DIVERSITY OF SOIL MICROFUNGI IN PINE FOREST AT DUHOK GOVERNORATE, KURDISTAN REGION, IRAQ

Samir **Kh**alaf **A**bdullah and **L**ava **H**ikmat **N**ashat
Biology Department, Faculty of Science, University of Zakho, Kurdistan Region – Iraq.
(Accepted for publication: May 21, 2014)

Abstract:

The soil microfungi inhabiting pine (*Pinus brutia* Tern.) forests in Atrush and Zawita, Duhok governorate(Kurdistan region),Iraq were examined by using five isolation methods with the objective to compare the diversity of soil microfungi at O1 and O2 soil horizon layers from both sites. A total of 26 genera and 51 species of soil fungi as well as yeasts and non- sporulating mycelia were isolated from the two sites. *Aspergillus* was represented by 17 species and thus showed the widest diversity among all recovered genera. *A.niger* and *A.fumigatus* were the most frequent species among the genus. Black aspergilli were the most common species among the genus. They were represented by five species *viz A.awamori, A.foetidus, A niger, A. sclerotioniger* and *A.vadianes. Penicillium* was the second in the number of species isolated and was represented by 6 species. These include *P. cammeberti, P. citrinum, P. coryophilum, P. digitatum , p. glabrum* and *P. roquefotri.*. Two species were identified in each of the genera *Absidia, Cladosporium, Emericella, Mucor and Paecilomyces*. The rest genera that included *Alternaria, Cunnighamella, Chaetomium, Corynascus, Eupenicillium, Fusarium, Gymnoascus, Melanocarpus, Monilia, Pestatiolopsis, Phaeoacremonium , Phialophora, Rhizopus, Sordaria, Stachybotrys, Scytalidium, Thermomyces, Trichoderma* and *Ulocladium* were each represented by one species. The highest similarity index for fungal community inhabiting soil at both sites was found in soil at O1 layer (Atrush) and O2 layer (zawita).The least (SI) was recorded between O1 layer (Zawita) and O2 layer (Atrush). *Absidia spinosa*, and *Mucor plumbeus* are newly recorded from Iraq; hence they represent new additions to the Iraqi mycobiota.

Keywords: microfungi, diversity, forest soil, Iraq.

Introduction

Soil is the habitat for living many organisms including, bacteria, fungi, algae, viruses and protozoa. It supports the growth of a variety of plants, animals and soil microorganisms (Chiacek *et al*., 1996).

Soil fungi play an important role as a major decomposers in the soil ecosystem. They also provide mankind with very useful pharmaceutical products, such as antibiotics and other valuable substances, including organic acids, enzymes, pigments and secondary metabolites used in the food industry and fermentation. In addition many soil fungi are biological control agents for plant pathogens and insect pests. On other hand , some of them are very harmful causing food spoilage and diseases to plants, animals, and humans (Manoch, 2004).

Despite the fact that several studies on Iraqi soil there were carried in different ecosystems, very little is known regarding their diversity in forest soil. Previous studies included desert soil (Abdullah *et al*., 1986), soil at date palm plantations (Abdullah and Zora, 1993), cultivated soil in middle and Southern parts of Iraq (Al-Doory *et al*., 1959; Ismail and Abdullah, 1977; Abdullah and Al-Bader(1989, 1990), forest soils (Al-Bader *et al*., 2000; Abdullah and Abdullah, (2008, 2009, 2010) and from soil at vineyards (Abdullah and Mohammed, 2011).

The present study was carried out on soil fungi present in Atrush-Zawita natural pine forest in Duhok governorate to study species abundance, diversity and taxonomy.

Materials and Methods

Site Description

The study was conducted in the unique natural pine forest restricted to Zawita-Atrush locality (36°52¯- 36°90¯N latitude and 43° 17¯-43° 58¯ E longitude). The forest supports pure stand of *Pinus bruitia* Tern trees covering a mountainous area of 100 Km square, 10 Km N.W of Duhok city (Townsend and Guest, 1966; Shahbaz, 2007).

Both sites were about 8 Km apart from each other and have similar climatic conditions, the average minimum temperature is 8.97c° and average maximum temperature is 22.34 c°. The total rainfall average is 578.5mm. The monthly average relative humidity (RH%) is ranging between 18.5% to 68% with a total average 44.18% (Duhok metrological station, 2005).

The soil type is belonging to the mountain soil according to the classification of Buringh (1960) that constitute the bulk of soil in Atrush-Zawita forest. Top soil is alkaline and mostly covered by individual tress of *Pinus bruitia*. The trees found to live up to 1600m in Zawita region (Shahbaz *et al*., 2002).

Collection of Soil Samples

A total of 20 samples were collected during November, 2011 from the two sites, 10 samples points were selected in each site (Atrush-Zawita). Soils were taken from the O1 horizon layer with sterile trowel for each location in each site (Atrush and Zawita) after first removing the litter layer (L1-L2). Similarly soil samples were collected from the O2 horizon layer after removing the O1 horizon layer. Afterwards, soil samples were stored in polythene bags at 5C° and were processed within 1-2 weeks after collection.

Isolation of Fungi from Soil

Five isolation methods were used: dilution plating method (Parkinson et *al*. 1971), direct plating method (Warcup, 1960), soil treatment with 5% Acetic acid (Furuya and Naito, 1979), treatment with 70% ethanol (Warcup and Baker, 1960), and treatment with 2% phenol (Furuya and Naito, 1980). Two types of media were used to isolate fungi: potato carrot agar (PCA) (20g peeled potato, 20g carrot, 20g agar, 1L distilled water) and malt extract agar (MEA). Media were supplemented with 50mg/L chloramphenicol.

Identification of Fungi

Identification of fungal isolates was based on morphological and cultural characteristics. General and specific taxonomic literature was used for identification of fungal species. Domsch *et al*., (1980); Klich (2002), Ellis (1971, 1976), Pitt and Hocking (1997), Watanabe (2002), Samson *et al.*, (2007), Frisvad and Samson (2004).

Data Analysis

Frequency of occurrence for soil samples was calculated based on the following formula:

$$\%FO = \frac{number\ of\ soil\ samples\ that\ a\ particular\ fungal\ species\ observed}{total\ number\ of\ soil\ samples} \times 100$$

Comparing the similarity of fungal species composition between different habitats, Sorensen´s index (SI) was applied (Sorenson, 1948). The index was calculated as the following formula

$$\mathbf{SI} = \frac{2c}{a+b}$$

Where

a = total number of species at site 1

b = total number of species at site 2

c = number of species common to both sites.

Similarity is expressed with values between 0 (no similarity) and I (absolute similarity).

Results

A total of 32 species belonging to 14 genera including yeasts and non sporulating mycelia were isolated from soil of O1 layer obtained from the two sites (Zawita and Atrush). Their frequency of occurrence is presented in table 1.

Twenty six species were detected on PCA medium and 32 species developed on MEA medium after incubation at 25ºC.

Aspergillus was represented by 12 species and thus showed the widest diversity among all recovered genera. *A.niger* and *A.fumigatus* were the most frequent species within the genus.

Black Aspergilli were the most common species among the genus. They were represented by five species *A. awamori, A.foetidus, A.niger, A.vadiances* and *A. sclerotioniger*.

Penicillium was second in the number of species isolated and was represented by 3 species. These include *P. camemberti, P. citrinum* and *P. glabrum*. The later species was the most frequent among the genus.

Two species were indicated for each of the genera *Mucor* and *Paecilomyces*. The rest genera that included *Alternaria, Cheatomium, Cladosporium, Fusarium, Gymnoascus, Monilia, Rhizopus, Sordaria, Stachybotrys, Ulocladium* were represented by one species each.

Twenty two species were found common to both sites (Zawita and Atrush). *Aspergillus alliaceus, A.ornatulus* and *Gymnoasus ressii*were detected only from Zawita sites whereas, *Mucor* sp., *Stachybotrys atra* and *Cladosporium gallicola* were detected from soil at Atrush site.

Table (1): % Occurrence of Fungi in Soil from O horizon (O1) Layer Incubated at 25ºC

	ZAWITA		***ATRUSH***	
FUNGAL SPECIES	**% Occurrence / on PCA 25°C**	**% Occurrence / on MEA 25°C**	**% Occurrence / on PCA 25°C**	**% Occurrence / on MEA 25°C**
A.awamori Nakaz	10%	20%	40%	30%
A. aliaceus Thom	-	10%	-	-
A.flavus Link	30%	20%	-	10%
A.foetidus Thom&Raper	10%	10%	20%	20%
A.fumigatus Fresen	70%	80%	60%	90%
A.niger Fresen	80%	90%	90%	100%
A.ochraceus K.Wilh	20%	20%	-	20%
A.ornatuluns Samson&W.Gams	-	10%	-	-
A.tamarii Kita	10%	10%	20%	-
A.terrus Thom	10%	30%		10%
A.vadiances Samson, de Vries, Frisvad & Visser	20%	40%	10%	-
A.sclerotioniger Samson & Frisvad	-	30%	-	30%
Alternaria alternata (Fr.) Keissler	10%	-	30%	10%
Cheatonium sp.	-	10%	20%	
Cladosporium gallicola Sutton	-	-	10%	20%
Fusarium sp.	10%		30%	40%
Gymnoascus ressii Baranetzky	-	10%	-	-
Monillia sp.	30%	40%	30%	10%
Mucor sp.	-	-	10%	10%
Mucor plumbeus Bonordon	-	30%	-	20%
P.camemberti Thom	10%	40%	10%	10%
P.citrinium Thom	-	30%	20%	20%
P.glabrum (Wehmer)Westling	40%	70%	20%	50%
Paecilomyces variotii Bainier	-	50%	40%	-
Paecilomyces sp.	40%	30%	10%	-
Rhizopus sp.	20%	60%	40%	50%
Sordaria fimicola(Roberg ex Desm.)Ces De Not.	-	10%	20%	40%
Stachybotrys atra Corda	-	-	20%	30%
Sterile mycelium(white)	40%	60%	30%	70%
Sterile mycelium(brown)	20%	30%	20%	30%
Ulocladium atrum preuss.	10%	-	10%	30%
Yeast	40%	60%	50%	40%

Table (2): % Occurrence of Fungi in Soil from O horizon Layer (O2) Incubated at 25ºC

FUNGAL SPECIES	ZAWITA		ATRUSH	
	% Occurrence / on PCA 25°C	% Occurrence / on MEA 25°C	% Occurrence / on PCA 25°C	% Occurrence / on MEA 25°C
A.awamori Nakaz	30%	50%	50%	40%
A.alliaceus Thom	-	30%	-	20%
A.carbonarius (Bainier)Thom	-	50%	-	30%
A.flavus Link	30%	30%	10%	20%
A.foetidus Thom&Raper	40%	50%	40%	30%
A.fumigatus Fresen	70%	90%	80%	100%
A.niger Tiegh.	80%	100%	50%	60%
A.ochraceus K.Wilh.	30%	50%	30%	30%
A.ornatulas Samson&W.Gams	-	20%	-	-
A.oryzae Ahlburg)Cohn.	-	-	-	20%
A.tamarii Kita	10%	20%	-	10%
A.terrus Thom	-	40%	30%	-
A.vadiances Samson,de Vries,Frisvad&Visser	-	50%	-	30%
A.sclerotioniger Samson&Frisvad	20%	30%	-	20%
Absidia spinosa Lender	20%	-	-	10%
Alternaria alternate (Fr.)Keissler	-	10%	-	-
Cheatonium sp.	40%	30%	20%	20%
Canninghamella echinulata (Thaxt.)Thaxt.	20%	-	-	-
Emericella nidulans (Eidam)Vuill.	10%	10%	-	-
Eupenicilium sp.	30%	90%	50%	100%
Fusarium sp.	40%	-	50%	20%
Gymnoascus ressii Baranetzky	10%	10%	-	-
Monillia sp.	40%	40%	30%	40%
Mucor sp.	20%	10%	20%	10%
Mucor plumbeus Bonordon	10%	10%	-	
P.digitatum (Pers.)Sacc.	10%	20%	-	10%
P.camemberti Thom			30%	20%
P.citrinium Thom	30%	20%	-	20%
P.glabrum (Wehmer)Westling	40%	40%	30%	40%
P.roquiforti Thom	10%	-	-	10%
Paecilomyces variotii Bainier	-	30%	-	10%
Paecilomyces sp.	40%	10%	-	-
Rhizopus sp.	40%	30%	50%	40%
Sordaria fimicola (Roberg ex Desm)Ces De Not.	40%	20%	-	30%
Stachybotrys atra Corda	-	30%	10%	30%
Sterile mycelium(white)	40%	50%	40%	100%
Sterile mycelium(brown)	-	-	-	20%
Ulocladium atrum Preuss.	10%	-	-	20%
Yeast	-	30%	50%	60%

Frequency of occurrence of fungi detected from the O2 layer at both sites is showed on Table 2. A total of 39 species including yeasts and non-sporulating mycelia assigned to 17 genera were detected after incubation at 25C°. *Aspergillus* showed the widest diversity and was represented by 14 species. *A.niger, A.fumigatus, A,awamori, A.foetidusand A.ochraceuss* were the most frequent species detected on both media. *Penicillium* was second and represented by five species among them. *P. glabrum* was the most frequent.

A.ornatulus, Alternaria alternate, Cunnighamella echinulata, Emericella nidulaus, Gymnousus ressii, Mucor plumbeus and *paecilomyces* sp., were isolated from Zawita soil, whereas, *A.oryzae* and *P. cammeberti* were detected in the soil at Atrush site.

Table 3 shows the data for % frequency of occurrence of fungi isolated from O1 layer on both PCA and MEA media after incubation at 40 C°.

A total of 31 species assigned to 16 genera including yeasts and non-sporulating mycelia were detected from both sites.

Aspergillus was represented by 12 species among them, *A.niger, A fumigatus* were the most frequent and showed high percentage of occurrence. *Pinicillium citrinum* was the only species isolated at 40ºC.

A. candidus, A. tamari, Cheatonium sp, Corynoascus spedonium, Melanocarpus sp, P. citrinium, Paecilomyces sp., Sordaria fimicola, and *Stachybotrys atra*, were isolated from Atrush site whereas *A. flavus, A. ochraceus, A. ornatulans, C. gallicola* and *G ymnoascus ressii* were detected in Zawita sites.

Table (3): % Occurrence of Fungi in Soil from O horizon Layer (O1) Incubated at 40c°

FUNGAL SPECIES	ZAWITA		ATRUSH	
	% Occurrence / on PCA 40°C	% Occurrence / on MEA 40°C	% Occurrence / on PCA 40°C	% Occurrence / on MEA 40°C
A.awamori Nakaz	70%	20%	-	10%
A.candidus Link	-	-	40%	-
A.carbonarius(Bainier)Thom	-	40%	-	10%
A.flavus Link	20%	10%	-	-
A.foetidus Thom&Raper	10%	50%	-	10%
A.fumigatus Fresen	30%	80%	50%	50%
A.niger Tiegh	100%	100%	90%	80%
A.ochraceus K.Wilh	30%	30%	-	-
A.ornatulus Samson&W.Gams	-	20%	-	-
A.tamarii Kita	-	-	-	40%
A.terrus Thom	-	10%	50%	40%
A.vadences Samson, de Vries,Frisvad&Visser	20%	-	10%	10%
Cheatomium sp.	-	-	-	40%
Cladosporium gallicola Sutton	20%	30%	-	-
Corynascus sepdonium(C.W.Emmons)Arx	-	-	10%	10%
Emericellanidulans(Eidam)Vuill	-	10%	60%	30%
Fusarium sp.	20%	-	-	10%
Gymnoascus ressii Baranetzky	-	10%	-	-
Melanocarpus sp.	-	-	20%	-
Monillia sp.	30%	10%	-	80%
Mucor sp.	-	10%	20%	70%
P.citrinium Thom	-	-	-	30%
Paecilomyce svariotii Bainier	20%	30%	-	20%
Paecilomyces sp.	-	-	-	10%
Rhizopus sp.	-	70%	60%	70%
Sordaria fimicola(Roberg ex Desm.)Ces De Not	-	-	-	60%
Stachybotrys atra Corda	-	-	30%	30%
Sterile mycelium(white)	10%	30%	40%	40%
Sterile mycelium(brown)	-	10%	-	-
Trichoderma sp.	-	-	10%	10%
Yeast	30%	-	-	40%

Table 4 shows the data for the % occurrence of fungi isolated from O2 layer on both media after incubation at 40ºC from both sites.

A total of 25 species distributed in 14 genera in addition to yeasts and non-sporulating mycelia were isolated. *Aspergillus* was the most frequent genus and showed the highest diversity. The genus was represented by 10 species among them A. *niger, A. fumigatus, A. awamori,* were the most frequent species. *Paecilomyces* was represented by two species the rest genera were represented by one species each.

A.candidus, A. ochraceus, A. terrus, C. sepedonium, E. nidulans, and *Trichoderma* sp, were detected in Atrush site, whereas, *A .flavus, Mucor plumbues, Paecilomyces* sp., and *Pestalotiopsis* sp., were isolated from Zawita site.

The majority of species were found common to both O1 and O2 soil layers except for *C. gallicola, E. rugulosa, Melanocarpus* sp, and *Pestalotiopsis* sp. were detected in O2 soil layer.

Corynascus sepedonium, Melanocarpus sp, and *Pestatiolopsis* sp, were not detected at 25ºc on both media.

Similarity index (SI) for soil fungal community in O1 and O2 horizon layers at Atrush site was higher (0.914) than that calculated for the two layers of O horizon (0.845) at zawita site.

The highest similarity index (0.929) was found between soil fungal communities from O1 layer at Atrush site with O2 layer at Zawita site. The least (SI) was found between O1 layer at Zawita site and O2 layer at Atrush site (Table 5).

Table (4): % Occurrence of Fungi in Soil from O horizon Layer (O2) Incubated at 40ºC

	ZAWITA		***ATRUSH***	
FUNGAL SPECIES	**% Occurrence / on PCA 40°C**	**% Occurrence / on MEA 40°C**	**% Occurrence / on PCA 40°C**	**% Occurrence / on MEA 40°C**
A.awamori Nakaz	70%	60%	-	40%
A.candidus Link	-	-	20%	-
A.carbonerius (Bainier)Thom		30%	-	20%
A.flavus Link	-	40%	-	-
A.foetidus Thom&raper	30%	80%	-	20%
A.fumigatus Fresen	80%	70%	60%	100%
A.niger Fresen	100%	100%	90%	100%
A.ochraceus K.Wilh.	-	-	-	20%
A.terrus Thom	-	-	20%	30%
A.vadiances Samson,de vries,frisvad&Visser	30%	30%	10%	10%
Absidia spinosa Lender	40%	40%	10%	-
Corynascus sepdonum(C.W.Emmons)Arx	-	-	10%	-
Emericella nidulans (Eidam)Vuill	-	-	20%	-
Monillia sp.	90%	80%	-	30%
Mucor sp.	-	30%	20%	20%
Mucor plumbeus Bonordon	30	30%	-	-
P.camemberti Thom	-	-	-	10%
P.citrinium Thom	30%	40%	-	20%
Paecilomyces variotii Bainier	20%	50%	-	60%
Paecilomyces sp.	40%	-	-	-
Pestatiolopsis sp.	30%	30%	-	-
Rhizopus sp.	30%	30%	40%	50%
Sordaria fimicola (Roberg exDesm)Ces De Not.	-	70%	-	40%

Stachybotrys atra Corda	70%	-	30%	30%
Sterile mycelium(white)	-	70%	40%	-
Sterile mycelium(brown)	-	30%	-	50%
Trichoderma sp.	-	-	10%	-
Yeast	40%	100%	-	30%

Table (5): Similarity index (SI) between Soil Fungal Communities at Zawita and Atrush Sites

Sites	Zawita Soil O1	Zawita Soil O2	Atrush Soil O1	Atrush Soil O2
Zawita **Soil** O1	----------			
Zawita **Soil** O2	0.864	----------		
Atrush **Soil** O1	0.845	0.929	----------	
Atrush **Soil** O2	0.739	0.849	0.914	----------

Discussion

Among the *Aspergillus, A. fumigatus, A. niger, A. awamorri, A. foetidus* were the major species according to their frequency of occurrence in both sites. *A .fumigatus* and *A. niger* have been reported as the most frequent isolates from soil of date palm plantation in Iraq and among the most frequent isolates known from the other soils in arid region (Moubasher and Mustafa, 1970; Halwagy *et al*. 1982: Abdullah *et al*., 1986; Abdullah and Zora, 1993 Abdullah *et al*., 2007). This is primarily related to their high tolerance to both relatively high temperature and drought conditions (Durell and shields, 1960; Christensen, 1969). *A. awamori* and *A. foetidus* have been recently reported among the most common species inhabiting soil (particularly vineyard soil) in Kurdistan region (Abdullah and Abdullah, 2009; Abdullah and Mohammed, 2011).

Five species of *Penicillium* found in our study, *P.citrinium* was the most common one. The fungus is cosmopolitan species which has been frequently reported from a variety of habitats (Domsch *et al.*, 1980).

Only twenty eight species isolated from plates incubated at 40ºC . *A. fumigatus, A .niger, A. terreus, A. candidus, Emericella* spp., *Paecilomyces variotii* and *Thermomyces* sp., were previously reported from Iraq as a thermotolerant species (Abdullah and Al-Bader, 1990). According to Cooney and Emerson (1964), definition of thermophilic and thermotolerant fungi, the above reported species are considered thermotolerant species, since they grow at temperature with optimum between 30–40 ºC.

Emericella nidulans and *E. rugulosa*, two soil borne ascomycetes were isolated in our study at 40 ºC. The former species was previously reported in several occasions from soil in Southern Iraq and from sediments of Shatt–Al Arab river and southern Marshes (Abdullah and Zora, 1993; Abdullah and Abbas, 2008; Abdullah *et al*., 2010). Moreover, the two species have been recently reported from soil in Kurdistan region of Iraq (Abdullah and Abdullah, 2009).

The Ascomycete isolate which identified as *Melanocarpus* detected at 40 ºC is very close to *M. thermophilus* which was reported by Guarro *et al*., (1996) from soil at Nineva forest, North Iraq.

Sordaria fimicola is a common coprophilous fungus. However, the fungus has been repeatedly isolated from soil (Domsch *et al*., 1980, Furuya and Naito, 1979; Abdullah *et al*., 2010) and perhaps originated from disintegrated dung pellets incorporated into soil.

Our results for fungal isolation from soil in pine forest of Zawita and Atrush were compared with those of studies carried out on date palm plantation and forest soil in Iraq. There were

obvious differences among species composition for genera with darkly pigmented mycelium as well as for ascomycetes. Dematiaceous genera reported previously from soil in Iraq (Al-Doory *et al*., 1959; El-Dohlob and Al-Helfi, 1982; Abdullah and Zora, 1993; Al – Bader *et a*l., 2000) showing a high species diversity were *Alternaria* (5 species), *Curvularia* (3 species), *Drechslera* (5 species), *Ulocladium* (4 species), *Stemphylum* (3 species), whereas, *Alternaria* and *Ulocladium* were each represented by one species in the soil of pine forest. Other dematiaceous were not detected during our study. It has been suggested that fungi with darkly pigmented mycelia are well adapted to withstand intense higher radiation (Durell & Shield, 1960; Ranzoni, 1968), hence, low diversity level among dematiaceous taxa was due to the fact that forest soil at Zawita and Atrush is receiving low solar radiation because of the density of pine trees.

References

Abdullah, S.K. and Abbas, B.A. (2008). Fungi inhabiting surface sediment of Shatt Al-Arab river and its creeks at Basrah, Iraq. Basrah. J. Sci. (B) 26: 68–81.

Abdullah, S.K. and AL-Bader, S.M. (1989). A new thermotolerant species of *Chaetomium* from Iraqi forest soil. Int. J. Mycol. Lichenol. 4:83-91.

Abdullah, S.K. and AL-Bader, S.M. (1990). On the thermophilic and thermotolerant mycoflora of Iraqi soil. Sydowia 42: 1-7

Abdullah, S.K. and Mohammed, A.A.H. (2011). prevalence of black Aspergilli in soil at vineyards in Duhok, Kurdistan region of Iraq. Proc. 4th Int. Sci. conf. Salahaddin Univ. Erbil. 3: 966-969.

Abdullah, S.K. and Zora, S.E. (1993). Soil microfungi from date palm plantations in Iraq. Basrah. J. Sci. 11B: 45-58.

Abdullah, S.K., Aldossari, M.N and Al Imara, F, J. (2010). Mycobiota of surface sediments in Marshes of southern of Iraq. Marsh Bulletin 5: 14–26.

Abdullah, S.K., AL-Khesraji, T.O. and EL-Edamy, T.Y. (1986). Soil mycoflora of the southern desert of Iraq. Sydowia 39: 8-16

Abdullah, S.K., AL-Saadoon, A.H. and AL-Salihy, H.M. (2007). Fungi from the tidal zone of khawr AL-Zubiar canal southern Iraq. Marsh Bulletin 2: 18-13.

Abdullah, S.K., Montfort, E., Asensio, L., Salinas, J., Lopes-Lorca, L.V. and Janson, H.B. (2010). Soil mycobiota of date palm plantation in Elche, SE Spain. Czech Mycol. 61: 149-162.

Abdullah, W.R. and Abdullah, S.K. (2008). Taxonomic study on black aspergilli from soil in Kurdistan region of Iraq. J. Duhok Univ. 12: 288-295.

Abdullah, W.R. and Abdullah, S.K. (2009). Taxonomic study on Aspergilli and their teleomorphs from soil in northern Iraq. Proc. Ist. Sci. conf. Biol. Sci. section Botany, Mosul University P. 328-363.

Abdullah, W.R. and Abdullah, S.K. (2010). Taxonomic study on penicilli from soil in Kurdistan region of Iraq. J. Duhok Univ. 13: 144-163.

AL- Bader, S.M., Abdullah, S.K. and Ayed, A.Y. (2000). A study of soil microfungal community in Mosul forest, North Iraq. Basrah J. Researches 24: 69-87 (In Arabic).

AL-Doory, Y., Tolba, M.K. and AL-Ani, H. (1959). On the fungal flora of Iraqi soils II. Central Iraq. Mycologia 51: 429-439.

Buringh, B. (1960) .soils and soil conditions in Iraq. Bagdad, Iraq.

Chiacek, L.J., Anderson, W.L. and Barak, P.W. (1996). Linkages between soil quality and plant, animal and human health. In SAS special publication 49.

Christensen, M. (1969). Soil microfungi of dry to mesic conifer hardwood forests in northern Wisconsin. Ecology 50: 9–27.

Domsch, K.H., Gams, W. and Anderson, T.H. (1980). Compendium of soil fungi. Academic press, New York

Durrel, L.W. and Shields, L.M. (1960) .Fungi isolated in culture from soil of the Nevada test site. Mycologia 52: 636-641.

EL-Dohlob, S.M. and AL-Helfi, M.A. (1982). Soil fungi of the South Iraq. Bas. Nat. Hist. Mus. Bull, 5:3-37.

Ellis, M.B. (1971). Dematiaceous hyphomycetes Commonwealth Mycological Institute, Kew, Surrey, U.K.

Ellis, M.B. (1976). More dematiaceous hyphomycetes Commonwealth Mycological Institute, Kew, Surrey, U.K.

Frisvad, J.C. and Samson, R.A. (2004) polyphasic taxonomy of *Penicillium* subgenus *Penicillium*. A guide for identification of food on air-borne treverticillate penicillia and their mycotoxins .Studies in mycology 49: 1-173.

Furuya, K. and Naito, A. (1979). An effective method for isolation of *Boothelia tetraspora* from soil. Trans. Mycol. Soc. Japan 20: 309-311.

Furuya, K. and Naito, A. (1980). Stimulation of ascospore germination by phenolic compounds in members of Sordariaceae. Trans. Mycol. Soc. Japan 21: 77-85.

Guarro, J., Abdullah, S.K., Al-Bader, S.M., Figueras, M.J. and Gene, J.C. (1996). The genus *Melanocarpus*. Mycol. Res. 100: 15–78

Halwagy, R, Moustafa, A.F. and Kamel, S.M. (1982) .Ecology of the soil mycoflora in the desert of Kuwait. J. Arid. Environ. 5:109–125.

Ismail, A.L.S. and Abdullah, S.K. (1977). Studies on the soil fungi of Iraq. Proc. Indian Acad. Sci. 86B, 151-154.

Klich, M.A. (2002). Idemtification of common *Aspergillus* species. CBS, Ultrecht, the Netherlands.

Manoch, L. (2004). Soil fungi in E.B.G. Jones, M. Tantichareon and K.D. Hyde (eds.) Thai Fungal Diversity. Biotech. Thialand pp 341-154

Moubasher, A.H. and Mustafa, A.F. (1970). A survey of Egyptian soil fungi with special reference to *Aspergillus, penicillium* and *Penicilium*- related genera. Trans. Bcit. Mycol. Soc. 54: 35–44.

Parkinson, D., Gray, T.R.G. and Williums, S.T. (1971). Isolation of microorganisms. In methods for studying the ecology of soil microorganisms. IBP Handbook No. 19 Blackwell Scientific Publication, London pp. 36-56.

Pitt, J.I. and Hocking, A.D. (1997). Fungi and Food spoilage. 2nd edition Blackie Academic of professional, London.

Ranzoni, F.V. (1986). Fungi isolated in culture from soils of the Sonoron desert. Mycologia 60; 365-371.

Samson, R.A., Noonim, P., Meijer, M., Houbraken, J., Frisvad, J. and Varga, J. (2007). Diagnostic tools to identify black aspergilli. Studies in Mycology 59: 129-145.

Shahbaz, S.E. (2007) Pinales with a field guide to the trees and shrubs of Kurdistan region of Iraq. Spriez-press and publisher, Duhok, Iraq.

Shahbaz, S.E., Pasha, A.A and Balo, A.H. (2002). The Altitudinal variation of *Pinus bruitia* Ten (Pinaceae) in Atrush Natural forest. J. Duhok Univ. 5: 23-32

Sorenson, T. (1948). A method of establishing group of equal amplitude in plant sociology based on similarity of species content and its application to analysis of the vegetation on Danish commens. Biologiske Skitter Det Konglige Danske Videskabernes Selskab 5: 1-34.

Townsend, C.C. and Guest, E. (1966). Flora of Iraq. Vol. I. Ministry of Agriculture and Agrarian Reform Bagdad, Iraq.

Warcup, J.H. (1960) . Methods for isololation and estimation of activity of fungi in soil. In D.Parkinson and J.S. Waid (eds.). the Ecology of soil fungi, Liverpool University press PP 3-21.

Warcup, J.H. and Baker, K.F. (1960). Occurrence of dormant ascospores in soil. Nature (London) 197: 1317-1318.

Watanabe, T. (2002). Pictorial Atlas of soil and seed fungi. Morphologies of cultured Fungi and Key to species. 2nd edition, CRC press. London.

جۆرێن (کەڕوێێن هویر) د ئاخا دارستانێن کاژان دا ل پارێزگەها دهوکێ – هەرێما کوردستانا عێراقێ

پوختە:

ڤەکۆلین ل سەر (کەڕوێێن هویر) د ئاخا دارستانێن کاژان ل ئەتروش و زاویتە ل پارێزگەها دهوکێ باکۆرێ عێراقێ هاتە کرن ئەوژی ب کارئینانا پێنج ڕێێن دابڕینا (کەڕو) ئەوژی ژبو بەراوردکرنا جۆرێن (کەڕوێێن هویر) د قاتێن ئاخێ دا ل هەر دو جهێن ناڤبری. (٥١) جۆرێن فگریاتان هاتنە دابڕین و دەست نیشان کرن ئەوژی دزڤڕنە بۆ (٢٦) ڕەگەزان زێدەباری (کەڕو و داڤێن کەڕوێی) ئەوێن نە پیس. ڕەگەزێ (اسبر جلس) دیاربو کو بلندترین جۆرە کو دبنە (١٧) جۆر . ئەو جۆرێن ڕەنگ ڕەش ژ ڕەگەزێ (اسبر جلس) ژ هەمویان بەربەلاڤ تڕە. ئەوژی (٥) جۆرن (*A.awamori, A.foetidus, A niger, A. sclerotionigerandA.vadianes.*

بەلێ ڕەگەزێ (*Penicillium*) ل ریژا دووێ هات پشتی (الاسبر جلس) کو ئەڤەژی دبیتە (٦) جۆر (و *P. cammeberti, P. citrinum, P. coryophilum, P. digitatum , p. glabrum P. roquefotri*

لێ ڕەگەزێن (*Absidia, Cladosporium, Emericella, Mucor and Paecilomyces*) هەرئێك ژ وان دبنە (٢) جۆر . بەلێ ڕەگەزێن دی هەمو کو ئەڤەنە (*Alternaria, Cunnighamella, Chaetomium, Corynascus, Eupenicillium, Fusarium, Gymnoascus, Melanocarpus, Monilia,Pestatiolopsis, Phaeoacremonium , Phialophora, Rhizopus, Sordaria, Stachybotrys, Scytalidium, Thermomyces, Trichoderma,Ulocladiu*

ب تنێ دبنە ئێك جۆر. بلندترین کۆمەلا فگریاتێن کو پتری یا وان وەکهەڤ ئەوبون یێن دناڤبەرا قاتێ ((zawita) O2دگەل O2 (Atrush)هاتینە تومارکرن . بەلێ ئەوێن دی یێن د کێمترین ئالی دا وەکهەڤ ئەو بون یێن دناڤبەرا ((zawita) O2دگەل O2 (Atrush)) هاتینە توامرکرن . هەردو جورێن *Absidiaspinosa,Mucorpleumbeus* ژبو جارا ئێکێ نە ا عیراقێ دهێنە تومارکرن .

تنوع الفطريات الدقيقة في تربة غابات الصنوبر في محافظة دهوك/ اقليم كوردستان العراق

الملخص:

تم دراسة الفطريات الدقيقة لتربة غابات الصنوبر في اتروش وزاويته من محافظة دهوك شمال العراق با ستخدام خمسة طرائق عزل للفطريات وذلك لغرض مقارنة تنوع الفطريات الدقيقة لطبقات التربة لكلا الموقعين. تم عزل وتشخيص احدى وخمسون نوعا من الفطريات تعود الى ٢٦ جنسا" فضلا" عن الخمائر والخيوط الفطرية غير المتجرثمة. اظهر الجنس اسبرجلس اعلى تنوع وتمثل بـ ١٧ نوع. كانت الانواع ذات اللون الاسود من الجنس اسبرجلس اكثر شيوعا" وتمثلت بخمسة انواع هي:

A.awamori, A.foetidus, A niger, A. sclerotioniger and *A.vadianes.*

اما الجنس *Penicillium* حل بالمرتبة الثانية بعد الاسبرجلس وتمثل بستة انواع شملت

P. cammeberti, P. citrinum, P. coryophilum, P. digitatum , p. glabrum and *P. roquefotri*

اما الاجناس *Absidia*, *Cladosporium*, *Emericella, Mucor and Paecilomyces*

فتمثلت بنوعين لكل منهما.اما بقية الاجناس و التي شملت

Alternaria, Cunnighamella, Chaetomium, Corynascus, Eupenicillium, Fusarium, Gymnoascus, Melanocarpus, Monilia, Pestatiolopsis, Phaeoacremonium , Phialophora, Rhizopus, Sordaria, Stachybotrys, Scytalidium, Thermomyces, Trichoderma and *Ulocladiu*

فتمثلت بنوع واحد لكل منهما. سجل اعلى معامل تشابه لمجتمع الفطريات المستوطنة للتربة ما بين O1 layer. O2 layer (zawita) and (Atrush) اما اقل معامل تشابه سجل ما بين طبقة(zawita) O2 مع O2 (Atrush). سجل النوعان *Absidia spinosa,Mucor pleumbeus* لاول مرة في العراق.