



Original Research Article

Determination of Microfungal Contamination on Automated Teller Machines and Bank Cards in Marmaris, Turkey

Vedat Kadir Özkan

Muğla Sıtkı Koçman University, Health Services Vocational School, 48700 Marmaris, Muğla, Turkey

*Corresponding Author: Vedat Kadir Özkan, Muğla Sıtkı Koçman University, Health Services Vocational School, 48700 Marmaris, Muğla, Turkey

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ABSTRACT

The aim of this study was to determine the microfungal contamination on automated teller machines (ATMs) and bank cards. In order to determine the contamination, a total of 60 samples including 30 samples from the ATMs and 30 samples from the bank cards were collected. The samples were taken by using moistened swap sticks on the ATM keypads and screens and from the back and front sides of the bank cards. 30 different microfungal species were obtained belonging to *Acremonium*, *Alternaria*, *Aspergillus*, *Cladophialophora*, *Cladosporium*, *Cunninghamella*, *Curvularia*, *Drechslera*, *Fusarium*, *Geotrichum*, *Penicillium*, *Rhizopus*, *Scopulariopsis* and *Trichoderma* genera. *Aspergillus* species was found to be dominant qualitatively and it was followed by *Alternaria*, *Cladosporium* and *Penicillium* genera. *Aspergillus* has also been obtained at high frequency quantitatively and it was followed by *Alternaria*, *Cladosporium*, *Scopulariopsis*, *Drechslera* and *Penicillium* genera. *Cladosporium cladosporoides* and *Scopulariopsis candida* are ranked first in terms of the number of colonies and they were followed by *Aspergillus niger*, *Curvularia lunata*, *Alternaria tenuissima* and *Drechslera* sp species. It was found that the ATMs were more contaminated than the bank cards in terms of microfungal contamination.

Keyword: Automated teller machines; bank card; microfungi; microfungal contamination

INTRODUCTION

Microfungi form a significant part of bioaerosol in the atmosphere. The tools, articles and surface can be easily contaminated by microfungi which can be found everywhere

since they are cosmopolitan organisms and they can be easily spread by the atmospheric movements. Fungal spores which are one of the significant causes of skin and respiratory

diseases, may range from 20.000 to 2 million spores/m³ in the air [1]. One of the bioallergens causing hypersensitivity pneumonitis is fungus and most of its species are described as the main reason of type-1 allergy. Additionally, fungi causing IgE sensitivity is closely related with allergic respiratory diseases, especially asthma [2,3]. The mold affect the human health in three specific mechanisms; harmful immune response, direct infection by the organisms and the effect of toxic-irritants they produce [4]. They can be transported from the contaminated surfaces and items to the humans by direct contact and then they are transported to the other people and items. People who do not pay attention to hygiene is an important factor as well as the atmospheric movements and the other carriers in the spread of microfungi. ATMs (automated teller machines) and bank cards are widely used by a great number of people everyday. Many operations are performed on ATMs without going to the banks. The screen and keys of the ATMs are contaminated by the atmosphere, unclean bank cards and human hands. Unless they are disinfected in accordance with the hygiene rules, they may be one of the major source of infection. Any kind of human infections can be transmitted to other people who touch the screen and keypads, and can be a threat to the health of society. Therefore, the cleaning of commonly used ATMs and the determination of the biological factors that contaminate them is important for public health. As a result of a literature survey, three related studies on the subject were encountered in Turkey [5-7] and other countries [8-10]. Studies except for İmalı et al. [6] are more focused on bacterial contamination.

As being the one of the important tourism and holiday resorts of the world and Turkey, a lot of foreign and domestic tourists come to Marmaris. Considering this feature of Marmaris the importance of this subject become much

more greater since the infections from the other cities and countries can be transmitted here or the infections here can be transmitted to other cities and countries. This research, which emerged in the light of these considerations, aims to determine the contamination of ATMs and the ATM users' bank cards in Marmaris.

MATERIALS AND METHODS

Sampling

In this study, a total of 60 samples from 30 ATMs and 30 bank cards belong to ten different banks were collected. The samples were taken by using moistened swap sticks on the ATM keypads and screens and from the back and front sides of the bank cards [5,6,8-12]. Samples were transferred to petri dishes containing rose bengal chloramphenicol agar (RbCA) by using surface spreading technique. Sampling was done in July which is the busiest month for domestic and foreign visitors.

Incubation and identification

Sampling petri dishes were left for incubation at 27°C for two weeks. The emerging microfungi colonies were counted and they were transferred to tubes containing Potato Dextrose Agar (PDA) and incubated for two weeks. After incubation, from each tube, petri dishes containing Malt Extract Agar (MEA) and Czapek Dox Agar (CzDA), inoculation was performed with diagnostic purpose. After two weeks incubation at 27 °C, growing microfungi colonies were identified for morphological and microscopic features by analyzing the relevant reference [13-16].

RESULTS AND DISCUSSION

In this research, 30 microfungial species belonging to 14 genera microfungus from the ATMs and the bank card were obtained. Microfungi types of qualitative and quantitative distribution are given in Table 1, microfungial distribution of species are given in Table 2.

Aspergillus, which is the most dominant species qualitatively, is followed by *Alternaria*, *Cladosporium* and *Penicillium* genera (Table 1). Considering the colony numbers, *Aspergillus* has again formed the maximum colonies and it was followed by *Alternaria*, *Cladosporium*, *Scopulariopsis*, *Drechslera* and *Penicillium* genera (Table 2). Maximum colonies among microfungi species were formed by *Cladosporium cladosporioides* and *Scopulariopsis candida*, these were followed by *Aspergillus niger*, *Curvularia lunata*, *Alternaria tenuissima* and *Drechslera sp* species (Table 1). The microfungi which are dominant in this research are widespread in nature because they produce too much spores, they have wide ecological tolerance and they can easily spread through the atmosphere, and they can contaminate almost any kind of surface [1,6,11-14,17,18]. These findings indicate compliance with the specified reference.

In studies in Turkey, fungi belonging to *Acremonium*, *Amblyosporium*, *Botrytis*, *Corynascus*, *Penicillium* and *Scopulariopsis* genera were isolated by İmalı et al. [6] and Türk et al. [5] described the fungi they obtained was identified only as yeasts and moulds. Tekerekoğlu et al. [7] investigated the bacterial contamination on ATMs. In this study, a total of 30 species of microfungi belonging to 14 genera in ATMs and bank cards have been identified (Table 1). According to studies conducted by İmalı et al. [6], obtained more microfungi quantitatively and qualitatively in this study. This may be because of different geographical and climatological factors and the number of users and user diversity. The research results was not compared to Türk et al. [5] because of having no identification done on genus and species level. Mabel et al. [9] obtained *Mucor*, *Penicillium* and *Aspergillus* genera from ATMs, but no identification done on species level. The indicated fungal genera *Penicillium* and *Aspergillus* were also obtained from this research.

Microfungal species obtained from this study, *Acremonium strictum*, *Aspergillus versicolor*, *Cladosporium herbarum* and *C. sphaerospermum* were isolated only from the bank cards; *Alternaria alternata*, *Aspergillus flavus*, *A. niger*, *A. terreus* and *Cladosporium cladosporioides* were obtained both from the ATMs and bank cards; other microfungi species were isolated only from ATMs (Table 1). Microfungal contamination on ATMs was found at a much higher frequency when it is compared to the bank cards. This can be explained by the situation of ATMs which are open to the atmosphere (without being in a cabin) and are cleaned rarely. Also, it is believed that maintaining bank cards in many different ways and having them cleaned occasionally reduce the microfungal contamination on them.

Acremonium species are found as saprophytes in dead plant materials and soil. However, *A. strictum* which is defined as opportunistic pathogens in humans and animals can cause mycetoma, mycotic keratitis and onychomycosis [16]. This fungus was isolated from only bank cards (Table 1).

Alternaria species are mostly plant parasites and their most common species are *A. alternata*. *Alternaria* species usually cause mycotic keratitis even if they appear as a saprophyte contaminants [16]. In this study, the number of *Alternaria* species were obtained more on ATMs than the bank cards (Table 1).

Aspergillus species are commonly found in warmer climates soil, compost, putrescent plant materials and stored grain [13]. *A. fumigatus* show pathogenicity in humans and animals and they are occasionally isolated from the human ear and eye sockets. It rarely causes lung and bladder infections and endocarditis. It also produces mitotoxin [13,16]. *Aspergillus* species of *A. fumigatus*, *A. flavus* and *A. niger* infect humans. In addition *A. nidulans*, *A. terreus* and *A. quadrilineatus* species can make less frequent infection in humans [19]. In this

study, the specified types of *A. flavus*, *A. niger* and *A. terreus* were isolated from both bank cards and ATMs (Table 1).

Cladophialophora bantiana is described as cerebral phaeohyphomycosis agent and it is

often isolated from soil . This fungus is neurotropic and can cause brain abscess [16]. In this study was obtained only from ATMs.

Table 1: Qualitative and quantitative distributions of microfungi on ATMs and bank cards

Microfungal Species	ATM	Bank Card	Colony Number
<i>Acremonium strictum</i> W.Gams	-	2	2
<i>Alternaria alternata</i> (Fr.) Keissler	4	1	5
<i>Alternaria brassicicola</i> (Schwein.) Wilts.	5	-	5
<i>Alternaria citri</i> (Penz.) Mussat	4	-	4
<i>Alternaria tenuissima</i> (Kunze ex Pers.) Wilts.	7	-	7
<i>Aspergillus carbonarius</i> (Bainier) Thom	2	-	2
<i>Aspergillus flavus</i> Link ex Gray	1	2	3
<i>Aspergillus foetidus</i> var. <i>pallidus</i> Naka.Simo & Wat.	3	-	3
<i>Aspergillus niger</i> van Tieghem	7	2	9
<i>Aspergillus parasiticus</i> Speare	5	-	5
<i>Aspergillus sclerotiorum</i> Huber	1	-	1
<i>Aspergillus terreus</i> Thom	1	1	2
<i>Aspergillus versicolor</i> (Vuill.) Tiraboschi	-	2	2
<i>Cladophialophora bantiana</i> (Saccardo) de Hoog et al.	4	-	4
<i>Cladosporium cladosporioides</i> (Fresen.) Viries	7	3	10
<i>Cladosporium herbarum</i> (Pers.) Link ex Gray	-	2	2
<i>Cladosporium sphaerospermum</i> Penz.	-	1	1
<i>Cunninghamella elegans</i> Lendner	2	-	2
<i>Curvularia lunata</i> (Wakker) Boedijn	9	-	9
<i>Drechslera biseptata</i> (Sacc.) Richardson & Fraser	3	-	3
<i>Drechslera</i> Ito sp.	7	-	7
<i>Fusarium oxysporum</i> Schlecht.	5	-	5
<i>Geotrichum candidum</i> Link	1	-	1
<i>Penicillium lanosum</i> Westling	5	-	5
<i>Penicillium restrictum</i> Gilman ex Abbott	3	-	3
<i>Penicillium verruculosum</i> Peyronel	1	-	1
<i>Rhizopus stolonifer</i> var. <i>stolonifer</i> (Ehrenb.) Vuill.	1	-	1
<i>Scopulariopsis brevicaulis</i> (Sacc.) Bain.	1	-	1
<i>Scopulariopsis candida</i> (Guég.) Vuill	10	-	10
<i>Trichoderma viride</i> Pers. ex Gray	1	-	1
Total colony number	100	16	116

Table 2: Qualitative and quantitative distributions of microfungal genera on ATMs and bank cards

Microfungal Genera	ATM	Bank Card	Colony Number
<i>Acremonium</i>	-	2	2
<i>Alternaria</i>	20	1	21
<i>Aspergillus</i>	20	7	27
<i>Cladophialophora</i>	4	-	4
<i>Cladosporium</i>	7	6	13
<i>Cunninghamella</i>	2	-	2
<i>Curvularia</i>	9	-	9
<i>Drechslera</i>	10	-	10
<i>Fusarium</i>	5	-	5
<i>Geotrichum</i>	1	-	1
<i>Penicillium</i>	9	-	9
<i>Rhizopus</i>	1	-	1
<i>Scopulariopsis</i>	11	-	11
<i>Trichoderma</i>	1	-	1
Total colony numbers	100	16	116

Cladosporium species show a world-wide distribution and they are the most common airborne fungi. They are isolated at high frequency as contaminants. Pathogenic species belonging to *Cladosporium* have been transferred to *Cladophialophora* genus [16]. *C. cladosporioides* was found with *Phialophora verrucosa* in a corneal case. Fungus ball formation in the human lung was also mentioned as *C. cladosporioides*. *C. sphaerospermum* species are sometimes isolated from humans and animals [13]. *Cladosporium* species in this study were isolated from both ATMs and bank cards.

Cunninghamella species are soil fungi which are mainly in mediterranean and subtropical zones. *C. bertholletiae* indicates pathogenicity on people and animals. This usually occurs with trauma and immune suppression. *C. elegans* is given as the synonym of *C. bertholletiae* [13,16]. *C. elegans* was only obtained from ATMs. *Curvularia* species are mostly subtropical and tropical plant parasites. However, that *C.lunata*,

C. pallescens and *C. geniculata* species which can be found everywhere were obtained from human infections including primarily mycotic keratitis [16]. In this study, *C. lunata* was only isolated from ATMs.

Drechslera species are often isolated from plants, soil and atmosphere [14]. The fungi which was isolated from diseased humans and animals were presently claimed as *Helminthosporium* or *Drechslera* and it was concluded that the fungi originally belonging to *Bipolaris* and *Exserohilum* genera [16]. *Drechslera* in this study were obtained from ATMs only.

The majority of *Fusarium* species which demonstrate a worldwide distribution is mostly soil fungus. A few species, especially *F. oxysporum*, *F. solani* and *F. moniliforme* has been identified as pathogens in humans and animals which cause hyalohyphomycosis, mycotic keratitis and onychomycosis. Some species produce mitotoxin [16,19,20]. In this

study, *F. oxysporum* was only isolated from ATMs.

Geotrichum candida shows a world-wide distribution. Pulmonary involvement is the most frequently reported form of the diseases but bronchial, oral, vaginal, cutaneous and alimentary infections have also been noted [16]. *G. candidum* was only obtained from ATMs in this study.

Penicillium species are common contaminants on various substrates and are known as potential mycotoxin producers. Human pathogenic species are rare; however, opportunistic infections leading to mycotic keratitis, otomycosis and endocarditis have been reported. By its spores and components in atmosphere entering from respiratory tract affect the human health and may cause allergic reactions [16,19]. The *Penicillium* species in this study were obtained from the ATMs.

Rhizopus species is one of the factors of opportunistic fungal infection. They can cause skin and mucous membranes allergies [19,20]. *R. stolonifer* var. *stolonifer* was only obtained from ATMs.

Scopulariopsis species are mostly found in soil. However, it is stated that some species especially *S. brevicaulis* is the commonest species of its genus and has a worldwide distribution. It may cause deep-seated gummosis ulcers, skin affections and commonly onychomycosis and hyalohyphomycosis [13,16]. The species of *Scopulariopsis* in this study were isolated from the ATMs.

Trichoderma is a very common genus particularly in soil and decaying wood. *T. viride* attacks to hair keratin by boring hyphae [13,16]. *T. viride* was only obtained from ATMs.

In this research, the isolation of microfungi producing mycotoxin which can cause allergic diseases and various mycoses in humans reveals the importance of complying with environmental and personal hygiene. Frequently used dirty tools and objects of daily life, such as ATMs and bank cards can bring

them into the source of infection and may pose a risk to public health. Pathogenic contaminants moved by people may cause an epidemic or even pandemic. This gains more importance in tourism and resort cities like Marmaris which is visited by several million people each year. Therefore, the common tools and goods used by people must be cleaned necessarily for not being a source of infection. Because visitors can bring any infection and can lead the infection spread everywhere they contact.

CONCLUSION

Consequently, in terms of microfungi contamination ATMs were more dirty than the bank cards. ATMs and bank cards which are used by many people must be cleaned frequently with appropriate disinfectant for not being the source of infection. By putting ATMs established anywhere outside bank offices in cabins will reduce the microfungi contamination. Such technological tools which are used by a large part of the population should be cleaned carefully to supply personal and environmental hygiene to not take the risk of causing epidemics or pandemics. The promotion of such research in order to protect the public health and to control the fungal disease is becoming a necessity. It is expected that this study will provide benefits to other studies and serve as a resource.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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