

## FUNGAL CONTAMINATION OF AIRCONDITIONER UNITS IN FIVE HOSPITALS OF ERBIL PROVINCE- KURDISTAN REGION /IRAQ

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### ABSTRACT:

During April 2018, 75 samples were collected from five hospitals in Erbil city. Samples were taken by sterile cotton swabs from the air dispenser window of air conditioner units (ACU). They were cultured directly on Sabouraud's dextrose agar incubated at 25° C ±2. The samples were collected from five departments in each hospital including out-patient ward (OP), in-patient ward (IP), emergency room (ER), intensive care unit (ICU), and operation theater (OT) A total of (410) fungal colonies were counted. They belong to 13 genera include ten hyphomycetes and only one of zygomycetes, basidiomycetes, and hemiascomycetes. *Penicillium* represented in the highest total occurrence (40%) followed by *Aspergillus* (38.66%) and *Alternaria* (21.33%). The total frequency showed that *Candida* was the highest (30%) followed by *Penicillium* (27.56%) and *Aspergillus* (13.17%). The highest density of filamentous fungi (no. of colony/sample) was detected in OP=16.75, and the lowest in OT=1.5. The diversity of isolates showed that (9) genera were recorded from ER(60%) and only one in OP (6%). All recorded genera in current study were regarded as indoor air pollutants. The predominant genera *Alternaria*, *Aspergillus*, *Penicillium*, *Cladosporium* and *Candida* are well-known allergens and may cause several pulmonary disorders as well as fetal infections in particular cases.

**KEYWORDS:** fungi, air-conditioner, hospital, asthma, allergy

### 1. INTRODUCTION

Air conditioner units (ACU) have an effective role in buildings air quality whereas the contaminated equipments swell out indoor bio aerosol pollutants particularly airborne fungi (Aligbe et al., 2016; Gniadek & Macura, 2011). Hazards of such biotic pollutants are more serious in hospital environment than in other buildings (Kelkar & Kulkarni, 2011) and the long stay in the hospital increase the risk (Khan & Karuppaiyil, 2011). Most of airborne fungi which contaminate hospital environment regard as agents of significant respiratory infections (Kelkar, Bal, & Kulkarni, 2005; Perdelli et al., 2006) and they may be related to sick building syndromes SBS (Pati, 2018). Early work by Arnow in 1978 showed the relation between *Aspergillus fumigatus* colonize ventilation system and aspergillosis (Arnow & Andersen et al., 1978). Nowadays, fungal contamination of buildings environment via (ACU) are widely discussed, and they are used as indicator for indoor air quality (Gniadek & Macura, 2011; GRBIĆ, VUKOJEVIĆ, et al., 2008; Cabral, 2010). Among several clinical departments, OT acquired the highest interest in studying microbial air pollutants (Kelkar, Bal, and Kulkarni, 2005; Yau, Chandrasegaran, and Badarudin, 2011).

The aims of the present study are: (1) Isolation and identification of fungi contaminated air conditioner units in five wards of five governmental hospitals in Erbil city. (2) Analyzing the fungal community structure. (3) Raising awareness of health hazards of (AC) as a source of contamination.

### 2. MATERIALS AND METHODS

#### 2.1 Sample collection

During April 2018, a (75) samples were collected from five governmental hospitals in Erbil city. All samples were taken by sterile moistened swabs from air dispenser window of split type

air condition units. The cotton swabs were pressed on the plastic sweepers in 10 deferent points for each air-conditioner (AC). Samples were collected (9 pm) after (12) hours continuous operation of the device. They were collected from emergency room (ER), patients ward (PW), laboratory (L) intensive care unit (IC) and operation theater (OT).

#### 2.2 Culturing and identification

Samples were cultured directly on Sabouraud's dextrose agar (SDA) with 150mg/L chloramphenicol, the cotton swabs were slightly press of on SDA surface, triplicate were prepared to each sample. Petri-dishes (90 mm) were incubated in 25° C ±2, and the plates were examined regularly from the fourth day until fourteenth. The mean of colony forming units (CFUs) in triplicate/sample were calculated, and fungal genera were identified based on morphological characteristics (Domsch, Gams, and Anderson, 1980; De Hoog, Guarro, et al., 2000).

#### 2.3 Fungal community

The total occurrence, the total frequency, and the prominence value (P.V.) of isolated fungi were calculated as in (Al-Bader, Ahmood, Majeed, Al-Hamdani, 2013):

TO% = (No. of times fungal appear \*100) / No. of collected samples

TF% = (No of fungal isolates \*100) / No. of total fungal isolates

$$P.V. = \sqrt{F} \times O \quad (F: \text{frequency}) \quad (O: \text{occurrence})$$

### 3. RESULTS

Among the (75) tested samples, (73) gave a positive result (97,3%), and the number of (colonies/plate) ranged from (0-59). A total of (410) CFU were counted, they belong to (10) genera hyphomycetes (76%) and single genus (7.6%) to each of zygomycetes, basidiomycetes, and hemiascomycetes (table-1). *Candida* and *Rhodotorula* the only yeasts developed from samples, the rest isolates were filamentous. Table-1/ Total

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occurrence (TO), total frequency (TF), and prominence value (PV) of fungal isolates in the five hospitals.

Table 1. Total occurrence (TO), total frequency(TF), and prominence value (PV) of fungal isolates in the five hospitals

	Fungal genera	O	O%	TC	F%	PV
1	<i>Acremonium</i>	2	2.67	2	0.49	3.77
2	<i>Alternaria</i>	16	21.33	35	8.45	94.95
3	<i>Aspergillus</i>	28	38.6	54	13.17	205.75
4	<i>Candida</i>	16	21.33	123	30.00	177.44
5	<i>Cladosporium</i>	11	14.67	11	2.68	36.48
6	<i>Drechslera</i>	1	1.33	25	6.10	5.00
7	<i>Mucor</i>	1	1.33	1	0.24	1.00
8	<i>Paecilomyces</i>	5	6.67	12	2.93	17.32
9	<i>Penicillium</i>	30	40.00	113	27.56	318.90
10	<i>Pithomyces</i>	3	4.00	3	0.73	5.19
11	<i>Rhodotorula</i>	2	2.67	17	4.15	8.24
12	Sterile mycelia(B&W)	8	10.6	4	0.97	16.00
13	<i>Trichoderma</i>	2	2.67	2	0.48	3.77
14	<i>Ulocadium</i>	2	2.67	8	1.95	3.77
	<b>Total no.</b>	127		410		

*Penicillium* had the highest O% (40%) followed by *Aspergillus* and *Alternaria*(38.66%, 21.33%) respectively. *Cladosporium* and sterile mycelia with moderate level, and the rest genera showed low O% (table-1).

The F% of isolated genera (table-1) indicted *Candida* and *Penicillium* with the highest level followed by *Aspergillus* (40%, 27.56%, 13.17%) respectively, while the rest have low F%.

Prominence value showed that *Penicillium*, *Aspergillus*, *Candida*, *Alternaria*, and *Cladosporium* had high values (table-1)

The relative density RD (CFU/plate) for only the filamentous fungal isolates showed a large diversity among hospital departments (table -2). Out-patient wards had the highest number (16.75/plate), while the lowest number was recorded in OT (1.5/plate). On the other hand, the number of recognized filamentous genera in each department were listed as (relative diversity RV), are ranged from nine in ER department to only single genus (*Cladosporium*) in OT (table-2).

Table 2. Relative density (RD), and relative diversity (RV) of filamentous fungi in five hospitals (out patient =OP) (emergency room=ER)(inpatient ward=IP)(intensive care=IC) (operation theater=OT).

	R D	R V
OP	16.75=(18)	7
ER	8.4=(8)	9
IP	4.08=(4)	5
IC	2.6=(3)	3
OT	1.5=(2)	1

#### 4. DISCUSSION

During the previous years there was a clear increase in cases of health care associated infections (HAIS). It is well known that fungi are involved agents of these diseases (CDC-Hospitalized Patients and Fungal Infections). The high ratio of positive samples (97.3%) agree with several previous studies it was affected by different factors include time of collection, type of sample and location. It was (38%) in wet cooling system in Iran (Mosayebi and Eslamirad, et al, 2017) while it (96%) air samples of OP in Poland (Gniadek and Macura, 2011). The isolated fungi from (AC) in the current study are common as outdoor airborne (Ramddn and Salih, 2010; Al-Bader, 1992) and their relation with respiratory infections is quietly known (Al-Bader, Ahmood, Majeed, and Al-Hamdani, 2013; Curtis,

Liberman, Stark, and Veter, 2004). *Penicillium*, *Aspergillus*, *Candida*, *Alternaria*, and *Cladosporium* had highest (PV) in tested samples, in addition to *Mucor* and *Trichoderma* among the most common indoor airborne fungi (Kurup, Der Shen, and Banerjee, 2000). Breathing their spores or vegetative structures cause hazardous effects to human respiratory system (Curtis L, Liberman, Stark, and Veter, 2004; Visagie, Houbraken, 2014). The recorded genera with high PV in this study were documented as allergies and cause several hygienic disorders:

*Penicillium*: The genus include (354) accepted species (Visagie, Houbraken, 2014; Samson, Uztan, et al., 2017): it is an aero-allergen contaminated hospital environments, and had been commonly isolated from (AC) (GRBIĆ, VUKOJEVIĆ, et al, 2008; Gniadek, and Macura, 2011; Samson and Uztan, et al., 2017; Claudia and de Menezes, et al., 2004). A (16) species produce different types of mycotoxins which in cooperate with polypeptides in getting asthma and rhinitis (Curtis, Liberman, Stark, and Veter, 2004) [20]. The high occurrence and frequency of *Penicillium* in current study indicate its hygienic impact in hospital environment.

*Aspergillus*: A cosmopolitant, highly active genus, develop on many substrates in different environments. At least 10 species from 250 related to *Aspergillus* are mycotoxin producers [20]. In the current study, we recorded five common species which were reported as factors of respiratory allergy. *Aspergillus* is predominant in outdoor and indoor air samples, and it was documented as the highest occurrence in hospitals environment (Gniadek, and Macura, 2011; Caggiano and Napoli et al., 2014; Klich, 2006). Several species are a common cause of human pulmonary disorders due to mycotoxins and other chemicals which were produced by *Aspergilli* (Klich, 2006; Castillo et al, 2016). The xerophile and the wide temperature range of growth of *Aspergillus* support fungus to be one of the most serious indoor air fungi.

*Alternaria*: A dematiaceous hyphomycetes has 40-50 species commonly isolated from plants, soil, and indoor air. The most frequent species *A.alternata* develop in humid indoor environment. Its spores and mycelia produce allergen agents (mycotoxins) that cause rhinitis and asthma (Sara and Tereza, et al., 2001).

*Candida*: An ascomycetous, normal flora yeast that produce airborne spores as blasto conidia, it occur in indoor air samples of particular environments (Wang et al, 2007). The genus is among the most frequent airborne fungi in hospital environment (Awosika, Olajubu, and Amusa, 2012), and there is an early document explain its relation with chronic asthma and rhinitis (Allergy, 1987; Cordeiro, Raimunda, Brilhantel, Pantoga, Renato, and Filho et al., 2010).

*Cladosporium*: A dematiaceous, common airborne, and surface plant associated hyphomycetes. As *Aspergillus* and *Alternaria*, it is rarely devoid of aerobiological studies. The genus is one of the predominant isolates in hospitals (GRBIĆ and VUKOJEVIĆ et al., 2008). Its health disorders were widely documented as well as the toxicity hazard (Curtis, Liberman, Stark, and Veter, 2004; Khan and Karuppayil, 2012).

*Paecilomyces*: A hyaline hyphomycetes occur commonly as indoor airborne, it was documented in hospital environment as well as other indoor air samples (Khan and Karuppayil, 2012; Airaudi and Marchisio, 1996). Beside the hyalohyphomycosis, *Paecilomyces* is an accidental agent of several types of respiratory diseases (Strelyaeva, Svistunov, Dzhomaa, and Sapozhnikov et al., 2015).

*Rhodotorula*: The Basidiomycetous yeast is a member of normal flora on human skin, and can easily be isolated from soil, water, and food. Even though it was documented as one of indoor air pollutants (Khan and Karuppayil, 2012), but its risk on respiratory system was either unrecorded or rare (Twaroch, Curin, Valenta, and Swoboda, 2015; Hasanin, Fatima, Al-Frayh, Al-Sedairy, 2005).

*Drechslera*, *Pithomyces*, and *Ulocladium*: A dematiaceous, hyphomycetes were mostly recorded in immune compromised patients. They are an aerobiological indoor pollutants, and consider as rare pulmonary allergens (Cordeiro, Raimunda, Brilhante, Pantoga, Renato, and Filho et al., 2010; Khan, Haleem, Mohan, and Karuppaiyil, 2012). A skin prick test of several asthma and allergy patients showed positive results related to *Drechslera* and *Ulocladium* allergens (Menezes E A, Gambale, Macedo, Castro, Paula, and Croce, 1998; Polizzi, Adams, Picco, Adriaens, Lenoir, Peteghem, De Saeger, and De Kimpe, 2011; Perdomo, Sutton, García, Fothergill, Cano, Gené, Summerbell, Rinaldi, and Guarro, 2011). *Pithomyces* had been isolated from respiratory specimens that suggest its probable impact as allergic agent (De Hoog and Guarro et al., 2000).

The hyphomycetes *Trichoderma*, and *Acremonium* beside *Mucor* the zygomycetes were uncommon in current study but they are well known airborne indoor and outdoor fungi, they were regarded as life threat agents to immunocompromised patients. Several previous studies mentioned their hygienic importance as (Juan F Fernandez, Diego J Maselli, Tamara Simpson, and Marcos I Restrepo, Pulmonary Mucormycosis: What is the best strategy for therapy? *Respir Care*) which mentioned the relation between SBS and *Trichoderma* volatile secretions, and the work about *Acremonium* infections in USA (Hasanin, Fatima, Al-Frayh, and Al-Sedairy, 2005). *Mucor* was widely described as rare but serious agents of several mucormycosis including lung and respiratory tract (Polizzi, Adams, Picco, Adriaens, Lenoir, Van Peteghem, De Saeger, and De Kimpe, 2011).

## 5. CONCLUSIONS

- 1- The recognized fungi are opportunistic pathogens, and their hygienic impact increases in hospital environment.
- 2- Fungi which had been isolated from external part of air-conditioner units were highly divers. Hospitalized patients, staff, and workers are at risk for getting fungal infection, no doubt, such expected harms increase positively with time spending inside the building and with immune depression.
- 3- Because ACU provides a suitable environment for fungal growth, a periodical cleaning of devices should not be ignored and a suitable and safe antifungal can be used to minimize contamination.
- 4- Much attention should be taken to the AC filters, dust and moisture of these parts induce growth and propagation of airborne fungi.

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