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Physicochemical analyses and mycoflora of desert soils in Upper Egypt

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Abstract

Most of the desert lands contain sandy soils, which include large areas in the world. The sandy or loam soils in Upper Egypt were placed under investigate of soil texture, and moisture content –in addition some chemical analyses. Where, had very low organic matter (mean= 0.28) with available total dissolved salts (mean= 0.53) and alkaline pH-value (mean= 9.00). The moisture content of samples was very low (mean= 2.59). All of desert soil samples (100% of the samples) proved to be contaminated by filamentous fungi. A total of 121 fungal species + 7 varieties of 32 genera were isolated and identified on the isolation medium (1% glucose Czapek's agar) at 28°C, based on dilution plate method. The gross fungal count was 94.36 colonies/mg dry soil. *Aspergillus* (36 sp. + 4 var.) was the most dominant genus based on frequency (95% of the samples) and count (55.34% of total fungal counts). *Penicillium* (28 sp. + 1 var.) had the second place (70% of the sample and 26.83% of grass count). *Ulocladium* occupied the third place (22.5% and 3.18%). *Acremonium* was one of the dominant genera (4th place). It occurred in 20% of the samples examined and 1.61% of gross fungal counts. The dematiaceous hyphomycetes, in addition ascospore-forming fungi were dominant in rare frequency. Whereas, sterile mycelia were high in frequency (52.5% of the samples) and low count (1.99% of gross fungal count).

Keywords: Desert soil, Chemical analyses, Filamentous fungi, Czapek's agar medium, Upper Egypt.

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INTRODUCTION

Egypt pays a great attention for development of its agriculture resources, either through land reclamation or through maximizing the productivity of soil unit [1]. Most part of Egypt are arid and semi-arid with climate characterized by hot dry summers and mild winter with very low precipitation. The Calcareous soils are widely spread which constitute about 25-30% of total area according to Ministry of Agriculture estimation. The pH of these soils is usually above 7 and may be a high 8.5, when these soils contain sodium carbonate, the pH may exceed 9, also may contain significant amount of trace elements including Fe, Al and Mn [2].

Sand is a very basic soil, made of particles of rock and hard minerals, such as silicon dioxide, the largest of the different types of soil particles. The large, relatively stable sand-particle size increases soil aeration, improves drainage in tight soils and creates plant-growth supporting qualities, or tilth [3]. Sandy soils are well ventilated and drained due to the high percentage of large pores, which makes their total porosity low when compared to clay soils and is quick to drain because of its low ability to retain water and the available water was few, the specific surface area and cation exchange capacity and its organic matter content is very low. So it is considered a poor soil in its nutrient availability and its ability to retain nutrients is low [4-6]. Deserts is a part of earth which receive very low amount of rain fall, less than 250 mm annually. Approximately 1/3 part of earth is included in deserts. There are 25 deserts in different continents of world, there are 4 major kind of deserts where, Egypt amongst subtropical deserts [7]. Of desert soils, the fungi can reach high proportions among the isolates [8]. Among the 246 new fungal taxa described in the last 60 years from the Middle East, mainly desert and salt marsh soils, 53 species are soil fungi [9], many of which are adapted to high temperatures or high salt concentrations. Alkaliphilic and alkalitolerant fungi form another ecological group that is adapted to unusual substrata. In highly alkaline soils a range of fungi that grow well on agar media with pH 9.8, particularly of *acremonium*-like and *Fusarium* species, has been found in Indonesia [10].

Based on fertility and healthy of desert soils in Upper Egypt, the present study aimed for studying: 1)

Soil analyses including soil texture, moisture and organic matter contents, pH values, total dissolving element salts in addition to macro- (Ca^{++} Mg^{++} & K^{+}) and micro- (Fe^{++}, Mn^{++} & Zn^{++}) element plus sodium (Na^{+}) as stress element. 2) Filamentous fungi /(frequencies and counts) isolated and identified from the soils with special reference to pathogenic and protecting fungal genera and species.

MATERIALS AND METHODS

A total of 40 samples (each, ~ 500 g) of desert soils were collected through autumn, winter and spring 2020 and 2021 from rhizosphere of 25 plants (17 species of 15 genera) in Upper Egypt (~ 600 km North Cancer Orbit) including Sohag, Qena, Luxor, Aswan and Red Sea Governorates (Table 1).

1- Analysis of soil samples

Of soil texture, the pipette method was used for particle-size [11]. Moisture content (M.C.) was determined by drying the soil sample (100 g) in an oven at 105°C for 24h and the percentage (M.C.%) was calculated according the equation

$$\text{M. C. \%} = \frac{\text{W1} - \text{W2 x 100}}{\text{W1}}$$

W_1 = initial weight (100 g) of soil W_2 = dry weight of soil

Organic carbon was determined by wet digestion method [12] through oxidation of soil carbon using acid dichromate reagent. Total dissolving salts were estimated by evaporation of soil solution (1:10) in an oven at 105°C and the percentage per dry soil was calculated. The pH-meter (EUTECH instruments pH 510 pH/mV/°C meter) was used for determination of soil pH. The pH was measured potentiometrically in a suspension of 10 g soil in 100 ml sterile dist. water. Cation exchange capacity was calculated as sum of charge equivalents of exchangeable K^{+}, Na^{+}, Ca^{++}, Mg^{++}, Fe^{++}, Zn^{++} and Mn^{++} as determined in 5 g soil in 100 ml sterile bi-dist. water by flame atomic absorption spectrophotometer (Perkin Elmer analyst 400 model). Total elemental contents were measured in dilute HNO3 solutions [13, 14].

2- Isolation and identification of soil fungi

Filamentous fungi were isolated by dilution plate method [15] on 1% glucose-Czapek's agar medium ($NaNO_3$, 2g; KH_2PO_4, 1g; $MgSO_4$. $7H_2O$, 0.5g; KCl, 0.5g; glucose, 10g; agar-agar, 18g; per 1 liter) at 28°±1°C. Isolated, predominant, morphologically distinct colonies were selected, purified by repeated culturing and maintained on glucose-Czapek's agar slants at 4°C. The isolates were identified based on their colony characteristics and microscopic observations including hyphae and spores morphology [16-23].

RESULT

Soil analyses

The desert soil was subjected to some chemical analyses as the followings:

1- Moisture content: The moisture content (M. C. %) was fluctuated between 0.2 – 9.6 % (mean = 2.59 % M. C.) of which 33 and 7 samples had ≥ 5 % and 5-10 % M.C., respectively.

2- Organic matter content: The organic matter (O.M. %) was fluctuated between 0.006 -0. 90 % (mean = 0.28 % O.M.) of which all samples had ≥ 1 % O.M.

3- pH value: All samples were alkaline and the pH value was ranged between 7.28 – 9.25 (mean = 9) of which 4, 18 and 18 samples tested had pH 7-8, 8-9 and ≤ 9, respectively.

4- Total dissolving salts: Concerning of total dissolving salts (T.D. S.) of the soil tested, a highly fluctuation were detected and the T.D. S. was estimated by 0.005-1.75mg /g (mean = 0.53) of which 6, 4, 2, 21 and 7 samples contained ≥ 0.025, 0.025- 0.050, 0.050-0.100 and 0.01-1.00 and ≤ 1.00 mg/g soil, respectively.

5- Element contents: Based on total dissolving salts of the soils , the water extracts (di-ionized water) were subjected for estimating the concentrations of mono- (Na^{+} and K^{+}) and bi-equivalents (Ca^{++}, Mg^{++}, Fe^{++}, Mn^{++}, Cu^{++} and Zn^{++}) ions.

I- Mono-equivalent ions

a- Sodium ions (Na^{+}) had the highest in counts amongst the cations of the desert soil tested and fluctuated between1870-96000 (mean = 31,903.75) µg/g x 10^{-3}.

b- Potassium ions (K^{+}) (the second mono-equivalent cation) were in general very low compared with sodium ions and varied between 6.6 - 34.8 (mean = 16.933) µg/g x 10^{-3}.

II- Bi-equivalent ions

Five bi-equivalent ions were calculated in the soil extracts of the desert soils under investigation . The cations (ions) were classified into macro-elements (Ca^{++} and Mg^{++}) and micro-elements(Fe^{++}, Mn^{++} and Zn^{++}) based on their utilization by the plants.

1- Macro-elements: The two macro-elements were calcium (Ca^{++}) and magnesium (Mg^{++}), where Ca^{++} had the higher counts in Egyptian soils and fluctuated between 8.1-854.0 (mean = 144.985) µg/g x10^{-3} . Whereas, Mg^{++} were very less in counts compared with Ca^{++} and ranged between 2.2-103.2 (mean =10.595) µg/g x 10^{-3}.

2- Micro-elements (trace elements): Three micro-elements ions (Fe^{++}, Mn^{++} and Zn^{++}) were subjected for quantities analyses. Fe^{++} had the best counts and ranged between 0.034-2.868 (mean = 0.512) µg/g x10-^{3}. Manganese (Mn^{++}) and Zinc (Zn^{++}) contents in soil were very low compared with iron (Fe^{++}) ions. Zn^{++} was detected in all samples varied between 0.010-0.091 (mean = 0.034) µg/g x10-^{3} in bi-ionized dist. H_2O

extracts of desert soils. Whereas, Mn^{++} had the lowest in quantily and estimated by 0-841 (mean = 0.076) µg/g x10-^{3} with regarding completely disappeared in 6 samples of the tested soils (Table,1).

Table 1: Collection of desert soil (40 samples) from the rhizosphere of dominant plants in Upper Egypt and their moisture contents (M.C. %) with some chemical analyses of soil including organic matter content (O.M%), pH values (pH), total dissolved salts (T.D.S mg/g) and some ions of elements µg/g x10^{-3} including mono-equivalent (Na^{+} and K^{+}) and bi- equivalent ($Ca^{++,}$ Mg^{++}, Fe^{++}, Zn^{++} and Mn^{++})

Sample No.	Place of collection	Latin name of the plant	M.C. %	O.M %	pH	T.D.S mg/g	Element µg/g x10^{-3}						
							Na^{+}	K^{+}	Ca^{++}	Mg^{++}	Fe^{++}	Mn^{++}	Zn^{++}
1	Sohag	*Citrullus colocynthis*	1.8	0.09	8.34	0.160	2000	51.5	854	13.3	0.0264	0.036	0.035
2	Sohag	*Pulicaria undulata*	1.5	0.22	8.93	0.266	1980	17.8	210	5.3	0.262	0.004	0.032
3	Sohag	*Pulicaria crispa*	0.96	0.20	9.73	0.071	22200	10.8	61.6	3.7	0.249	0	0.022
4	Sohag	*Alhagi maurorum*	0.83	0.20	9.85	0.010	48200	11.5	44.6	3.2	0.264	0.126	0.026
5	Sohag	*Citrullus colocynthis*	0.62	0.08	8.93	0.320	31400	23.1	122.2	11.7	0.368	0.127	0.032
6	Sohag	*Ziziphus spina-christi*	2.1	0.02	7.61	0.011	42600	6.6	14	2.2	0.769	0	0.017
7	Sohag	*Zilla spinose*	0.2	0.10	9.50	0.180	22900	15.6	56.6	3.5	0.307	0.009	0.02
8	Sohag	*Pulicaria crispa*	1.1	0.079	8.92	0.100	26600	10.8	20.2	3.5	1.731	0.001	0.032
9	Sohag	*Artemisia herba-alba*	3.09	0.038	8.43	0.321	22300	11.7	118	2.2	0.777	0.007	0.034
10	Sohag	*Zygophyllum coccineum*	0.4	0.09	9.00	0.008	26000	11	27.3	3.5	1.596	0.011	0.038
11	Marsa alaem	*Zygophyllum coccineum*	5.4	0.38	9.00	0.343	24000	12.6	160	3.8	0.269	0.001	0.036
12	Wadi-Elgemal	*Tamarix nilotica*	3.08	0.24	9.12	0.060	21000	26.2	214.4	36.8	0.270	0.841	0.041
13	Wadi-Elgemal	*Acacia tortilis*	7.6	0.33	8.68	0.220	20200	15.5	147	11.9	0.252	0.122	0.046
14	Marsa alaem	*Tamarix nilotica*	6.2	0.34	8.17	0.043	26300	9.2	313	3.9	0.258	0.006	0.036
15	Marsa alaem	*Artemisia herba-alba*	7.6	0.24	8.57	0.505	37700	8.9	358	4.2	0.300	0.012	0.033
16	Marsa alaem	*Zygophyllum coccineum*	6.8	0.26	8.99	0.019	36300	17.3	135	10.2	0.357	0.035	0.05
17	Marsa alaem	*Tamarix nilotica*	9.6	0.38	9.55	0.039	32000	20.2	124	13.5	0.259	0	0.048
18	Marsa alaem	*Artemisia herba-alba*	0.47	0.57	9.67	0.950	70500	7.4	8.1	2.2	0.353	0.048	0.034
19	Qena	*Zilla spinose*	1.58	0.40	9.71	0.900	42200	8.1	9.9	14.6	0.268	0.038	0.042
20	Qena	*Sonchus oleraceus*	4.6	0.90	9.70	0.671	26200	16.8	14.6	10.2	0.713	0.116	0.035
21	Qena	*Phragmites australis*	1.66	0.19	9.68	0.722	38000	13.9	18.6	8.5	0.800	0.214	0.037
22	Qena	*Pulicaria undulata*	4.06	0.30	9.68	0.828	30400	12.6	17.1	3.5	0.279	0.001	0.034
23	Luxor	*Pulicaria crispa*	6.24	0.63	9.90	0.850	37000	11	22.6	5.7	0.261	0.011	0.018
24	Luxor	*Citrullus colocynthis*	4.85	0.17	9.77	0.700	24200	15.8	23.7	10.5	0.369	0.128	0.022
25	Luxor	*Alhagi maurorum*	1.61	0.24	8.98	1.40	61200	30.6	357	10.5	0.258	0.007	0.038
26	Aswan	*Zygophyllum album*	0.79	0.54	9.53	0.036	1870	16.4	490	6.5	0.256	0.004	0.091
27	Aswan	*Rauwolfia vomitoria*	0.46	0.52	9.72	0.084	28800	28.6	64.9	5.8	0.233	0.023	0.022
28	Aswan	*Imperata cylindrical*	1.22	0.36	9.77	0.03	44000	17.9	54.2	3.7	0.034	0.044	0.032
29	Sohag	*Cynodon dactylon*	1.02	0.94	9.66	0.660	32600	29.8	174	10.1	0.262	0.097	0.036
30	Sohag	*Sonchus oleraceus*	2.06	0.33	9.82	1.15	36000	25.5	128.2	11.8	0.271	0.028	0.029
31	Sohag	*Tamarix nilotica*	1.97	0.006	8.55	1.55	96000	16.5	665	103.2	0.361	0.163	0.01
32	Sohag	*Artemisia herba-alba*	0.85	0.092	8.80	1.30	32100	11.8	54	3.1	0.919	0	0.021
33	Sohag	*Pulicaria crispa*	1.25	0.007	9.57	0.005	25900	12.4	37.9	3.6	0.353	0	0.034
34	Sohag	*Zilla spinose*	0.85	0.42	8.60	0.855	24200	23.2	48.4	4.8	0.400	0.102	0.044
35	Sohag	*Imperata cylindrical*	1.57	0.12	7.54	1.75	28100	8.9	38.7	2.5	2.868	0.413	0.028
36	Sohag	*Solanum nigrum*	1.08	0.20	7.62	1.00	29200	10.8	82.2	6.9	0.590	0.001	0.040
37	Sohag	*Artemisia herba-alba*	2.37	0.20	7.28	0.607	48000	14.6	56	2.2	0.620	0	0.026
38	Sohag	*Citrullus colocynthis*	2.31	0.24	8.43	0.006	21200	11.4	55.4	18.8	0.497	0.06	0.035
39	Sohag	*Artemisia herba-alba*	0.69	0.21	8.42	1.45	26400	18.2	64	13.7	0.655	0.099	0.034
40	Sohag	*Solanum nigrum*	1.23	0.22	8.45	0.972	28400	34.8	335	25	0.269	0.160	0.037
Average (mean)			0.2-9.6 (2.59)	0.006-0.90 (0.28)	7.28-9.85 (9.00)	0.005-1.75 (0.53)	1870-96000 (31,903.7	6.6-34.8 (59.17)	8.1-854.0 (519.54)	2.2-103.2 (63.61)	0.034-2.868 (0.264)	0-0.841 (0.072)	0.010-0.091 (0.039)

Mycoflora of desert soils

Forty samples of desert soils were examined with isolation and identified of filamentous fungi to species levels on 1% glucose-Czapek's agar at 28°C. The gross fungal count was moderate (94.36 colonies/mg dry soil) in the soils (Table 2).

A total of 121 fungal species + 7 varieties of 32 genera were identified from the soils tested. *Aspergillus* was quite the most dominant based on frequency (95% of the samples) and count (55.34% of gross count). The genus was represented by 36 species + 4 varieties. *A. niger* and *A. terreus* were superior in counts collectively, 41.7% of total aspergilli. *A .versicolor* and *A. fumigatus* had moderate counts (collectively, 34.85%) and moderate occurrence (27.5 & 25% of the samples, respectively). Two species (*A. carbonarius* and *A. ustus*) in addition to 2 species varieties (*A. terreus* var. *aureus* and *A. terreus* var. *africanus*) were low in frequencies (22.5 or 12.5% of the samples) with variable counts (collectively, 12.64%). Whereas, other *Aspergillus* species were identified in low frequencies (2.5 - 10% of the sample) with counts collectively, 10.8 % of gross count.

Penicillium (28 species and 1 species variety) was isolated and identified from desert soils tested represented 26.83% of gross count, of which 2 species (*P. citrinum* and *P. funiculosum*) had variable degree of counts, and occurrence. *P. citrinum* was superior of *Penicillium* count (15.32% of gross fungal count) and moderate frequencies (30% of the samples). Whereas, *P. funiculosum* was observed in low frequencies (15% of the samples) with moderate count (13.27% of gross fungal count). The remaining penicillia were rare in frequencies (2.5-7.5% of the samples) with variable counts (collectively, 71.41% of gross fungal count).

Ulocladium occupied the third place according the occurrence (22.5% of the samples) and count (3.18% of gross fungal counts). Of the genus, 7 species were isolated and identified. *U.* ***alternariae*** was the dominant (12.5% of the samples; 24% of total *Ulocladium* and 0.76 % of gross count). Whereas, the other 6 species had low counts (collectively, 76% of total *Ulocladium*) with rare occurrence (2.5- 10% of the samples).

Acremonium (*A. strictum* and *A. implicatum*) had the fourth place based on frequency and count (20% of the samples and 1.61% of gross count), *A. strictum* was parallel with the genus as frequency (20% of the samples) and count (86.84% of total *Acremonium*). But, *A. implicatum* was less in frequency and count (2.5% of the samples and 13.16% of total *Acremonium*). *Scopulariopsis* (3 species) had the fifth place and was parallel with the genus *Acremonium* as frequency (20% of the samples) and count (1.89% of gross count). Whereas, four genera (11 species) namely: *Botryotrichum, Torula, Emericella* and *Fusarium* were detected in low frequencies of occurrence (12.5% - 15% of samples) with very low in counts (0.25% - 1.31% of gross count).

Regarding of the rare frequency of occurrence (≥ 10% of the samples) of desert soil, 36 species of 23 genera were listed. Of the previous genera 1, 2, 6 and 14 genera were represented by 4, 3, 2 and 1 species, respectively collectively accounting 7.63% of gross fungal count. The dematiaceous hyphomycetes e.g *Humicola* (3 species), *Alternaria* and *Curvularia* (each, 2 species), *Monodictys, Oidiodendron, Drechslera* and *Phoma* (each, 1 species) in addition ascospore-forming fungi e.g *Eurotium* (3 species), *Chaetomium* and *Microascus* (each, 1 species) were rare in frequencies and counts. Sterile mycelia (black and white) were dominant (52.5 % of the samples and 1.99% of gross fungal count) as shown in Table, 2.

Table 2: Total count (TC) of fungal genera and species isolated from desert soils (40 samples), number of cases of isolation (NCI) and occurrence remark (OR) on 1% glucose-Czapek's agar at 28 ± 1°C

Type of soil / Genera & species	Desert (sandy or loam) soil	
	T.C	**N.C.I & O.R**
Aspergillus	**52.22**	**38 H**
A. niger Van Tieghem	9.22	25 H
A. terreus Thom	12.56	21 H
A .versicolor (Vuillemin) Tiraboschi	15.44	11 M
A. fumigatus Fresenius	2.76	10 M
A. terreus var. *aureus* Thom & Raper	4.20	9 L
A. carbonarius (Bainier) Thom	0.96	5 L
A. terreus var. *africanus* Fennell & Raper	0.80	5 L
A. ustus (Bainier) Thom & Church	0.64	5 L
A. flavus Link	1.40	4 R
A. flavipes (Bainier & Sartory) Thom & Church	0.16	4 R
A. sulphureus (Fresenius)Thom & Church	0.24	4 R
A. sydowii (Bainier & Sartory) Thom & Church	0.24	4 R
A. candidus Link	0.44	4 R
A. carneus Blochwitz	0.12	3 R
A. spelunceus Raper & Fennel	0.28	3 R
A. allahabadii Mehrotra & Agnihotri	0.40	2 R
A. deflectus Fennell & Raper	0.16	2 R
A. flavus var. *columnaris* Raper & Fennell	0.08	2 R
A. ***fumigatiaffinis*** **Hong, Frisvad & Samson**	0.20	2 R
A. caespitosus Raper & Thom	0.04	1 R
A. asperescens Stolk	0.36	1 R
A. melleus Yukawa	0.08	1 R

A. wentii Wehmer	0.08	1 R
A. awamori Nakazawa	0.20	1 R
A. cervinus Massee	0.04	1 R
A. oryzae (Ahlburg) Cohn	0.04	1 R
A. rugulosus Thom & Raper	0.04	1 R
A. tamarii Kita	0.04	1 R
A. ochraceus Wilhelm	0.04	1 R
A. ambiguus Sappa	0.48	1 R
A. ficuum (Reich.) Hennings	0.04	1 R
A. chrysellus Kwon & Fennell, n.sp.	0.04	1 R
A. flaschentraegeri Stolk	0.04	1 R
A. granulosus Raper & Thom	0.12	1 R
A. janus var. *brevis Raper & Thom*	0.04	1 R
A. kanagawaensis Nehira	0.04	1 R
A. microcysticus Sappa	0.04	1 R
A. nutans McLennan & Ducker	0.04	1 R
A. parasiticus Speare	0.04	1 R
*A. **puniceus*** Kwon-Chung & Fennell	0.04	1 R
Penicillium	**25.32**	**28 H**
P. citrinum Thom	3.88	12 M
P. funiculosum Thom	3.36	6 L
P. asperum (Shear) Raper & Thom	0.20	3 R
*P. **resticulosum*** Birkinshaw, Raistrick & G. Smith	0.28	3 R
*P. **caseicolum*** Bainier	4.28	3 R
P. aurantiocandidum Dierckx	9.68	3 R
P. solitum Westling	0.40	3 R
P. pallidum G.Sm	0.20	2 R
P. piceum Raper & Fennell	0.08	2 R
P. verruculosum Peyronel	0.12	2 R
P. lanosocoeruleum Thom	0.72	2 R
P. lanosum Westling	0.16	2 R
P. duclauxii Delacroix	0.40	2 R
P. piscarium Westling	0.16	2 R
P. corylophilum Dierckx	0.04	1 R
P. italicum Wehmer	0.04	1 R
P. janthinellum Biourge	0.04	1 R
P. jensenii Zaleski	0.04	1 R
P. variabile Sopp	0.04	1 R
P. camemberti Thom	0.12	1 R
P. nigricans Bainier	0.04	1 R
P. putterillii Thom	0.04	1 R
P. javanicum Van Beyma	0.28	1 R
P. expansum Link	0.04	1 R
P. kapuscinskii Zaleski	0.04	1 R
P. lilacinum Thom	0.56	1 R
P. luteum Zukal	0.04	1 R
P. psittacinum Thom	0.04	1 R
P. diversum var. *aureum* Raper & Fennell	0.04	1 R
Ulocladium	**3.00**	**9 L**
*U. **alternariae*** **(Cooke) Simmons**	0.72	5 L
U. botrytis Preuss	0.92	4 R
U. atrum Preuss	0.56	3 R
*U. **oudemansii*** Simmons	0.56	3 R
U. chartarum (Preuss) Simmons	0.08	2 R
U. chlamydosporum Mouchacca	0.12	1 R
U. consortiale (Thüm.) Simmons	0.04	1 R
Acremonium	**1.52**	**8 L**
A. strictum W. Gams	1.32	8 L
A. implicatum (Gilman & Abbott) Giraldo, Gen & Guarro	0.20	1 R
Scopulariopsis	**1.78**	**8 L**
S. brumptii Salvanet-Duval	0.34	3 R
S. brevicaulis (Saccardo) Bainier	0.32	3 R
S. candida (Gugéguen) Vuillemin	1.12	3 R
Botryotrichum	**1.24**	**6 L**
B. piluliferum Saccardo & Marchal	0.68	5 L
B. atrogriseum Van Beyma	0.56	4 R
Torula	**0.24**	**6 L**
T. herbarum (Pers.) Link ex S. F. Gray	0.16	4 R
T. graminis Desm.	0.08	2 R
Emericella	**0.80**	**5 L**

E. nidulans Eidam	0.64	2 R
E. nidulans var. lata Thom & Raper	0.08	2 R
E. ***nidulans* var. *acristata*** Fennell & Raper	0.04	1 R
E. violaceus Fennell & Raper	0.04	1 R
Fusarium	**0.36**	**5 L**
F. oxysporum Schlechtendal	0.16	4 R
F. moniliforme Sheldon	0.16	3 R
F. chlamydosporum Wollenweber & Reinking	0.04	1 R
Humicola	**0.36**	**4 R**
H. fuscoatra Traaen	0.12	2 R
H. grisea Traaen	0.16	1 R
H. insolens Cooney & Emerson	0.08	1 R
Rhizopus	**1.08**	**4 R**
R. oryzae Went & Prinsen-Geerligs	0.08	1 R
R. stolonifer (Ehrenb.) Vuill	1.00	3 R
Stachybotrys	**0.24**	**4 R**
S. kampalensis Hansf.	0.04	1 R
S. chartarum (Ehrenberg) Hughes	0.04	1 R
S. ***sansevieriae*** G.P. Agarwal & N.D. Sharma	0.12	1 R
S. albipes Berkeley & Broome	0.04	1 R
Alternaria	**0.12**	**3 R**
A. alternata (Fries) Keissler	0.08	2 R
A. citri Ellis & Pierce apud Pierce	0.04	1 R
Drechslera spicifera (Bainier) Von Arx	**0.20**	**3 R**
Macrophomina phaseolina (Tassi) Goidanich	**0.12**	**3 R**
Rhizoctonia solani Kühn	**1.2**	**3 R**
Trimmatostroma	**1.64**	**3 R**
T. betulinum (Corda) Hughes	0.72	3 R
T. salicis Corda	0.92	2 R
Ascotricha guamensis Ames	**0.28**	**2 R**
Cladosporium	**0.64**	**2 R**
C. sphaerospermum Penzig	0.60	1 R
C. herbarum (Persoon) Link	0.04	1 R
Eurotium	**0.12**	**2 R**
E. amstelodami Thom & Church	0.04	1 R
E. chevalieri Mangin	0.04	1 R
E. proliferans Smith	0.04	1 R
Mucor	**0.16**	**2 R**
M. racemosus Fresenius	0.04	1 R
M. hiemalis Wehmer	0.12	1 R
Acrophialophora fusispora (Saksena) Samson	**0.08**	**1 R**
Chaetomium globosum Kunze	**0.04**	**1 R**
Circinella simplex Van Tieghem	**0.12**	**1 R**
Curvularia	**0.08**	**1 R**
C. pallescens Boedijn	0.04	1 R
C. verruciformis Agarwal & Sahni	0.04	1 R
Cylindrocarpon candidum (Link)Wollenweber	**0.28**	**1 R**
Gliocladium roseum Bainier	**0.04**	**1 R**
Microascus trigonosporus Emmons & Dodge	**0.04**	**1 R**
Monodictys castaneae (Wallroth) Hughes	**0.08**	**1 R**
Oidiodendron griseum Robak	**0.04**	**1 R**
Paecilomyces. terricola (Mill., Giddens & Foster) Giraldo, Gen & Guarro	**0.04**	**1 R**
Phoma exigua Desmazieres	**0.20**	**1 R**
Sterile mycelium (S.m.)	**1.88**	**21 H**
S.m (white)	1.24	12 M
S.m (black)	0.64	9 L
Gross total count	**94.36**	
No. of genera and species	**121 sp. + 7 var. of 32 genera**	
No. of infected samples	**100%**	

Occurrence Remark (OR):

H: High occurrence, 20-40 samples (50-100% of the samples).

M: Moderated occurrence, 10-19 samples (25-47.5% of the samples).

L: Low occurrence, 5-9 samples (12.5-22.5% of the samples).

R: Rare occurrence, 1-4 samples (2.5-10% of the samples).

DISCUSSION

Fungi are very successful inhabitants of soils, due to their high plasticity and their capacity to adopt various forms in response to adverse or un favorable

conditions [24]. Due to their ability to produce a wide variety of extracellular enzymes, ability to break down all kinds of organic matter, decomposing soil components and there by regulating the balance of carbon and different nutrients [25]. Fungi convert dead organic matter into biomass, organic plus amino acids and carbon dioxide [26]. The diversity and activity of fungi is regulated by various biotic (plant and other organisms) and abiotic (soil pH, moisture, salinity, structure and temperature) factors [27, 28]. Fungi can be found in almost every environment and can live in wide range of abiotic factors [29]. Therefore, the present study was designed to throw light on soil analyses, and mycoflora of desert soils in Upper Egypt.

1- Soil analyses

Regarding the results obtained, the desert soil were sandy or sandy/loam, low moisture contents (seldom of rain), low organic matter, alkaline pH with moderate total dissolving salts. The elements in the soil samples had available contents of macro-elements (K^{+}, Ca^{++} & Mg^{++}) in addition to Fe^{++} with low contents of Mn^{++} and Zn^{++} as micro-elements whereas, Na^{+} as stress element was moderate in most samples tested. Based on soil analyses with correlation the micro-organisms (bacteria and fungi) of the previous literatures in this aspect, soil health and the closely related terms of soil quality and fertility, is considered as one of the most important characteristics of soil ecosystems. The integrated approach to soil health assumes that soil is a living system and soil health results from the interaction between different processes and properties, with a strong effect on the activity of soil microbiota [26]. The colonization of land by plants appears to have coincided with the appearance of mycorrhiza- like fungi. Over evolutionary time, fungi have maintained their prominent rate in the formation of mycorrhizal associations. In addition, however they have been able to occupy other terrestrial niches of which the decomposition of recalcitrant organic matter is perhaps the most remarkable [30]. Plant roots exude substantial amounts of low molecular weight organic compounds such as amino acids, sugars and organic acids, resulting in increased microbial population and activity [31-34]. During the evolution of terrestrial microbial life, fungi become the major decomposers of recalcitrant organic matter. Bacteria on the other hand have been able to maintain a significant role in the degradation of simple substances [30].

The soils had alkaline pH values (7.28 - 9.85), where 20 samples (50%) had pH 9 or more (9 - 9.85). The variation in soil pH is related to parent material, rainfall, topography and organic matter content of the soil [1]. In this respect, The correct pH is crucial for the healthy plant growth and its effects on the amount of nutrient available [35]. Also, soil pH is considered as one of the most essential factors influencing plant up take of trace elements [36]. Based on the results obtained concerning total dissolving salts (TDS) and sodium ions (Na^{+}) concentrations in the soils tested, the soil had moderate concentration of TDS (mean= 0.53 µg/g dry soil) as well as Na^{+} concentration (mean= 31903.75 µg/g $x10^{-3}$). According to the previous studies concerning the salinity and saline-alkaline soils, soil salinity is one of the key factors that chreatens plant existence worldwide and is a major challenge to sustain crop production and soil quality. It limited research on there's pones of microbial communities and enzyme activities under soil amendments application of saline-alkaline soils [37]. Agricultures land derived from saline-alkaline soils will not have high plant growth and productivity unless they are ameliorated by using the appropriate agronomic and amendments practices [38]. Soil enzyme activity play a key role in nutrients recycling making them accessible to plants and micro-organisms [39]. Soil micro-organisms are considered to be one of the vital factors for evaluating soil quality and the application of soil amendments increasing the enzyme activity, which leads to a higher yield [38, 40, 41]. Also, regulations of the microbial community composition and function involve a pH-dependent mechanism [39]. Concerning the available micro-elements contents, three elements (Fe^{++}, Mn^{++}& Zn^{++}) were estimated, where the iron ions have the best counts in the soils tested. In this respect, iron (Fe) is one of the most studied element and the most important in mineral nutrition of the plants [2].

2- Soil mycoflora

Of desert soil ,the gross fungal count of filamentous fungi was low in desert compared with cultivated soil (94.36 and 652.4 colonies/mg dry soil, respectively; each, 40 samples). Regarding soil analyses, the moisture and organic matter contents were very low in desert, with sharply increase of alkaline pH values [68]. Also, number of genera and species was retarded (121 sp. + 7 var. of 32 gen. and 148 sp. + 7 var. of 4 gen., in both desert and cultivated soils, respectively). In this respect, the diversity and activity of fungi is regulated by various biotic (plant and other organisms) and abiotic (soil pH, moisture and organic matter contents, salinity and temperature factors [27, 28]. The great majority of fungal species are likely to occur in the soil environment at some stage in their life-cycle, having different function in soils, which include both active roles such as degradation of dead plant materials, or in active roles where propagules are present in soil as resting states [42]. The fungal contribution to the decomposition of easily degradable substrates is highest in acid soils and this pattern has been attributed to the ability of fungi in its superior osmotic stress tolerance capabilities in comparison with those of the bacteria [43].

Concerning to isolated fungal genera and their species, *Aspergillus* (95% of samples; 36 species + 4 varieties) and *Penicillium* (70%, 28 sp.+ 1 var.) collectively represented 82.17% of gross count were the highest in frequencies and counts. In this respect, the

two genera are cosmopolitan and prevalent components of different ecosystems in a wide range of environmental and climatic zones [16, 17, 22, 23, 44-50]. In the same way, the two genera, respectively were the dominant in cultivated soil (70.55% of gross count) of the same region in Upper Egypt (~ 600km Northern Orbit of Cancer). Also, since Montasir 1956, the previous two genera in addition to *Fusarium* and some species of dematiaceous hyphomycetes plus order: Mucorales were the dominant in Egyptian desert and cultivated soils and some arab counties [23, 49, 51, 52]. Samson *et al.*, [53] reported that, the genera of *Aspergillus* and *Penicillium* include more than 680 species, both pathogenic and beneficial. Several species are pathogenic to plants, animals and human and/or produce different types of toxins. On the other hand, several species are widely used in different industrial applications e.g. production of foods, drugs, drinks, organic acids and large varieties of enzymes. Regarding to isolated and identified species (62 species + 5 varieties) of the two genera, two species were high (*A. niger* and *A. terreus*), three moderate (*A. versicolor, A. fumigates* and *P. citrinum*) and 3species plus 2 varieties in low (*A. Carbonarius, A. ustus, A. terreus* var. *aureus, A terreus* var. *africanus* and *P. funiculosum*) frequencies, respectively. The previous fungi except, *A. terreus* var. *aureus* and *A. terreus* var. *africanus*, were widely detected in the desert soils. In other hand, some fungal species including *A. flavus, P. chrysogenum* and *P. corylophilum* were widely detected from the soils in Egypt and some arab countries [23, 49, 50, 52] and less in the present study.

Dematiaceous hyphomycetes (DH) occupied the second group of desert soil based on number of genera and species (33 species of 14 genera) in low count (7.46% of gross count). Based on isolated species and their genera of DH, *Ulocladium* and *Stachybotrys* (each, 7 species) had the highest number of species, whereas, *Ulocladium* and *Trimmatostroma* (7 & 2 species, respectively) had the best counts (collectively, 65% of total DH). DH are darkly pigmented fungi found all over the world as plant pathogens, saprophytes [54], some toxigenic [55, 56], opportunistic human and animal pathogens [57, 58, 59] in addition to mycotic Keratitis [59, 60, 61]. *Stachybotrys* and *Trimmatostroma* were widely detected with variation of species number in desert soil [23, 49, 62]. Regarding to chemical analyses of desert soil in this study, the two genera may amongst alkaliophilic and xerophilic fungi. This group (DH) was widely observed as air-borne fungi in addition to phyllosphere and phylloplane of some desert plants [62, 63].

Of *Fusarium* and *Fusarium* related genera as pathogenic and/or root infecting fungi (7 species of 4 genera) were isolated and identified of which *Acremonium* (2 species, 20% of samples and 1.61% of gross count), *Fusarium* (3, 12.5% and 0.38%, respectively) in addition to *Rhizoctonia* and *Cylindrocarpon* (each, 1 species, 2.5-7.5% and totally, 1.57%, respectively). Regarding to these genera in the previous literature and reviews, *Fusarium* is a cosmopolitan genus of filamentous fungi that includes many toxin-producing plant pathogens of agricultural products. Collectively, *Fusarium* diseases are including wilts, blight, rots and cankers in many horticultural, field, ornamental and forest crops in both agricultural and natural ecosystems and opportunistic human pathogens [64]. Acremonium was widely detected from tropical [65] and subtropical [23, 49, 66, 68] regions of the world including desert, cultivated and saline soils in addition to grains with silica shell [67]. The latter two species (*Rhizoctonia solani* and *Cylindrocarpon candidum*) were rare in frequencies and counts in desert soil, in other side, *C. candidum* had clearly (3 species) dominant in cultivated soil [68]. Based on chemical analyses of desert and cultivated [68] soils (each, 40 samples, ~ 60 km north cancer orbit) with regarding of frequencies and counts of the 4 genera, *Fusarium* and *Cylindrocarpon* are acidophilic (or acidiotolerant) fungi with available moisture and organic matter contents. Whereas, *Acremonium* trands may alkaliophilic (or alkaliotolerant) and *Rhizoctonia* needs more studied in this field.

Three genera of order: Mucorales were detected and identified in rare frequencies (2.5-10% of the samples) with very low in counts (0.12-1.08% of gross count). Of the genera, 5 species were observed in rare occurrence with promotion *Rhizopus stolonifer* (7.5% of samples and 73.53% of total Mucorales), whereas the remaining species were rare with very low in count (each, 2.5% and collectively 26.47 of total Mucorales). In this respect, most species of Mucorales with ruderal characteristics, including rapid growth, prolific spore production relatively simple fixed carbon compounds [69, 70, 71], degrade organic matters [30] and safe biodegradation of hydrocarbons [72]. Mucoromycota (e.g. Mucorales) have the ability to accumulate of lipids (in dry cells) in high biomasses especially *Cunninghamella* [73, 74], *Mucor* [75, 76], *Rhizopus* [77, 78] and *Syncephalastrum* [78]. On other side, species of Mucorales cause mucomycosis, a rare but highly fatal infection, causing cutaneous, rhino-orbital, pulmonary, rhino-cerebral and disseminated bloods stream infections [79]. Recently, these fungi, genus *Mucor*, have be frequently reported associated by COVID-19 pations as black fungus [80].

Regarding Ascospore-forming fungi isolated and identified from the desert soil, a total of 8 species in addition to 2 varieties of 5 genera (*Emericella, Eurotium, Ascotricha, Chaetomium, Microascus*) were detected represented 1.36% of total fungi. In this regards, the great majority of fungi (~ 80000 species) were named and described to occur in the soil environment, having many different functions in soils, which include both active roles or inactive roles where propagules are present in the soil as resting states of

which about 17% of the known fungal species can be successfully grown in culture [42]. Of the previous genera 8 species and 2 varieties were identified in rare frequencies (2.5-5% of the samples). Some of the detected species are known by ability of mycotoxins producers e.g. sterigmatocystin by *Emericella nidulans* [81], Chaetoglobosins A & C by *Chaetomium globosum* [82], anthraquinones by *Eurotium glaucus* especially *E. chevalieri* [83, 84].

Sterile mycelia (filamentous fungi without spores) were highly detected (52.5% of the samples) in desert soil with low counts (1.99% of gross count). The sterile mycelia were represented by white (30% of samples and 65.96 of total sterile mycelia) and dark (22.5% and 34.03, respectively). Concerning of the previous literatures, sterile mycelia were detected as endophytic fungi [85]. Also [85] proved that black sterile mycelia stimulated the growth of wheat plant whereas, white depressed the rate of growth.

CONCLUSION

Based on, some physico-chemical analyses and filamentous fungi survey of desert soil in Upper Egypt, the soil is not fertile but may healthy in agricultural trends. Also, analysis of water source must take in consideration.

RECOMMENDATION

Reclamation of desert soil, biofertilizer mast carry's out for increasing the fertility with decreasing the pH value of the soil, especially by using available strains of yeasts.

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