9**	**1**	**4**	**3**	**-**	**8**	**29.6**
P. chrysogenum	1	-	-	-	1	2.8	-	-	-	-	-	-	-	-	-	-	-	-
P. citreonigrum	-	-	-	-	-	-		-	1	-	1	2.7		1	2	-	3	11.1
P. citrinum	1	-	-	1	2	5.8	1	1	-	1	3	8.1	1	-	-	-	1	3.7
P. palitans	1	4	1	1	7	20	1	1	1	-	3	8.1	-	3	1	-	4	14.8
P. solitum	-	1	-	-	1	2.8	-	-	-	-	-	-	-	-	-	-	-	**-**
Scopulariopsis	**1**	**-**	**-**	**-**	**1**	**2.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
S. brevicaulis	1	-	-	-	1	2.8	-	-	-	-	-	-	-	-	-	-	-	**-**
Ulocladium	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**3.7**
U. alternariae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3.7
Total	**8**	**12**	**7**	**8**	**35**		**12**	**13**	**7**	**5**	**37**		**2**	**9**	**12**	**4**	**27**	
%	**22.9**	**34.2**	**20**	**22.9**		**100**	**32.5**	**35.1**	**18.9**	**13.5**		**100**	**7.5**	**33.3**	**44.4**	**14.8**		**100**

*Jan, January; *Apr, April; *Jul, July; *Oct, October; *C, Carpet; *W, Wall; *P, Prayer beads.

Cladosporium, *Aspergillus* and *Penicillium* (Srikanth et al., 2008; Adhikari et al., 2004; Ustaçelebi, 1999). In addition to this, the most commonly encountered fungi are *Alternaria*, *Aspergillus*, *Aureobasidium*, *Botrytis*, *Cephalosporium*, *Cladosporium*, *Curvularia*, *Drechslera*, *Epicoccum*, *Fusarium*, *Gliocladium*, *Helminthosporium*, *Paecilomyces*, *Penicillium*, *Phoma*, *Saccharomyces*, *Scopulariopsis*, *Starchybotrys*, *Stemphylium*, *Trichoderma*, *Trichophyton*, *Trichothecium* and *Ulocladium* (Kurup et al., 2000; Li and Yang, 2004). The majority of the above mentioned fungi were isolated as part of this study. The mould fungi that give rise to negative effects on health show variability. Mould fungi affect human health through both immune and non-immune mechanisms. The allergens that are produced by

Table 4. The percentage distribution and occurrences of fungi genera and species isolated from the carpets, walls and prayer beads of the Nuruosmaniye mosque according to month.

Genera and species name	Carpet						Wall						Prayer beads					
	Jan	Apr	Jul	Oct	Colony quantity	%	Jan	Apr	Jul	Oct	Colony quantity	%	Jan	Apr	Jul	Oct	Colony quantity	%
Aspergillus	**3**	**4**	**3**	**10**	**20**	**51.4**	**7**	**3**	**1**	**4**	**15**	**39,5**	**5**	**2**	**2**	**2**	**11**	**78.6**
A. flavus	1	-	1	1	3	7.7	3	-	-	-	3	7,9	3	-	-	-	3	21.4
A. fumigatus	-	4	1	8	13	33.3	1	3	1	3	8	21	1	2	2	2	7	50
E. nidulans	1	-	-	-	1	2.6	-	-	-	-	-	-	-	-	-	-	-	-
A. niger	1	-	-	-	1	2.6	-	-	-	-	-	-	-	-	-	-	-	-
A. parasiticus	-	-	-	1	1	2.6	3	-	-	1	4	10,6	1	-	-	-	1	7.1
A. sydowii	-	-	1	-	1	2.6	-	-	-	-	-	-	-	-	-	-	-	-
Chaetomium	**2**	-	-	**-**	**2**	**5.1**	-	**2**	-	-	**2**	**5,3**	-	-	-	-	-	-
C. globosum	2	-	-	-	2	5.1	-	2	-	-	2	5,3	-	-	-	-	-	-
Cladosporium	**4**	**3**	**2**	**-**	**9**	**23**	**3**	**2**	**3**	**1**	**9**	**23,7**	-	-	-	-	**-**	**-**
C. cladosporioides	3	2	1	-	6	15.3	1	2	2	-	5	13,1	-	-	-	-	-	-
C. sphaerospermum	1	1	1	-	3	7.7	2	-	1	1	4	10,6	-	-	-	-	-	-
Penicillium	**5**	**-**	**-**	**1**	**6**	**15.4**	**3**	**3**	**3**	**2**	**11**	**28,9**	**1**	**-**	**2**	-	**3**	**21.4**
P. chrysogenum	1	-	-	-	1	2.6	-	-	-	-	-	-	-	-	-	-	-	-
P. citreonigrum	1	-	-	-	1	2.6	1	2	3	1	7	18,4	-	-	2	-	2	14.3
P. citrinum	1	-	-	1	2	5.1	1	1	-	1	3	7,9	-	-	-	-	-	-
P. palitans	1	-	-	-	1	2.6	-	-	-	-	-	-	1	-	-	-	1	7.1
P. solitum	1	-	-	-	1	2.6	1	-	-	-	1	2,6	-	-	-	-	-	**-**
Trichoderma	**1**	-	**1**	**-**	**2**	**5.1**	**1**	-	**-**	**-**	**1**	**2,6**	-	-	-	-	**-**	**-**
Trichoderma longibrachiatum	1	-	1	-	2	5.1	1	**-**	-	-	1	2,6	**-**	**-**	**-**	**-**	-	-
Total	**15**	**7**	**6**	**11**	**39**		**14**	**10**	**7**	**7**	**38**		**6**	**2**	**4**	**2**	**14**	
%	**38.5**	**18**	**15.3**	**28.2**		**100**	**36.9**	**26.3**	**18.4**	**18.4**		**100**	**42.8**	**14.3**	**28.6**	**14.3**		**100**

*Jan, January; *Apr, April; *Jul, July; *Oct, October; *C, Carpet; *W, Wall; *P, Prayer beads.

moulds can cause IgE dependant responses such as allergic rhinitis immunologically and allergic asthma. Less commonly they can give rise to immune dependant disorders such as Allergic Bronchopulmonary Aspergillosis (ABPA), allergic fungal sinusitis and hypersensitivity pneumonitis. Non-immune effects are those as infection, inhalation temperature, mucous membrane irritation and effects linked to mycotoxins (Mazur and Kim, 2006). Exposure to mould indoors has been reported to have the following effects; on the respiratory system such as asthma, 'wheezing' and sinusitis; haematological effects such as pulmonary haemorrhage and pulmonary haemosiderosis; on the central nervous system such as chronic fatigue, weakness, memory loss, irritability, anxiety, depression, tremors, tinnitus and on the reproductive system such as abortus and ovary endometriosis. Particularly in those who have a weak immune system, exposure to mould has been reported to cause systemic infections that can be life threatening (Curtis et al., 2004).

Two studies similar to the study in hand have been carried out in Turkey. One of these studies researched the micobiota in the carpets and air in three different mosques in Edirne (Tikveşli, 2013). Whilst the other study researched the fungi

Table 5. Colony quantity of isolated fungi according to season**.**

Seasons	Colony quantity
Winter	57
Spring	53
Summer	43
Autumn	37
Total	**190**

present in the air both indoors and outdoors of the Edirne Selimiye Mosque Library (Kızılyaprak et al., 2007).

The genera of fungus most isolated in the current study are, in order, as follows; *Aspergillus*, *Penicillium*, *Cladosporium*, *Chaetomium*, *Trichoderma*, *Alternaria*, *Scopulariopsis* and *Ulocladium* (Table 2). According to results of the similar studies carried out in Turkey, the genera of fungus most identified were *Cladosporium*, *Penicillium*, *Alternaria* and *Aspergillus* respectively (Tikveşli 2013). In another study, *Alternaria*, *Cladosporium*, *Penicillium* and *Aspergillus* were the genera detected in an indoor environment (Kızılyaprak et al., 2007). In a study carried out by Gómez de Ana et al (2006) the genera most detected were *Cladosporium*, *Penicillium*, *Alternaria* and *Aspergillus*. In another study carried out by Li and Kuo (1992) in line with the findings of the current study, the genera of *Aspergillus*, *Penicillium* and *Cladosporium* revealed the highest concentrations. Although, the above mentioned genera were identified in the study at hand also, a difference was ascertained in the order of concentrations levels. However, similarly, the types most detected remained the same (Sarıca et al., 2002; Dassonville et al., 2008; Suerdem and Yildirim, 2009).

Throughout the study, the first of the three species most isolated was *A. fumigatus* at 25.8%, *A. flavus at 12.7%* and followed by *A. parasiticus* at 10% (Table 2 and Figure 1). *A. fumigatus* can give rise to the invasive pulmonary disorder called aspergillosis. It is for this reason that the last few years has witnessed an increase in the studies that focus on the effect on the human health of fungi at home and in the workplace (Aríngoli et al., 2008; Kilic et al., 2010).

In a study carried out on random individuals who suffered allergies with fungus spores, it was generally determined that particle size was above 5 µm whereas in delayed type allergies, the diameter of the spore was much smaller and that the conidia had descended to the depths of the lung. The *A. fumigatus* conidia clusters accumulate on the upper respiratory pathways and the diameter of the conidia is 2 and 3.5 µm. Fungi such as *A. glaucus* and *A. niger* that possess thorny conidia and fungi such as *A. terreus* and *A. fumigatus* that have conidia with a partially scabrous surface get stuck and accumulate in the respiratory system more easily. Of these conidia, those with a diameter of around 5 µm can reach the bronchus, those with a diameter of up to 1 µm can reach the entrance to the alveoli and those of 0.5 µm diameter can reach the alveolus. The fact that the conidia can travel so far is the reason for the significance of the extreme susceptibility in the delayed type (Kurup et al., 2000; Özyaral et al., 2006). Due to the fact that fungus structures reach the bronchi and even the alveolus, and accumulate in the tissues and survive for an unlimited period of time in humans due to the environment they live in, ensures that hypersensitivity ensues. Either the term “delayed type hypersensitivity pneumonitis” or “extrinsic allergic alveolitis” is used for this disorder (Eduard, 2006).

It is known that carpets accrue more dust than wooden floors. Studies show that carpets contain more allergens (Beguin and Nolard, 1999). A carpet is an important allergen reservoir (Tranter et al., 2009). Old and worn-out carpets can be a breeding ground for fungi (Roberts et al., 1999). Studies have proven the strong link between dust and disorder symptoms (Niemeier et al., 2006).

The species of fungus most isolated from the carpet of the New Mosque were *A. fumigatus and P. palitans* at 20%, the species most isolated from the walls of the New Mosque was *A. flavus* at 24.4% and the species most isolated from the prayer beads of the New Mosque was *A. parasiticus* at 18.6% (Table 3). The species most isolated from the Nuruosmaniye Mosque’s carpets was *A. fumigatus*, at a rate of 33.3%, *A. fumigatus*, at a rate of 21% from the walls and the highest concentration of isolated species at 50% of *A. fumigatus*, from the prayer beads (Table 4). In their study carried out in 2005, Hicks et al identified the *Aspergillus* and *Penicillium* genera to be the most commonly detected in carpet dust (Hicks et al., 2005). In another study carried out by Celtik et al. (2011) *Cladosporium*, *Penicillium*, *Alternaria* and *Aspergillus* were the genera most isolated in floor dust. The results of these studies are in line with the results of the current study.

Throughout the study, the New Mosque was the mosque that had the highest rate of isolated fungi at 52.1%. An evaluation of the fungus isolated from the New Mosque’s materials; walls, carpets and prayer beads, reveal that its walls had the highest value of fungi isolated at 19.5%. This was followed by its carpets at 18.4% and prayer beads at 14.2% (Table 2). The concentration of fungus isolated at the Nuruosmaniye Mosque was 47.9%. Among the materials sampled, the carpets revealed the highest rate of fungus isolation at 20.5%, followed by the walls at 20% and the prayer beads at 7.4% (Table 2).

The difference in fungus concentration at both stations may be attributed to the following factors: The presence of various plants and trees that might be a source of fungus, the limited number of windows which ensures insufficient ventilation and variations in the floor area of buildings (Tikveşli, 2013). On the other hand, the fact that visitor numbers were made up of from different cultures and concentrations, the hygiene awareness of those visiting and the cultural composition of the community surrounding the station can be thought to also be important factors.

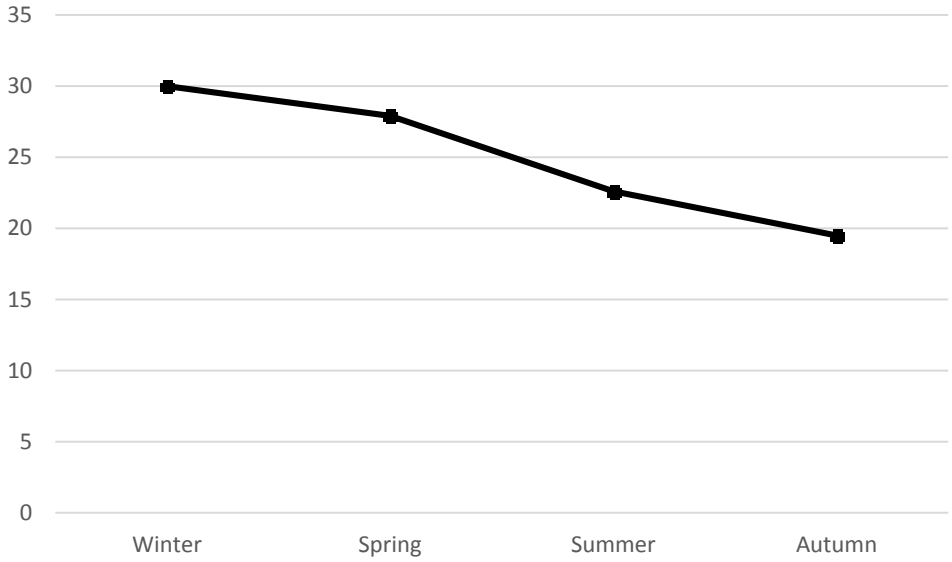

Figure 2. The percentage of fungi isolated from the New and Nuruosmaniye mosques throughout the study according to season.

Air-conditioning systems are an indoor source of fungi. Due to the fact that fungus spores can travel from an external to an internal environment ensures that there is a seasonal variation in spore concentrations. Throughout the study the highest level of fungus reproduction was observed in the winter season. Winter was followed in order by spring, summer and autumn (Figure 2).

The study observed that *Alternaria* and *Cladosporium* showed the highest level of isolation in January. In line with the current study the study carried out in Edirne (2013) detected that the concentration of the *Alternaria* genus was higher in an internal environment in the winter and summer. In addition to this, this study determined that the *Alternaria* genus was similar to the *Cladosporium* genus and that a positive moderate relationship was established between the two genera (Fang et al., 2005). In the above study the *Aspergillus* genus was most isolated in the month of April and the *Penicillium* genus witnessed the highest level of isolation in January. In line with the study at hand, a similar study carried out in Istanbul (2006) detected high levels of *Aspergillus* in the spring season and the Edirne (2013) and Istanbul (2006) studies detected very high concentrations of *Penicillium* during the winter season, particularly January (Çeter and Pınar, 2009; Fang et al., 2005). This indicates that climatic characteristics have an instrumental effect on fungi. Research carried out by Mota et al. (2008) determined that climatic and vegetation variations affected fungus concentrations.

As far as is known, a study either nationally or internationally that has researched the carpets, walls and prayer beads in terms of fungus species and concentration of two different mosques has yet to be encountered. All of the above factors being part of this study ensure that it is one of a kind. Despite the fact that such studies are few and far between in Turkey, they have nonetheless gained momentum in terms of becoming more varied over the last few years.

CONFLICT OF INTERESTS

No conflict of interest declared.

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