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Fresh Water Fungi of Saudi Arabia

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Abstract

A survey was conducted to screen the fresh water fungi from different areas of Saudi Arabia viz. Al-Ahsa, Al-Direyah, Al-Haer, Al-Kharj, Al-Qasim and Wadi Laban. Twenty six species were recorded from as an aquatic fungi and thirty two species as an aero-aquatic fungi from fresh water, while twenty-six species were isolated as an aero-aquatic fungi from under water soil of these regions. Percent relative frequency of each fungus was also calculated.

Introduction

Fresh water is a rich source of hyphomycetes usually known as aquatic, amphibious or Ingoldian (Marvanova, 1988). These fungi may also grow on the plant debris fallen in the water which serves as a substrates for the growth (Chamier and Dixon, 1982; Nelson, 1964; Sridhar and Kaveriappa, 1989), intermediaries in a food chains between plant detritus and invertebrates (Barlocher and Kendrick, 1976) and also exhibit both morphological and physiological adaptations for plant litter degradation in the water (Suberkropp and Klug, 1981). Some species of these water-borne fungi are pathogenic to water inhabitants like fishes. *Saprolegnia* although an aquatic fungus but also cause damping off disease in rice plants (Rattan *et al.*, 1978).

Common mold flora which are found commonly in almost every type of environment, were also recorded from aero-aquatic environment (El-Hissy, 1974). *Beverwykella* species were earlier recorded as an aero-aquatic hyphomycetes (Nawawi and Kuthubutheen, 1988). Bokhary *et al.* (1992) recorded 37 species of marine fungi from eastern coast of Saudi Arabia while Aleem (1978) reported some marine fungi from West coast of Saudi Arabia, However, no report is available for fungi recorded from fresh water of Saudi Arabia. The aim of this study was to study aquatic and aero-aquatic fungi from different localities of Saudi Arabia of fresh water of ponds, dams, and water collected for irrigation canals in the agriculture farms.

Materials and Methods

Fresh water samples were collected in sterile bottles from fresh water sources of different places of Saudi Arabia like ponds, dams, and from the canals used for irrigation in the agricultural forms. The places from where samples were collected are Al-Hassa (eastern region), Al-Haer, Al-Direyah, Wady Laban (these locations are around Riyadh city), Al-Kharj (Agriculture town about 80 km from Riyadh), and Al-Qasim (about 320 km from Riyadh, also an agriculture region). The fallen leaves of different plants around the area of fresh water collection, were also collected and mixed together.Water samples from different sources of a particular locality were mixed together and 20 ml of this water sample was then poured in each plate. A total number of 25 plates were used for each type of locality. The fallen leaves of different plants of a particular area were mixed together, converted into small pieces and sterilized by autoclaving at 121°C for 15 minutes. About two grams of these leaves were taken into each plate containing sample water. These plates were then incubated at room-temperature (22-25 °C) for a period of 3 months. Regular observation was made after 5 days of incubation under the stereo-microscope for fungal appearance. Appeared fungus was then observed under the light microscope for identification and isolated on cornmeal agar (Oxoid Ltd, London) and on sterilized corn seeds in sterilized water (Rattan *et al.*, 1978).

For aero-aquatic fungal isolation from fresh water, yeast-starch-glucose-peptone agar medium (yeast extract 1 g, glucose 10 g, starch 1g, K_2HPO_4 1g, Na_2HPO_4 0.1 g, $MgSO_4$ 0.1 g, peptone 2g, agar 20 g and water 1000 ml) was used. One ml of mixed sample (as described earlier) was poured into each plate and then molten medium (at about 45 °C) was added into each plate (approx. 20 ml). Streptomycin sulphate (0.03 g/L) was added into the medium after autoclaving and prior to distribution of medium into plates.

Aero-aquatic fungi from soil beneath the fresh water were isolated in the same way as from fresh water except that 0.1 g of soil was distributed for a particular type of samples into each plate. Soil samples from beneath the water of same areas were collected into sterilized polyethylene bags and as earlier soil samples from different sources of a particular locality were mixed together and then soil from this mixed sample were distributed into the plates.

Percent relative frequency of aquatic fungi was calculated according to the following formula:

$$\%RF \quad \frac{\text{No. of plates in which species found including all sites}}{\text{Total No. of plates incubated including all sites}} \times 100$$

Percent relative frequency of aero-aquatic fungi was calculated according to the following formula:

$$\%RF \quad \frac{\text{No. of colonies per ml of water including all sites}}{\text{Total No. of colonies per ml of water including all sites}} \times 100$$

Results and Discussion

A total number of 30 species belonging to 25 genera of aquatic hyphomycetes were isolated from different localities, Al-Hassa, Al-Direyah, Al-Haer, Al-Kharj, Al-Qasim and Wadi Laban, of Saudi Arabia (Table 1). All these fungi

are reported for the first time from Saudi Arabia as aquatic fungi. Out of these, 12 species were recorded from Al-Hassa, nine each from Al-Direyah, Al-Kharj and Al-Qasim, ten species from Wadi Laban. The highest percent frequency was shown by *Pythium debaryanum* and *Tricladium* sp. (20% each), while the lowest (1.3%) was shown by *Anguillospora* which was only isolated from Al-Hassa samples followed by *Aplanus androgynus, Articulospora, Calyptralegnia achlyoides, Clavariopsis, Dactylella appendiculata, Descelsia sp., Dictyuchus pseudoachlyoides, Flagellospora curvula* and *Sterigmatobotrys* sp. (2% each). These species were also recorded from only one particular site only. Four species of *Dictyuchus* namely *D. anomulus, D. monosporus, D. pseudoachlyoides, D. achylyoides* while two species of each were recorded for the genus *Calyptralegnia* and *Pythium*. Other genera was represented by single species only.

Aero-aquatic fungi isolated from fresh water on yeast-starch-glucose-peptone agar medium are given in (Table 2). A total number of 32 species belonging to 22 genera of fungi were isolated as aero-aquatic fungi from fresh water. Out of these 14 species were isolated from Al-Hassa sample, 17 each from Al-Direyah and Al-Kharj, 20 from Al-Haer, 12 from Al-Qasim and 16 from Wadi Laban. *Aspergillus* was the predominant genus with four species followed by *Alternaria, Cladosporium, Mucor Penicillium, Pythium, Stachybotrys* and *Ulocladium* (two species each). Other genera were represented by single species only. *Aspergillus carbonarius, A. flavus, A. fumigatus, A. niger, Alternaria alternata, Mucor racemosus, Penicillium chrysogenum, Ulocladium chlamydosporum* and *U. tuberculatum* was found in all types of samples. *Aspergillus niger, A. flavus, A. fumigatus,* and *Penicillium chrysogenum* showed the greater number of colonies per ml of water as compared to others. The highest percent relative frequency was shown by *Penicillium chrysogenum* followed by *Aspergillus niger, A. fumigatus,* and *A. flavus* in descending order.

A total number twentysix fungal species belonging to 1[illegible] genera were isolated from under water soil (Table 3). Out of these 17 species were isolated from Al-Haer 13 from Al-Qasim, twelve each from Al-Direyah and Al-Kharj and 1[illegible]

Table 1: Aquatic fungi recorded from fresh water of different areas of Saudi Arabia

Fungi	No. of plates in which species recorded/Areas						
	Al-Ahsa	Al-Direyah	Al-Haer	Al-Kharj	Al-Qassim	Wady Laban	% RF
Achlya racemosa	4	-	-	-	-	-	2.[illegible]
Actinospora megalospora	-	-	3	-	-	4	4.[illegible]
Alatospora acuminata	-	-	-	-	4	-	2.[illegible]
Allomyces arbuscula	-	5	3	5	-	-	8.[illegible]
Anguillospora sp.	2	-	-	-	-	-	1.[illegible]
Aplanus androgynus	-	-	-	-	3	-	2.[illegible]
Arbusculina irregularis	2	4	3	4	5	3	14.[illegible]
Articulospora sp.	3	-	-	-	-	-	2.[illegible]
Calyptralegnia achlyoides	-	-	3	-	-	-	2.[illegible]
C. ripariensis	-	-	-	4	-	-	2.[illegible]
Clavariopsis sp.	-	-	-	-	-	3	2.[illegible]
Colispora elongata	-	4	-	-	-	-	2.[illegible]
Cylindrocarpon aquaticum	-	-	-	-	3	2	3.[illegible]
Dactylella appendiculata	3	-	-	-	-	-	2.[illegible]
Descelsia sp.	-	-	-	-	-	3	2.[illegible]
Dictyuchus anomulus	-	2	-	2	-	-	2.[illegible]
D. monosporus	-	-	-	-	4	-	2.[illegible]
D. pseudoachylyoides	-	-	3	-	-	-	2.[illegible]
D. achlyoides	2	3	-	4	-	-	6.[illegible]
Flagellospora curvulla	-	-	-	-	-	3	2.[illegible]
Ingoldiella mutans	3	5	3	2	4	-	1[illegible]
Isoachlya sp.	-	-	-	-	2	-	
Pythium debaryanum	4	5	6	8	3	4	2[illegible]
P. transeversum	-	-	-	3	-	-	
Sterigmatobotrys sp.	3	-	-	-	-	-	
Tetracladium sp.	-	2	5	-	-	-	
Tricladiomyces sp.	-	-	-	-	-	5	
Tricladium sp.	4	5	3	7	4	8	2[illegible]
Triposporium sp.	3	-	-	-	-	3	
Vermispora sp. 5	-	-	-	-	-	3.3	
Total No. of species	12	9	9	9	9	10	

% RF = Percent relative frequency.

No. of replicates from each area were 25

Table 2: Aero-aquatic fungi isolated from fresh water on yeast-starch-glucose-peptone agar medium from different areas of Saudi Arabia (No. of colonies per ml of water)*.

Fungi	Areas						
	Al-Ahsa	Al-Direyah	Al-Haer	Al-Kharj	Al-Qassim	Wady Laban	% RF
Alternaria alternata	4 ± 2	6 ± 2	2 + 1	8 ± 2	3 ± 1	4 ± 2	1.75
Alternaria sp.	-	-	-	5 ± 2	-	-	0.32
Acremonium sp.	7 + 3	-	6 ± 2	-	-	5 ± 2	1.17
Aspergillus carbonarius	18 ± 5	25 ± 4	16 ± 3	22 ± 4	26 ± 5	15 ± 2	7.92
A. flavus	39 ± 4	29 ± 3	22 ± 4	19 + 3	32 ± 4	21 ± 3	10.52
A. fumigatus	36 ± 5	31 ± 4	25 ± 3	42 ± 5	35 ± 3	16 ± 3	12.02
A. niger	43 ± 5	49 ± 5	35 ± 4	26 ± 4	26 ± 5	31 ± 3	13.64
Beverwykella sp.	-	-	10 ± 3	-	-	-	0.65
Chaetomium sp.	-	7 ± 2	-	-	-	-	0.45
Cladosporium cladosporioides	12 ± 3	-	-	8 ± 2	-	-	1.30
C. herbarum	-	16 ± 3	12 ± 3	-	-	-	1.82
Cochliobolus spicifer	-	-	-	-	-	8 ± 3	0.52
Epicoccum purpurascens	-	-	-	-	8 ± 2	-	0.52
Fusarium chlamydospora	-	13 ± 3	15 ± 3	12 ± 4	-	-	2.61
Drechslera sp.	-	-	-	8 ± 2	-	-	0.52
Geotrichum candidum	16 ± 3	8 ± 2	6 ± 2	9 + 3	-	6 ± 2	2.92
Monilia sp.	-	7 ± 2	9 ± 2	-	-	11 ± 3	1.75
Mucor racemosus	13 + 3	18 ± 3	11 ± 2	9 ± 2	6 ± 2	7 ± 2	4.16
M. pusillus	-	-	-	-	8 ± 3	-	0.52
Penicillium arabicum	-	-	9 ± 3	-	-	-	0.58
P. chrysogenum	39 ± 5	46 ± 5	36 + 3	43 ± 6	23 ± 5	29 ± 4	14.03
Pythium debaryanum	-	-	7 ± 3	6 ± 2	-	5 ± 2	1.17
P. intermedium	11 ± 3	-	-	-	-	-	0.71
Saprolegina sp.	9 ± 2	13 ± 3	-	8 ± 2	-	7 ± 2	2.34
Stachybotrys atra	-	9 ± 3	-	-	-	-	0.58
Stachybotrys sp.	-	-	6 ± 2	-	-	-	0.39
Scopulariopsis brevicaulis	-	-	6 ± 3	-	-	-	0.39
Trichoderma sp.	-	-	-	8 ± 2	-	0.52	
Trichothecium roseum	-	-	-	8 ± 3	-	-	0.52
Spirodactylon sp.	-	12 ± 3	9 ± 2	-	-	8 ± 3	1.88
Ulocladium chlamydosporum	16 ± 4	12 ± 4	8 ± 3	12 ± 3	19 ± 4	26 ± 4	6.04
U. tuberculatum	13 ± 5	16 ± 3	21 ± 5	10 + 2	8 ± 3	19 ± 3	5.65
No. of species	14	17	20	17	12	16	

± Standard deviation; $P < 0.05$ level significant; %RF = Percent relative frequency

species each from Al-Hassa and Wady Laban. *Aspergillus* again was the predominant genus with seven species as compared to four from fresh water. *Alternaria, Cladosporium, Mucor, Penicillium* and *Ulocladium* come next with two species each. *Alternaria alternata, Aspergillus flavus, A. fumigatus, A. niger, P. chrysogenum, U. chlamydosporum* and *U. tuberculatum* were isolated from all the samples. *Aspergillus niger* showed the highest relative frequency (16.28%) as compared to *P. chrysogenum* in the case of fresh water. *Penicillium chrysogenum* came at second position with 12.56 per cent RF while *A. fumigatus* maintained the 3rd position with RF of 10.71 per cent. The lowest RF was exhibited by *Aspergillus amstelodami* with 0.44%. In general most of the fungi showed a slightly lower RF as compared to RF in the case of per ml fresh water.

No work so for been done on aquatic fungi of Saudi Arabia. All species reported here are new to Saudi Arabian fungal taxa. Bokhary *et al.* (1992) reported genera like *Anguillospora, Arbusculina, Flagellospora, Pythium, Saprolegnia* and *Tricladium* from marine water or sea foam of east coast but with different species which are found here from fesh water. *Dictyuchus* species and *Calyptralegina achylyoides* were earlier reported from neighbouring country Iraq (Rattan *et al.*, 1978). *Allomyces arbuscula, Aplanus androgynus, Dictyuchus, Achlya racemosa, Isoachlya, Saprolegnia* and *Pythium debaryanum* were reported earlier from river Nile in Egypt (El-Hissy, 1974). All the fungi recorded here, are already reported earlier as aquatic hyphomycetes elsewhere (Marvanova, 1988; Sridhar and Kaveriappa, 1989; Suberkropp and Klug, 1981).

The aero-aquatic fungi reported here like *Alternaria alternata, A. chlamydospora, Aspergillus* species, *Cladosporium cladosporioides, Fusarium chlamydospora, Mucor sp., Penicillium chrysogenum, Stachybotrys* and *Ulocladium* species were earlier also reported from sea water and sea foam (Bokhary *et al.*, 1992). The common

Table 3: Aero-aquatic fungi isolated from under water soil on yeast-starch-glucose peptone agar medium from diffe areas of Saudi Arabia (No. of colonies per gram of soil)*.

Fungi / Areas	Al-Ahsa	Al-Direyah	Al-Haer	Al-Kharj	Al-Qasim	Wady Laban	% RF
Alternaria alternata	14 ± 2	16 ± 3	8 ± 2	10 ± 3	14 ± 3	13 ± 5	8.1
A. chlamydospora	-	-	9 ± 3	15 ± 2	-	-	2.4
Aspergillus amstelodami	4 ± 2	-	-	-	-	-	0.4
A. candidus	-	16 ± 2	6 ± 2	9 ± 3	-	-	3.3
A. clavatus	-	-	-	-	8 ± 3	-	0.8
A. flavus	14 ± 3	16 ± 2	10 ± 3	8 ± 2	11 ± 4	19 ± 4	8.5
A. fumigatus	29 ± 5	21 ± 5	16 ± 2	14 ± 3	10 ± 2	8 ± 2	10.7
A. niger	32 ± 3	36 ± 5	20 ± 3	18 ± 2	15 ± 4	22 ± 3	16.2
A. terreus	-	-	-	-	12 ± 3	-	1.3
Beverwykella sp.	-	-	8 ± 2	-	-	-	0.8
Chaetomium sp.	-	6 ± 2	-	-	-	-	0.6
Cladosporium cladosporioides	8 ± 2	-	-	4 ± 1	-	-	1.3
C. herbarum	-	6 ± 2	8 ± 2	-	-	-	1.5
Cochliobolus spicifer	-	-	-	-		5 ± 2	0.5
Epicoccum purpurescens	-	-	-	-	10 ± 3		1.0
Fusarium chlamydosporum	-	10 ± 2	7 ± 2	6 ± 2	-	-	2.5
Geotrichum candidum	14 ± 2	-	6 ± 2	-	8 ± 2	7 ± 3	3.8
Monilia sp.	-	5 ± 1	6 ± 2	-	-		1.2
Mucor racemosus	-	-	-	12 ± 3	8 ± 2	-	2.1
M. pusillus	-	-	-	-	6 ± 3	-	0.6
Penicillium arabicum	-	-	6 ± 2	-	-	-	0.6
P. chrysogenum	16 ± 3	21 ± 3	18 ± 4	15 ± 3	19 ± 3	26 ± 5	2.5
Pythium debaryanum	-	-	7 ± 2	-	-	11 ± 2	1.9
Stachybotrys sp.	-	-	6 ± 2	-	-	-	0.6
Ulocladium chlamydosporum	12 ± 2	8 ± 2	6 ± 2	9 ± 3	14 ± 3	19 ± 4	7.4
U. tuberculatum	18 ± 3	12 ± 3	10 ± 2	13 ± 3	8 ± 2	12 ± 3	7.9
No. of species	10	12	17	12	13	10	

± Standard deviation; * $P < 0.05$ level significant; % RF = Percent relative frequency.

mold flora isolated here like *Alternaria, Aspergillus, Chaetomium, Cladosporium, Fusarium, Drechslera, Geotrichum, Mucor, Penicillium, Stachybotrys, Spirodactylon* and *Ulocladium* were also earlier reported from Saudi Arabia as terrestrial fungi from various environments (Bokhary and Parvez, 1992, 1995). The occurrence of more fungal species on sterilized leaves than on synthetic medium indicate that the sterilized leaves could be a good source of isolation of water-borne fungi (Sridhar and Kaveriappa, 1989). *Beverwykella sp.* was reported as an aero-aquatic hyphomycetes from Malaysia (Nawawi and Kuthubutheen, 1988)

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