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Viable Airborne Fungi of Outdoor Environments of Yunusemre District, Manisa, Turkey

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Abstract

This research is on the viable air fungi was sampling during 12 months in the different points of Yunusemre. Fungal propagules were collected each month from eight isolation points. The concentrations of fungi were reported as cfu / m^3 of air. Fungal identification was made according to their micro and macro morphological characters through the literature. As a result, the average concentration of culturable fungi is 412 cfu / m^3 in Yunusemre air. 36 species in 9 genus were identified in this research. *Penicillium* is the most plenty genus that more than 33% of the all isolated fungi. *Cladosporium* was the preponderant fungal genus.

Keywords: Airborne fungi, bioaerosol, fungal allergy, outdoor air, Yunusemre.

1. Introduction

Atmospheric aerosol that particles of different sizes, shapes and origin in the outdoor and indoor air [1]. This particles classified as biological (fungal cells or spores, bacteria, viruses, pollens, protozoa and algae), chemical and physical [2]. Fungal particles (spores and cells) are generally common organisms in the air. They correlated with air pollution and some health effects on plants, animals and humans [3]. Fungi may cause great damages on historical artifacts because they have biodeteriogenic capacity of organic substances [4]. Also, airborne particles associated with an increased respiratory symptoms (wheezing, coughing, COPD and allergy) and decreased lung capacity [5].

In 1726, an asthma attack that caused by fungal particles reported [6]. Today, more than a hundred fungus are recognized as allergens [7], and they are involved with some human, animal and plant infections [8]. Many studies about fungal biodiversity in the air were carried out for determination of their effects on the humans [9].

Cells and spores of fungi are found in concentrations and varieties according as geographic location, the substrate type (inorganic / organic), climatic conditions of air, and isolation methods [2]. The dominant fungal genera in the air reported that *Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium* [3]. However, little known about the fungal biodiversity in Yunusemre district. Therefore, it is inevitable to survey on diversity of air fungi across different points in Yunusemre. Eight isolation points were selected for the study depending on different characters (agrarian, rural and urban) in Yunusemre. The main goal of this research were to determine that the diversity of viable fungi in the air of outdoor environments in Yunusemre.

2. Materials and Methods

2.1. Sampling Sites

Yunusemre (211.673 inhabitants) is in the Manisa city, west Turkey. The average altitude is 75 m. It has continental climate and the mean annual temperature is 17.025 ^{0}C, the mean annual relative humidity is 68.64 % and the mean annual rainfall is 730 kg/m^2. In January; the average temperature is 6.8 ^{0}C, and in July; the average temperature is 27.1 ^{0}C. The least rains takes place in the summer, and the most in winter. The snowy day's number is less than five per year. The prepotent wind direction is S or SE. Climatic data was supplied by the Meteorological Branch Office, Manisa. This research was conducted on eight sampling points in Yunusemre. The ostensible characters of the sampling points are given in Table 1.

Table 1. Some features of the selected sampling sites.

No	Name	Locality Coordinate	Altitude
1	Karakoca	38°33'26.65"N / 27°19'52.38"E	467 m
2	Keçiliköy	38°36'23.56"N / 27°22'06.71"E	149 m
3	YSE Square	38°36'56.65"N / 27°24'12.21"E	72 m
4	Bozköy	38°36'39.71"N / 27°23'23.35"E	112 m
5	Ingolstadt Avenue	38°37'32.42"N / 27°23'04.72"E	67 m

6	Horozköy	38°38'06.07"N / 27°23'38.79"E	47 m
7	Muradiye	38°39'11.38"N / 27°19'59.17"E	33 m
8	Osmancalı	38°45'43.58"N / 27°15'06.56"E	298 m

2.2. Sampling, Isolation and Identification

Air samples were collected from the eight isolation points between January and December monthly, using gravimetric method [10]. Samples were taken when the weather was dry and stable at the between 08.00 – 10.00. Fungal particles were collected in five Petri dishes containing RBCA (Rosebengal Chloramphenicol Agar) were open to air for 20 min in all isolation points. Totally, 480 samples were taken during the study. Incubation temperature of the Petri dishes was 27^0C, and examined throughout seven-ten days for counting of fungal colonies [11]. The cfu / m^3 of air was calculated according to Omelyansky formula [12];

$N = 5a \times 10^4 (bt)^{-1}$ [N is the fungal concentration; a is the fungal colony number per Petri; b is the area of plate (cm^2); and t is the open time of Petri (min)]

Identification of fungal colonies by using MEA (Malt Extract Agar), PDA (Potato Dextrose Agar), CZ (Czapek Dox Agar), CYA (Czapek Yeast Agar) and G25N (Glycerol Nitrate Agar) and incubated at 27 ^{0}C for 7-10 days, after that diameters of colonies were measured. The stereomicroscope and a high resolution light microscope used to for determine that the colonial and morphological characters [13]. Species level identification of isolated fungi were done according to different mycological references [14-17]. All fungal isolates save in Manisa Celal Bayar University, Biology Department.

3. Results and Discussion

All fungi isolated in eight sampling points in Yunusemre air are listed in the Table 2. 480 samples were collected by gravimetric method during the one year. Totally, 9628 colonies were counted and the fungal isolates showed 9 genera and 36 species from the air. Also the average concentration of airborne culturable fungi is 412 cfu / m^3 in Yunusemre.

As a results, the commonly prevalent genus was *Cladosporium* (Table 2). The preponderant fungus was *Cladosporium herbarum*. *Penicillium* species were more than 33% of the total isolated fungal species (Table 2). Other genera (*Rhizopus*, *Trichoderma*, *Fusarium*, *Mucor* and *Cunninghamella*) were found in according to references [5, 9-11]. In October, September and November; high fungal propagules densities were observed (570, 505 and 460 cfu / m^3, respectively). The months in which least fungi were observed were January, April and March (140, 210 and 290 cfu / m^3, respectively) (Figure 1).

Many of fungi found in this research are known to may cause allergy. Examples are *Alternaria alternata*, *Cladosporium herbarum*, *C. cladosporoides*, *C. sphaerospermum*, *Aspergillus flavus*, *A. fumigatus*, *A. niger* var. *niger*, *Mucor racemosus*, *Penicillium brevicompactum*, *P. chrysogenum*, *P. citrinum* and *P. expansum* [10, 11] (Table 2). Tilak [18], related the % 2-30 of the respiratory allergies to fungal spores. He also reported *Alternaria* and *Cladosporium* species to be the most allergy causing fungi. Also, some fungi that found in this research are known to produce mycotoxins. These are *Alternaria alternate*, *A. tenuissima*, *Aspergillus flavus*, *A. fumigatus*, *A. niger* var. *niger*, *A. parasiticus*, *A. terreus*, *A. versicolor*, *Fusarium equiseti*, *F. oxysporum*, *Penicillium brevicompactum*, *P. chrysogenum*, *P. citrinum*, *P. expansum* and *P. viridicatum* [19,20]. This study has shown that fungi which can cause the respiratory system diseases and produce mycotoxins were encountered frequently in the sampling areas.

4. Conclusion

Aeromycological studies are important to understand the diversity of fungi by air, their distribution, and to derive strategies for to control fungal diseases [21]. This research is the first study in Yunusemre air. In this work, we identified 36 fungus species in the sampling air.

Yunusemre has suitable habitat for diversity of fungi according to its climatic conditions. As a result, a high percentage of fungal particles in air may cause allergy [11] and asthma [10]. Isolating and identifying of fungi will be a useful contribution to the community health departments. Details of the diversity of them in the different areas may be of assistance for the treatment of allergic diseases.

Table 2. Fungal species and sampling sites.

Sampling Sites	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
**Alternaria alternata* (Fr.) Keissl.	+	+			+	+	+	+
A. brassicicola (Schwein.) Wiltshire	+	+	+	+				+
A. tenuissima (Kunze) Wiltshire		+	+	+		+		
**Aspergillus flavus* Link		+		+	+	+		+
**A. fumigatus* Fresen.		+	+	+	+			

A. glaucus (L.) Link	+	+	+			+	+	
**A. niger var. niger* Tiegh.	+	+		+	+	+		+
A. parasiticus Speare	+	+		+			+	
A. rubrobrunneus Samson & W. Gams	+	+	+	+		+		
A. terreus Thom			+	+		+	+	
A. versicolor (Vuill.) Tirab	+			+		+		+
A. wentii Wehmer	+		+	+		+		
Cladosporium cladosporioides Fresen.	+	+	+		+	+	+	+
**C. herbarum* (Pers.) Link	+	+	+	+	+	+	+	+
**C. oxysporum* Berk. & M.A. Curtis	+	+	+		+	+		+
**C. sphaerospermum* Penz.	+	+		+	+		+	
Cunninghamella echinulata Thaxt.			+			+		+
Fusarium equiseti (Corda) Sacc.			+		+			
F.oxysporum Schltdl.				+	+		+	
**Mucor racemosus* Fresen.	+		+			+	+	
**Penicillium brevicompactum* Dierckx		+						
**P. chrysogenum* Thom	+		+		+			+
**P. citrinum* Thom		+	+	+		+	+	
P. digitatum (Pers.) Sacc.	+				+	+	+	+
**P. expansum* Link	+		+	+				+
P. funiculosum Thom	+		+	+			+	
P. glabrum Wehmer	+				+			+
P. italicum Wehmer	+		+				+	
P. lanosum Westling	+	+	+					
P. purpurogenum Stoll				+	+	+	+	
P. verruculosum Dierckx	+	+	+				+	+
P. viridicatum Westling		+	+	+				+
Rhizopus oryzae Went & Prins		+	+		+			+
R. stolonifer var. stolonifer Ehrenb.			+			+	+	
Trichoderma hamatum Bonord.	+	+		+			+	
T. viride Pers.		+			+			+

**known as allergen*

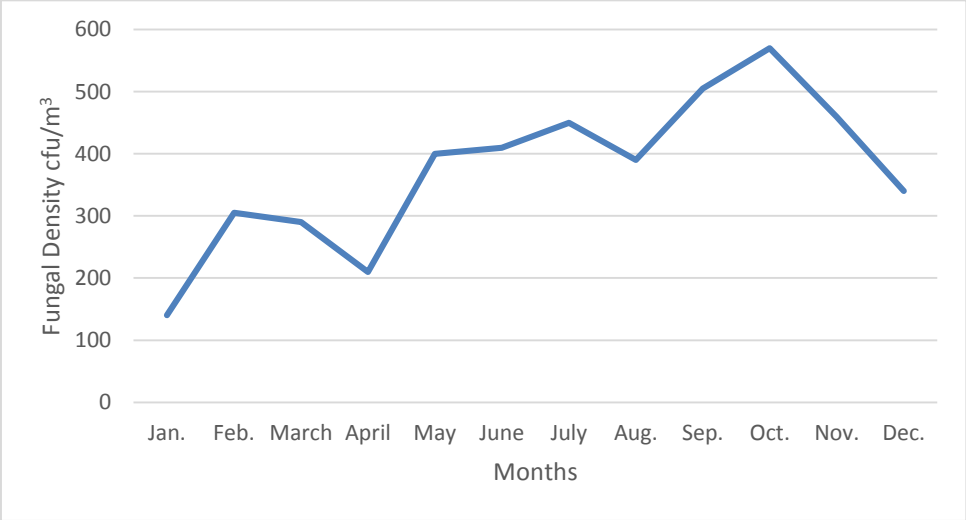

Fig. 1. Fungal spore densities by months.

Ethics

There are no ethical issues after the publication of this manuscript.

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