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Mycoflora of Desert Sand Dunes of Riyadh Region, Saudi Arabia

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Abstract. Sand dunes collected from different locations around Riyadh were screened for fungal flora. A total number of forty seven species of fungi were isolated from the rhizosphere of sand dune plants while only fourteen species were isolated from non-rhizosphere sand dunes at different media used. Physical, mechanical and chemical analyses of sand dunes were also carried out. Thirty eight osmophilic fungal species were isolated on M20 and M40 medium and thirty thermophilic fungal species isolated from rhizosphere and non-rhizosphere sand dunes. The genus *Aspergillus* was predominant, exhibiting highest number of species in all the cases.

Introduction

The mycoflora of coastal and lake sand dunes have been extensively studied and include the mycorrhizae associated with plants [1-5], as well as lignicolous fungi [6]. Though fungi are important for stabilizing sand grains [7; 8], only meager reports from North America and elsewhere [9; 10] are available on the study of desert sand dunes fungi.

On the other hand the rhizosphere and non rhizosphere soil mycoflora of agricultural and desert soils of Saudi Arabia have been extensively studied in central and south-western regions [11-18], but those of the eastern, north-eastern and northern regions are barely investigated [19-22]. Other types of soil mycoflora like amylolytic, cellulolytic, osmophilic, thermophilic have also been reported from different regions but not yet investigated in significant detail [17; 18; 23; 24]. Osmophilic fungi were reported from salt marshes of Kuwait [25], and the thermophilic ones from various types of soils and habitats elsewhere [26-28].

The mycoflora of desert sand dunes, which differed from normal desert soil in having loose sand grains, very low water contents and lower resistance to temperature variations, of Saudi Arabia are yet to be investigated. Hence, in the present study an attempt was being made to isolate sand dune mycoflora with special attention paid to the mesophilic, osmophilic and thermophilic fungi that could survive under the unusual environmental conditions. The mesophilic fungi are those which had a wide temperature range of 5-35 ^{0}C with optimum temperature between 20-27 ^{0}C for growth. The osmophilic fungi are those which required high concentration of sugar (above 20%) for growth. Thermophilic fungi are those which could grow only above 40 ^{0}C and required a heat treatment at 80 ^{0}C to activate spore germination while thermotolerant fungi had a range of temperature from 25-45 ^{0}C with an optimum of above 30 ^{0}C for growth [18].

Materials and Methods

Collection of sand dune samples

Sand dune samples from the rhizosphere of the sand dune plants, *Artemisia abyssinica, A. monosperma, Citrulus colosynthis, Cyperus conglomeratus, Fafonia bruguleri, Gagea raticulata, Hammada elegans, Hellotroplum digynum, Horwoodia dicksoniae, Moltkiopsis ciliata, Pulicaria crispa, Punicum turgidum, Rhazya stricta, Salsola baryosoma* and *Zygophyllum album,* were collected from Riyadh-Makkah highway, Riyadh-Dammam highway and Thumamah area all around a radius of 50 km from Riyadh. These different samples were intermixed for further study. Non-rhizosphere sand dune samples were also collected from the same places but devoid of any plantation. These samples were also intermixed for further study.

Study of mycoflora of sand dune

Five grams of sand dunes were taken at random from the mixed sample and poured into 45 ml of sterile distilled water in 50 ml flask. Five replicates were prepared in the same way for each type of sample. These flask were then put on a rotary shaker (1000 rpm) for 30 minutes. Fungi were isolated by serial dilution plate method [18]. Media for

isolation of fungi were Malt Extract Agar, Czapek Dox Agar, Sabouraud dextrose Agar, Cellulose Agar, Starch Agar and Lignin Agar. The first three were available commercially (BDH-Chemicals). For the latter three, cellulose, starch and lignin were added (1% w/v) instead of sucrose in the Dox medium.

For isolation of mesophiles, inoculated plates were incubated for 14 days at 15, 25 and 35 ^{0}C in the dark. For isolation of osmophilic species, inoculated plates were incubated at 25 ^{0}C in the dark. For isolation of thermophilic species, the sand dune samples were at first put into a water bath at 80 ^{0}C for 30 minutes to activate spore germination; later plates were incubated at 45 ^{0}C and 55 ^{0}C in the dark.

Thermophilic species were isolated on potato dextrose agar [18]. For isolation of osmophilic species, M20 (malt + 20% sucrose) and M40 (malt + 40% sucrose) media were used. Purification of fungi was carried out every day after three days of incubation up to a total period of 14 days of incubation.

Physical, mechanical and chemical analyses of sand dunes

Sand dune pH was measured electrometrically with 10 g sand dune in 10 ml distilled water. Physical and mechanical analyses were carried out according to the techniques described earlier [29]. Chemical analysis of sand dune was done according to Rich [30].

For identification of fungi, taxonomic keys and literature were used as stated earlier [18; 21-24].

Results and Discussion

The results of some physical, mechanical and chemical analyses of sand dunes from the three areas are summarised in Table 1. Desert sand dunes have slightly alkaline pH (pH 7.7-8.2). All the three types of samples exhibited almost similar physical texture. Mechanical analysis of these samples were also similar with 98% sand, 1.5% silt and 0.5% clay. Chemically sand dunes are rich in minerals. Sand dune samples collected from Makkah road were found to be richer in organic matter (0.23%), iron (14 ppm) and manganese (4.7 ppm) and also slightly more alkaline (pH 8.2) as compared to the other two, while Ca CO_3 content (4.2%) was highest in the samples of Thumamah area. Sand dunes are found to be almost similar in physical, mechanical and chemical texture to those of desert soil except sand dunes contain 98% sand as compared to 69% in desert soil [18; 20].

Table 1. Physical, Mechanical and Chemical analysis of sand dune

Type of analysis	Sample sites		
	Makkah Road	Thummamah	Dammam Road
Physical			
pH	8.2	7.8	7.7
EC (mmhos/cm)	1.4	2.1	1.9
Ca CO_3 %	2.6	4.2	3.4
Organic matter %	0.23	0.16	0.19
Mechanical			
Sand %	98	97.5	98
Silt %	1.5	1.5	1.5
Clay %	0.5	1.0	0.5
Chemical			
Zn^{++} ppm	0.42	0.31	0.24
Fe^{+++} "	14	11	9.7
Mn^{++} "	4.7	1.6	1.9
Cu^{++} "	0.79	0.64	0.67
Na^{+} "	6.2	7.9	8.2
K^{+} "	0.6	0.4	0.5
Ca^{++} "	7.5	6.8	6.6
Mg^{++} "	3.3	3.1	3.9
Cl^{-} "	2.2	2.6	1.9
SO^{4--} "	8.9	10.2	9.6

A total number of 47 mesophilic fungal species belonging to 23 genera were isolated from the rhizosphere of sand dune plants (Table 2). The genus *Aspergillus* yielded the highest number of species (thirteen), followed by *Penicillium* (six); *Chaetomium, Mucor* and *Ulocladium* (three each); *Alternaria* and *Fusarium* (two each). The highest number of mesophilic fungal species were isolated from Czapek Dox agar (CZA) and Sabouraud dextrose agar, while lignin medium yielded the least number of fungal species. Interestingly *Chaetomium brasiliense* was grown on only lignin medium. *Aspergillus flavus, A. fumigatus* and *A. niger* were found on all media and at all incubation temperatures.

Table 2. Isolation of mesophilic fungal species (No. of colonies per gram of sand dune)* at different media from rhizosphere soil (readlings are the mean of 5 replicates sand dunes samples)

Fungi	MEA			SDA			CZA			Cellulose			Lignin			Starch		
	15	25	35	15	25	35	15	25	35	15	25	35	15	25	35	15	25	35
Alternaria alternata (Fr. :Fr.) Keissler	-	29	43	16	52	46	12	39	25	-	-	-	-	-	-	-	16	14
A. chlamydospora Mouchacca	-	16	9	-	39	43	16	49	35	-	16	-	-	32	23	14	36	32
Aspergillus carbonarius (Bain.) Thom	26	52	46	18	46	44	23	62	46	16	49	43	-	22	39	9	36	32
A. ellipticus Raper & Fennel	16	46	32	7	49	39	21	66	54	16	33	22	-	-	19	21	44	23
A. flavus Ling :Fr.	19	63	56	26	59	43	18	61	66	21	59	43	13	29	39	16	46	36
A. fumigatus Fres.	29	56	46	69	52	56	26	69	62	23	66	62	19	56	44	26	56	61
A. glaucus Link :Fr.	-	33	16	-	36	14	-	26	36	-	14	-	-	-	-	-	23	-
A. niger Van Tieghem	16	59	43	21	66	61	17	56	44	29	59	43	13	58	69	33	71	66
A. parasiticus Speare	-	-	21	-	-	29	-	-	13	-	-	36	-	-	19	-	-	33
A. pseudodeflectus Samson & Mouchacca	-	-	7	-	-	11	-	-	12	-	-	7	-	-	-	-	-	13
A. raperi Stolk & Meyer	9	39	26	16	32	26	21	44	49	-	-	-	-	-	-	14	22	16
A. restrictus G. Smith	-	21	29	-	19	15	-	17	26	-	39	36	-	-	-	-	-	21
A. silvasticus Fennell & Raper	-	-	-	-	16	-	-	19	23	-	32	19	-	-	-	-	26	-
A. subsessilis Raper & Fennell	-	-	16	-	-	23	-	-	39	-	-	22	-	-	-	-	-	-
A. terreus Thom	-	21	-	-	32	39	-	21	31	-	-	-	-	-	-	-	-	-
Biopolaris sp.	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-
Chaetomium bostrychodes Zoff.	-	21	36	-	23	39	-	19	21	-	28	36	-	-	-	-	-	-
C. brasiliense Batista & Pontual	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-
C. carinthiacum Sorgel	-	39	23	-	21	16	-	29	13	-	39	46	-	16	29	-	-	-
Cladosporium cladosporioides (Fres.) de Vries	-	16	23	15	19	39	11	36	42	-	-	-	-	-	-	-	-	-
Cunninghamella echinulata	-	23	-	-	23	36	-	19	29	-	-	-	-	-	-	-	-	-
Drechslera fugax (Wallr.) Shoemaker	-	-		-	-	-	-	16	-	-	-	-	31	34	-	-	-	-
Eupenicillium Scott	-	16	29	-	19	30	-	11	16	-	36	39	-	-	-	-	-	-
Exophiala moniliae de Hoog	-	-	-	-	-	-	-	-	-	-	-	-	-	26	21	-	12	16

Table 2. (Contd.)

Fungi	MEA			SDA			CZA			Cellulose			Lignin			Starch		
Fusariella aegyptiaca Mouchacca	-	29	-	-	36	-	-	19	-	-	-	-	-	-	-	-	-	-
F. chlamydosporum Wollenw. & Reinking	21	46	39	26	52	33	16	46	32	-	-	-	-	-	-	-	-	-
Fusarium oxysporum Schlecht.	16	49	32	19	46	42	23	49	40	-	-	-	-	-	-	-	-	-
Hendersonula toruloidae Nattrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mucor pusillus Lindt.	26	29	36	18	46	13	16	19	39	-	-	-	-	-	-	-	-	-
M. racemosus Fres.	16	39	14	19	46	32	19	47	26	-	-	-	-	-	-	-	-	-
M. strictus Heghem.	-	14	8	-	23	16	-	31	26	-	-	-	-	-	-	-	-	-
Penicillium chrysogenum Thom	19	46	33	16	42	23	36	49	32	-	33	32	-	-	-	22	49	36
P. cyaneum (Bain. & Sartory) Biourge	-	22	29	-	16	19	-	8	12	-	8	6	-	-	-	-	16	-
P. sclerotiorum Van Beyma	12	36	21	16	43	26	19	34	29	6	11	16	-	-	-	-	17	-
P. tarraconense Ramirez & Martinez	-	15	-	-	30	16	-	11	4	-	-	-	-	-	-	-	13	26
P. thomii Maire	-	16	32	-	14	26	-	11	19	-	16	19	-	-	-	-	14	8
P. verrucosum Dierckxi	-	8	-	-	12	-	-	26	4	-	9	3	-	-	-	-	33	-
Periconia sp.	-	-	-	-	12	-	-	-	-	-	-	-	14	19	32	-	-	-
Phialophora richardsiae (Nannf. apud Melin & Nannf.) Conant	-	16	-	-	14	-	-	33	26	-	-	-	-	-	-	-	16	-
Rhizopus stolonifer (Ehrenb. :Fr.) Vuill	14	29	16	21	43	40	-	31	16	-	-	-	-	-	-	-	-	-
Saccharomyces sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scytalidum lionicola Pesante	-	-	-	-	-	-	-	-	-	-	-	-	-	26	29	-	-	-
Trichoderma harzianum Rifai	-	9	3	-	12	7	-	16	26	-	29	39	-	24	-	-	16	26
Ulocladium chartarum (Preuss) Simmons	-	26	-	-	34	-	-	14	-	-	36	25	-	-	-	-	-	-
U. chlamydosporum Mouchacca	-	16	6	-	29	16	-	39	16	-	14	16	-	-	-	-	-	-
U. tuberculatum Simmons	-	23	16	-	42	33	-	49	32	-	26	34	-	-	-	-	-	-
Verticillium chlamydosporium Goddard	-	12	-	-	16	-	-	11	6	19	39	26	-	-	-	-	-	-

MEA = Malt Extract Agar, SDA = Sabouraud Dextrose Agar,

CZA = Czapek Dox Agar

15,25,35 = Temperature °C

* = $P < 0.05$ level significant

Non-rhizosphere sand-dunes yielded only 14 mesophilic fungal species (Table 3) with the genus *Aspergillus* yielding the highest total number (eight), followed by *Penicillium* (four). *Eupenicillium catenatum* and *Scytalidium lignicola* were the only other fungi isolated. All species found here were also reported earlier from different soil types collected from different regions of Saudi Arabia [13; 14; 16-22]. The genus *Aspergillus* and *Penicillium* also dominated in all types of soil including household dusts [31].

Thirty themophilic species were isolated from rhizosphere and non-rhizosphere soil at 45 ^{0}C and 55 ^{0}C of incubation (Table 4). Out of 28 species isolated at 45 ^{0}C from rhizosphere soil, 27 species could grow at 55 ^{0}C, while out of 20 species isolated at 45 ^{0}C from non-rhizosphere, 19 species could also grow at 55 ^{0}C. *Aspergillus* was the dominant genus represented by six species followed by *Penicillium* and *Talaromyces* with three species for each. *Aspergillus fumigatus* exhibited the highest number of colonies per gram of sand dune both in rhizosphere and non-rhizosphere soil. *Aspergillus* was also reported earlier as the predominant thermophilic genus isolated from different types of soil both in Saudi Arabia [18] and elsewhere [26-28]. *Achaetomium cristelliferum, A. strumerium, Aspergillus carbonarius, A. fischeri, A. flavus, Eupenicillium catenatum, Exophiala moniliae, Penicillium chrysogenum, P. sclerotiorum, P. thomii, Torula caligans, Ulocladium chlamydosporum* and *U. tuberculatum* were not reported earlier by Bokhary *et al.* [18] as thermophilic or thermotolerant species from different types of soils in Saudi Arabia while many species reported earlier [18] as thermophilic such as *Rhizopus microsporus, R. rhizopodiformis, Thermoascus crustaceus, Thielavia albomyces, Acremonium alabamense, Phialophora* sp. and *Sphaerosporium* sp. were not isolated from sand dunes in the present study.

A total number of 38 fungal species were isolated from sand dunes as (xerophilic) osmophilic species on M20 and M40 medium (Table 5). Out of these 31 species were isolated from rhizosphere sand dunes on M20 medium as compared to 19 on M40 medium. Twenty five species were isolated from non-rhizosphere sand dunes on M20 medium as compared to only 15 on M40 medium. *Aspergillus* was again the predominant osmophilic fungus and represented by 21 species. A similar result was also reported earlier by Abdel-Hafez from Saudi Arabia [17]. *Bahusaganda* sp. was not reported by Abdel-Hafez [17] as an osmophilic fungus from desert soil or from any other types of soils in Saudi Arabia [13; 14; 16; 18; 21; 24].

In conclusion Czapek Dox agar medium was found to be the most suitable for the isolation of mesophilies from rhizosphere sand dunes although malt extract agar and Sabouraud dextrose agar were also good for isolation. However in the case of non-rhizosphere sand dunes almost the same number of species were isolated on all the media used. This might be due to the survival of a fewer number of fungi in non-rhizosphere sand-dunes. Both the temperatures used (45 ^{0}C, 55 ^{0}C) were found to be equally good for isolation of thermophiles. For osmophiles M20 medium was most

suitable as compared to M40. This is probably due to survival of only those fungi which could bear higher osmotic pressure of M40 medium.

The highest number of fungal species were isolated at 25 ^{0}C followed by 35 ^{0}C in both rhizosphere and non-rhizosphere sand dunes. The number of colonies per gram of sand dunes of a particular species was also generally higher at 25 ^{0}C followed by 35 ^{0}C and the least at 15 ^{0}C in both rhizosphere and non-rhizosphere and also on all the media used.

Table 3. Isolation of mesophilic fungi (No. of colonies per gram of sand dune)* from non-rhizospheric sand due on different media

Fungi	MEA			SDA			CZA			Cellulose			Lignin			Starch		
	15	25	35	15	25	35	15	25	35	15	25	35	15	25	35	15	25	35
Aspergillus carbonarius	3	6	9	-	5	7	3	6	8	-	11	10	-	-	-	4	9	5
A. ellipticus	-	4	3	-	7	4	-	9	4	3	4	6	-	-	-	-	5	-
A. flavus	8	13	19	6	11	9	3	7	5	6	11	16	-	-	6	4	7	7
A. fumigatus	7	12	15	11	19	15	7	9	11	9	13	21	4	8	15	9	14	16
A. raperi	-	9	-	-	13	6	-	9	3	-	19	9	-	-	-	-	12	6
A. subsessilis	-	-	-	-	-	-	-	-	-	-	-	6	-	4	6	-	-	-
A. terreus	6	13	6	4	12	5	6	8	15	-	12	16	-	-	-	-	6	5
Eupenicillium catenatum	-	5	12	-	4	6	-	4	9	-	4	3	-	6	9	-	9	9
Penicillium chrysogenum	9	16	19	11	22	29	8	12	16	6	9	12	8	16	15	9	16	19
P. cyaneum	-	14	-	-	6	3	-	9	-	-	5	4	-	7	-	-	6	13
P. sclerotiorum	4	13	14	-	16	19	-	14	13	5	14	19	4	16	13	-	12	21
P. thomii	-	-	14	-	-	12	-	6	9	-	-	-	-	-	-	-	-	6
Scytalidium lignicola	-	-	-	-	-	-	-	-	-	-	-	-	14	19	18	-	-	-

15, 25, 35 = Temperature of incubation in °C.
* = P > 0.05 level significant

Table 4. Thermophilic fungi isolated from sand dunes (No. of colonies per gram of sand dune)* on potato dextrose agar

	Incubation temprature			
	45 °C		55 °C	
Fungi	**R**	**NR**	**R**	**NR**
Achaetomium cristelliferum Faurel & Locquin-Linard	16± 4	12± 3	18± 3	15± 2
A. strumarium Rai & al.	15± 3	-	14± 3	-
Acremonium strictum W. Gams	22± 4	-	19± 3	-
Aspergillus carbonarius	18± 3	12± 3	16± 4	22± 4
A. fischeri	-	16± 4	-	21± 4
A. flavus	30± 3	28± 5	18± 4	16± 3
A. fumigatus	56± 5	50± 5	62± 5	69± 5
A. quadrilineatus Thom & Raper	18± 3	-	21± 4	-
A. regulosus Thom & Raper	16± 2	18± 2	12± 3	10± 3
Eupenicillium catenatum	21± 3	29± 4	16± 3	18± 4
Exophiala moniliae	29± 4	33± 5	20± 3	18± 2
Humicola grisea Traaen	18± 3	-	16± 3	-
Malbranche sulphurea (Miehe) Sigler & Carmichael	-	36± 3	-	30± 4
Mucor pusillus Lindt	39± 5	-	34± 5	-
Paecilomyces variottii Bainier	29± 4	20± 4	16± 3	14± 2
Penicillium chrysogenum	42± 5	39± 5	36± 3	34± 3
P. sclerotiorum	26± 4	-	21± 3	-
P. thomii	21± 5	29± 5	20± 4	19± 2
Pythium myriotylum Drechs	28± 6	-	21± 5	-
Rhizomucor miehei	32± 4	26± 3	22± 4	16± 3
Scytalidium thermophilus	28± 5	32± 5	40± 5	35± 4
Talaromyces emersonii Stolk	36± 4	32± 3	46± 4	42± 4
T. thermophilus Stolk	32± 3	39± 4	49± 3	44± 4
T. leycethanus Evan & Stolk	39± 5	45± 4	43± 4	42± 5
Thermoascus aurantiacus Miehi	30± 3	16± 4	35±4	26± 5
Thermomes lanuginosus Tsiklinski	45± 5	-	46± 5	-
Thielavia terrestris (Apinis) Malloch & Cain	18± 3	-	22± 3	-
Torula caligans (Batista & Upadhyay) M.B. Ellis	19± 4	-	-	-
Ulocladium chlamydosporum	16± 3	21± 4	8± 2	-
U. tuberculatum	12± 3	15± 3	11± 2	6± 2

R = Rhizospheric sand dunes NR = Non-rhizospheric sand dunes
± = Standard deviation
* = P > 0.05 level significant

Table 5. Isolation of osmophilic species from sand dunes (No. of colonies per gram of sand dune)* on M20, M40 medium incubated at 25 °C temperature

Fungi	Medium			
	M20		M40	
	R	NR	R	NR
Atternania chlamydospora	16± 3	8± 2	-	-
A. sp.	-	-	12± 4	-
Aspergillus carbonarius	32± 5	26± 4	14± 3	10± 2
A. conicus Blochwitz	-	-	16± 2	-
A. cristatus Thom & Raper	16± 3	-	29± 4	-
A. chevalieri (Mangin) Thom & Church	18± 5	-	-	-
A. flavus	32± 5	30± 5	-	-
A. fumigatus	43± 6	49± 5	-	-
A. glaucus	29± 4	25± 4	36± 5	32± 3
A. gracilis Bainer	-	-	29± 4	-
A. granulosus Raper & Thom	22± 6	29± 5	28± 3	36± 4
A. medius Meissner	16± 3	33± 4	26± 4	25± 4
A. nidulans	32± 4	36± 5	-	-
A. niger	36± 3	16± 4	-	-
A. ochraceus Wilhelm	-	29± 4	-	32 ±5
A. parasiticus	16± 3	20± 3	-	-
A. penicilloides Spegazzini	20± 4	-	36± 4	-
A. pseudoglaucus Ohtsuki	26± 5	16± 3	39± 4	30± 3
A. repens (de Bary) Fischer	-	16± 3	-	27± 5
A. restrictus	23± 4	-	27± 5	-
A. rubur (Konig, Spiek, & Brem) Thom & Church	-	-	18± 4	-
A. terreus	30± 5	28± 5	12± 3	18± 4
A. umbrosus Bainier & Sartory	-	32± 3	-	20± 2
Bahusaganda sp.	24±4	18± 3	39± 4	30± 5
Chaetomium sp.	26± 4	-	-	-
Chlamydomyces sp.	15± 3	-	-	-
Drechslea sp.	21± 4	-	-	-
Enibellisia chlamydospora (Hoes & al.) Sin	36± 4	42± 5	-	-
Eurotium amstelodami Mangin	30± 5	26± 5	12± 3	16± 4
E. halopilicum Delacr	32± 5	46± 5	36± 3	49± 5

Table 5. (Contd.)

Fungi	Medium			
	M20		M40	
	R	NR	R	NR
E. tonophilum Ohtsuki	24± 3	-	-	-
Penicillium chrysogenum	42± 4	55± 5	23± 3	26± 4
Phoma sp.	22± 3	-	-	-
Stachybotrys atra Corda	36± 4	26± 4	20± 3	16± 3
Ulocladium atrum Preuss	18± 3	22± 3	-	-
U. chlamydosporum	23± 3	26± 4	-	-
U. tuberculatum	29± 5	16± 4		

M20 (Malt plus 20% Sucrose)
M40 (Malt plus 40% Sucrose)
± = Standard Deviation
R = Rhizospheric sand dunes
NR = Non-rhizospheric sand dunes

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الفلورا الفطرية للكثبان الرملية بالمملكة العربية السعودية

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ملخص البحث. تم جمع عيّنات من الكثبان الرملية حول منطقة الرياض لفحص الفلورا الفطرية. ولقد كان العدد الكلي ٤٧ نوعًا فطريًا عزلت من المنطقة الجذرية لنباتات التلال الرملية بينما عزل ١٤ نوعًا فطريًا من المنطقة غير الجذرية (التي لا يوجد بها نباتات) على منابت مختلفة، كما تم في هذا البحث إجراء الفحوصات والتحليلات: الكيميائية، الفيزيائية والميكانيكية لتربة الكثبان الرملية. وعند إجراء التجارب لعزل الفطريات المحبّة للحرارة والفطريات الجفافية (الصحراوية) وجد ٣٨ نوعًا فطرياً جفافيًا استطاعت النمو على ٢٠٪ و ٤٠٪ من السكروز في مستخلص الشعير وثلاثون نوعًا فطريًا محبًا للحرارة من المنطقة الجذرية والمنطقة غير الجذرية لتربة الكثبان الرملية. وتبين من هذه الدراسة أن الجنس اسبرجيلس هو السائد والذي أظهر أعدادًا كثيرة من الأنواع في كل الحالات.