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Research Article

Growth and Ecological studies of fungi in marine ecosystem

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Abstract

Colony growth rate of the fungi was studied on seven different types of solid media (PDA, SDA, CMA, CZA, MA, RBA, and OMA). Effect of different ecological parameters such as pH (5-9), temperature (20-60°C), salinity (5-40%), metals (FeSO₄ and ZnSO₄), carbon (CMC, starch and mannitol) and nitrogen sources (ammonium nitrate and calcium nitrate) on the growth of fungi was also determined. Maximum growth rate of fungi was observed in PDA than other media. Maximum fungal growth was observed in pH 8, 30°C (temperature), 5% (salinity), FeSO₄ (metal), carboxy methyl cellulose (carbon source) and ammonium nitrate (nitrogen source) after 8 days of growth in liquid medium.

Introduction

In spite of this fact, the fungi in soil have a wide range of tolerance to the physico chemical properties of the soil (Garrett, 1956; Brown, 1958; Pugh, 1980; Lockwood, 1981). In most of the cases under soil dilution plate technique, the fungi of Deuteromycetes were reported from various soils with dominance of *Aspergillus*, *Penicillium* and *Trichoderma*, and suggested that they are developed from the dormant propagules (Christensen *et al.*, 1962. Dwivedi, 1966). Since soil is a four-dimensional space-time continuum, it shows fluxuation in physicochemical parameters, which result in the dynamic change in the population of fungi (Austwick, 1968). The soil reaction (pH) in relation to soil microflora has been reported by several (Griffin, 1972; Bissett and Parkinson, 1979a,b). The fungi can be categories into three groups based on their range of tolerance to temperature. They include (a) thermophilic fungi surviving at or above 40°C; (b) mesophilic fungi – thriving between 10°C - 40°C and (c) psychrophilic fungi – thriving at or below 10°C (Cooney and Emerson 1964; Crison, 1964; Emerson, 1968). Soil is a vulnerable site for the accumulation of chemicals, which results in a diverse array of

effects on target and non-target organisms and the associated ecological processes (Grossbard, 1976; Bollen, 1979).

Temperature appears to be an important factor affecting the occurrence and distribution of fungi (Suberkropp, 1984). Some species are more common in temperate climates and others are more common in the tropics (Barlocher, 1992). In temperate climates, seasonal shifts in species composition can occur, with species common in the tropics becoming dominant during the summer and absent in winter (Chauvet, 1991; Suberkropp, 1984). The effect of temperature on the growth and sporulation of aquatic Hyphomycetes has received relatively little attention and in all instances, fungi were grown on agar media containing relatively high conc. of nutrients (Koske and Duncan, 1974; Suberkropp, 1984; Webster *et al.*, 1976).

Metal tolerance and antibiotic resistance has been studied by number of researchers (Nakahara *et al.*, 1977; Hermansson *et al.*, 1987; Sabry *et al.*, 1997). It has been suggested that under environmental conditions of metal stress, metal and antibiotic

resistant microorganisms will adapt faster by the spread of R- factors than by mutation and natural selection (Silver and Misra, 1988). High prevalence of metal tolerant microbes has been reported earlier from seawater (Sabry *et al.*, 1997) and there are wide variations between the observations of different researchers (Niето *et al.*, 1989; Chang *et al.*, 1997; Hassen *et al.*, 1998).

A deep penetration of Ascomycetes and Denteromycetes is observed only in lightwood containing vessels with wide lumina inch permit adequate aeration of the interior (Becker and Kohlmeyer, 1958a,b). Vishniac (1960) reported that in 25 isolates of non- filamentous marine fungi and stimulation of growth by the addition of low levels of sodium bicarbonate to the medium. Siegenthaler *et al.* (1967) have shown that phosphate uptake in *Thraustochytrium roseum* is maximally stimulated by sodium chloride in range of concentrations 0.2 – 0.4 molar. Ritchie and Jacobson (1963) determined that the “Phoma pattern” in *Zalerion maritima* was based on an osmotic rather than an ionic effect of the seawater concentrations.

In the present study was carried out to find the growth and various ecological parameters of fungi isolated from marine habitat of east coast of Tamil Nadu, India

Materials and Methods

Growth and Morphological characteristics of fungi on various media

In this study the most dominant species (31 sp.) of fungi were selected. All the fungi were inoculated (agar block containing fungi) in center of seven fungal media such as PDA, SDA, CMA, CZA, MA, RBA and OMA. The inoculated plates were incubated at room temperature (28°C) for 6 days. After incubation period, the radial growth (diameter in mm) of each fungus was measured (Palacios – Cabrera *et al.*, 2005).

Effect of physical and chemical parameters on fungal growth

In this study, the most dominant fungal species (31 sp.) were selected and studied for biomass, effect of various parameters such as pH, temperature, salinity and carbon and nitrogen sources (Booth, 1971a; Boyd and Kohlmeyer, 1982; Aneja, 2001).

Effect of Fungal Biomass

All the fungi were inoculated into Potato Dextrose broth (PD) and incubated at room temperature. After incubation for 8 days, the optical density was measured at 600 nm. The fungal fresh and dry weights were also determined.

Effect of pH on fungal growth

All the fungi were inoculated into Potato Dextrose broth (PD) broth containing different pH ranges (5, 6, 7, 8 and 9) and incubated at room temperature. After incubation for 8 days, the optical density was measured at 600 nm. The fungal fresh and dry weights were also determined.

Effect of Temperature on fungal growth

All the fungi were inoculated into Potato Dextrose broth (PD) broth and the tubes were incubated at different temperature range (20, 30, 40, 50 and 60°C) and incubated at room temperature. After incubation for 8 days, the optical density was measured at 600 nm. The fungal fresh and dry weights were also recorded.

Effect of Salinity on fungal growth

All the fungi were inoculated into Potato Dextrose broth (PD) containing different salinity ranges such as 5, 10, 20, 30 and 40 % and incubated at room temperature. After incubation for 8 days, the optical density was measured at 600 nm. The fungal fresh and dry weights were also recorded.

Effect of Carbon and Nitrogen Sources on fungal growth

All the fungi were inoculated into Potato Dextrose broth (PD) broth containing different carbon sources (Carboxy Methyl Cellulose, Starch, and Mannitol) and nitrogen Source (Ammonium nitrate and Calcium nitrate) and incubated at room temperature. After incubation for 8 days, the Optical density was measured at 600 nm. The fungal fresh and dry weights were also determined.

Effect of Heavy metals on fungal growth

All the fungi were inoculated into Potato Dextrose broth (PD) broth containing different heavy metals (Ferric sulphate and Zinc sulphate) and incubated at room temperature. After incubation for 8 days, the Optical density was measured at 610 nm. The fungal fresh and dry weights were also measured.

Results and Discussion

Growth characteristics of fungi on various parameters

Maximum growth rate of fungi was observed in PDA than other media. (Table 1)

Growth characteristics of fungi on various parameters Fungal biomass study

In this study, *A. oryzae* showed maximum optical density with 1.955 followed by *A. sydowi* (1.934), *A. ochraceus* (1.929), *A. niger* (1.883) and *A. flavus* (1.873) were showed maximum growth on 8 days of incubation and least by *A. clavatus* (0.389), *N. crassa* (0.410) and *A. luchensis* (0.421) (Table 2).

Fresh weight of the fungi were also maximum in *A. oryzae* with 9.28 mg followed by *A. sydowi* (8.08 mg/g), *A. flavus* (7.80 mg/g) and *A. ochraceus* (7.68 mg/g). Minimum of fresh weight was observed in *P. rubrum* (0.39 mg/g). Dry weights of the fungi were also maximum *A. oryzae* with (3.02 mg/g) followed by *A. luchensis* (2.72 mg/g), *A. flavus* and *A. erythrocephalus* (2.41 mg/g) individually. Minimum of dry weight was observed in *R. oryzae* and *P. citrinum* (0.20 mg/g) (Table 2).

Ecological studies were carried out by various physico-chemical parameters. Among these, pH (8), temperature (30°C), salinity (5%), metals (FeSO₄), carbon source (CMC) and nitrogen source (ammonium nitrate) influenced the maximum growth of fungi in liquid media on 8 days of incubation at room temperature. Fresh and dry weights of the fungi were maximum in above conditions.

Effect of pH on the growth of fungi

In this study, the maximum growth was observed in pH 8 after 8 days of incubation. In this pH, *A. luchensis* showed maximum growth with 2.876 (optical density) followed by *R. nigricans* (2.314), *A. niger* (2.223), *N. crassa* (1.993), *P. citrinum* (1.925) and *A. sulphur* (1.918). Minimum growth rate was observed in *A. funiculosus* (0.635) followed by *A. ustus* (0.774) and *A. conicus* (0.782) (Table 3a).

Fresh weight of the fungi were also maximum in *A. erythrocephalus* and *A. flavus* with 2.97 mg/g followed by *A. fumigatus* with 2.86 mg/g, *A. niger* with 2.85 mg/g and *A. fumigatus* with 2.86 mg/g. Minimum of fresh weight was observed in *P. rubrum* with 1.00 mg/g (Table 3b). Dry weights of the fungi were also maximum *R. stolonifer* with 0.90 mg/g and minimum of dry weight was observed in *A. candidus* with 0.04 mg/g, *A. versicolor* with 0.06 mg/g, and *A. sydowi* with 0.07 mg/g (Table 3c).

The effect of temperature, pH, salinity and salinity-temperature interaction for thermophilic and thermotolerant fungi from Sundarban mangrove swamp have been investigated by several investigators (Jaitly, 1982, 1983; Jaitly and Rai, 1982). They have observed that forms like *A. fumigatus*, *Humicola* and *Thermomyces* have a wide range of temperature tolerance.

Effect of temperature on the growth of fungi

In this study, the maximum growth was observed in temperature range of 30°C after 8 days of incubation. In this temperature study, *A. flavus* showed maximum growth with 2.645 (optical density) followed by *A. ustus* with 2.613, *N. crassa* with 2.546 *A. funiculosus* with 2.448, *A. fumigatus* with 2.136 and *A. niger* with 2.109. Minimum growth rate was observed in *P. janthinellum* with 1.009 followed by *P. citrinum* with 1.069 and *Mucor* sp. with 1.291 (Table 4a).

Fresh weight of the fungi were also maximum in *A. conicus* with 1.71 mg/g followed by *P. rubrum* (1.65 mg/g), *Cladosporium britannicum* (1.58 mg/g) and *A. fumigatus* (1.53 mg/g). Minimum of fresh weight was observed in *A. funiculosus* (0.32 mg/g) (Table 4b). Dry weight of the fungi was also maximum *A. terreus* (0.55 mg/g) and *A. niger* (0.51 mg/g). Minimum of dry weight was observed in *A. luchensis* and *A. conicus* (0.11 mg/g), *P. citrinum* (0.12 mg/g), and *N. crassa* (0.16 mg/g) (Table 4c).

This result was discussed with earlier studies by Ritchie (1957,1959). They found that water, temperature and salinity have a combined effect on the growth rate of certain fungi. Studies of some fungi isolated from mangrove swamps and marine habitats clearly indicate that the incubation temperature increases, the salinity optima also increase until the temperature becomes a limiting factor (Chowdhery, 1975; Jaitly, 1983; Ritchie, 1957, 1959).

The effect of temperature, pH, salinity and salinity-temperature interaction for thermophilic and thermotolerant fungi from Sundarban mangrove swamp have been investigated by several investigators (Jaitly, 1983; Jaitly and Rai, 1982). They have observed that forms like *A. fumigatus*, *Humicola* and *Thermomyces* have a wide range of temperature tolerance. Boyd and Kohlmeyer (1982) studied that the influence of temperature on the seasonal and geographic distribution of three marine fungi and dry weight of fungi analysed. The effect of temperature on the growth and sporulation of aquatic hyphomycetes has been studied by Koske and Puncan (1974), Suberkropp (1984) and Webster *et al.* (1976).

Effect of salinity on the growth of fungi

In this study, the maximum growth (optical density) was observed in salinity 5% after 8 days of incubation. In this salinity study, *A. niger* showed maximum growth (2.773) followed by *A. flavus* (1.986), *A. carbonarius* (1.788), *A. oryzae* (1.662) and *P. citrinum* (1.644). Minimum growth rate was observed in *N. crassa* (0.497) followed by *R. nigricans* (0.560) and *Mucor* sp. (0.593) (Table 5a).

Fresh weight of the fungi were also maximum in *A. luchensis* (2.96 mg/g) followed by *A. versicolor* (2.40 mg/g), *A. oryzae* (2.31 mg/g) and *A. candidus* (2.21 mg/g).

Minimum of fresh weight was observed in *N. crassa* (1.00 mg/g) and *A. clavatus* (1.40 mg/g) (Table 5b). Dry weights of the fungi were also maximum *A. candidus* (0.88 mg/g), *A. conicus* (0.79 mg/g) and *A. varicolor* (0.71 mg/g). Minimum of dry weight was observed in *A. ustus* and *A. wentii* (0.35 mg/g), and *A. ochraceus* (0.37 mg/g) (Table 5c).

The above parameters were discussed with the studies carried out by Hohnk (1952, 1953, 1955, 1956) on the physiology, ecology and distribution of marine fungi in relation to salinity. Chowdhery (1975) reported that mangrove isolates have higher osmotic optima as compared to their fertile soil counterparts. In mangrove swamps, the microbial life has to withstand high salinity and fungi found in this habitat show a high degree of osmotic tolerance and increased salinity optima. Jaitly, (1983), Jaitly and Rai, (1982) investigated the effect of temperature, pH, salinity and salinity- temperature interaction for thermophilic and thermotolerant fungi from sundarban mangrove swamp.

It is interesting therefore that in considering the physiological response of terrestrial and marine fungi to increasing salinities, it can be seen that there is good correlation with the observed distribution of these fungi under natural conditions. Typically marine fungi exhibit a broad tolerance to salinity while the terrestrial fungi are inhibited by higher salinities, especially their reproduction and spore germination. Thus, the statement of Jones and Jennings (1964) can be extended 'the reduced vegetative growth, reproduction and spore germination in terrestrial fungi under saline conditions may be the factors in maintaining the fungus flora of the sea distinct from that of non-marine habitats. Studies on the salinity tolerance of marine fungi have preoccupied many mycologists as can be seen from the following papers (Borut and Johnson, 1962; Jones, 1963; Jones *et al.*, 1971).

Effect of carbon and nitrogen sources on the growth of fungi

In this study, the maximum growth was observed in carboxy methyl cellulose after 8 days of incubation. In this study, *A. sulphureus* showed maximum growth with 2.931(OD) followed by *A. terreus* with 2.911(OD), *A. clavatus* with 2.871(OD) and *A. ustus* with 2.673(OD). Minimum growth rate was observed in *C. britannicum* with 1.392 (OD) followed by *F. semitectum* with 1.421 (OD) and *P. citrinum* with 1.446 (OD) (Table 6a).

Fresh weight of the fungi was also maximum in *A. candidus* (1.99 mg/g) and minimum in *P. rubrum* (0.58 mg/g) (Table 6b). Dry weights of the fungi was maximum in *A. wentii* (0.32 mg/g) and minimum in *A. terricola* (0.08 mg/g) (Table 6c).

In starch after 8 days of incubation, *A.ustus* was showed maximum growth with 2.269 (OD) followed by *A.sulphureus* with 2.168 (OD), *A. ochraceus* with 2.204 (OD) and *A. fumigatus* with 2.181(OD). Minimum growth rate was observed in *N. crassa* with 0.340 (OD) followed by *Mucor* sp with 0.362 (OD) and *C. britannicum* with 0.484 (OD) (Table 6a).

Fresh weight of the fungi were also maximum in *A. niger* (1.51 mg/g) and minimum of fresh weight was observed in *P. citrinum* (0.46 mg/g). Dry weight of the fungi were also maximum *N. crassa* and *A. sydowi* (0.15 mg/g) and minimum of dry weight was observed in *A. sacchari* (0.03 mg/g) (Tables 6 b,c).

In mannitol after 8 days of incubation, *P. rubrum* was showed maximum growth with 2.520 (OD) followed by *A. ustus* with 2.245 (OD), *A. terreus* with 2.204 (OD) and *A. nidulans* with 2.190 (OD). Minimum growth rate was observed in *R. stolonifer* with 0.324 (OD) followed by *P. citrinum* with 0.538 (OD) and *R.oryzae* with 0.802 (OD) (Table 6a).

Fresh weight of the fungi were also maximum in *A. flavus* (1.83 mg/g) and minimum of fresh weight was observed in *R. stolonifer* (0.49 mg/g). Dry weight of the fungi were also maximum *A. wentii* (0.27 mg/g) and minimum of dry weight was observed in *A.carbonarius*,*A.nidulans*,*A.sulphureus*,*A.terricola* and *A.versicolor* with (0.07mg/g) (Tables 6b,c).

In ammonium nitrate after 8 days of incubation, *R. oryzae* showed maximum growth with 2.030 (OD) followed by *A. ochraceus* with 2.014 (OD) and *A.nidulans* with 1.933 (OD). Minimum growth rate was observed in *N. craasa* with 0.202 (OD) and *Mucor* sp. with 0.287 (OD) (Table 6a).

Fresh weight of the fungi was also maximum in *A.carbonarius* (1.91 mg/g) and minimum of fresh weight was observed in *R. nigricans* (0.75 mg/g). Dry weight of the fungi were also maximum in *A. flavus* (0.36 mg/g) and minimum of dry weight was observed in *Mucor* sp. with 0.04 mg/g (Tables 6b,c).

In calcium nitrate on 8 days of incubation, *A. nidulans* showed maximum growth with 1.552 (OD) followed by *A.erythrocephalus* with 1.426 (OD) and *Rhizopus nigricans* with 1.417 (OD). Minimum growth rate was observed in *N. craasa* with 0.146 (OD) and *Mucor* sp. with 0.270 (OD) (Table 6a).

Fresh weights of the fungi were also maximum in *A. candidus* (1.54 mg/g) and minimum of fresh weight was observed in *R. oryzae*(0.53 mg/g). Dry weight of the fungi were also maximum *A. flavus* (0.26 mg/g) and minimum of dry weight was observed in *R. nigricans* and *Mucor* sp. (0.06 mg/g) (Tables 6b,c).

Swart (1958) studied that the mycoflora in the soil of mangrove Swamp of Inhaea Island has suggested that these swamp are rich in simple carbohydrate and nitrogen and the dominance of the speices of *Aspergillus* and *Penicillium* indicates their preference for simple organic compounds.

Effect of metals on the growth of fungi

In ferric sulphate after 8 days of incubation. In this study, *R. oryzae* and *C. britannicum* showed maximum growth with 2.069 (OD) followed by *P. citrinum* with 1.817 (OD) and *Rhizopus stolonifer* with 1.701 (OD). Minimum growth rate was observed in *A. fumigatus* with 1.046 (OD) and *Mucor* sp. with 1.087 (OD) (Table 7a). Fresh weight of the fungi was also maximum in *N. crassa* (1.71 mg/g) and minimum of fresh weight was observed in *A. ochraceus* (0.67 mg/g). Dry weight of the fungi was also maximum in *C. britannicum* (1.16 mg/g) and minimum of dry weight was observed in *A. ustus* (0.10 mg/g) (Table 7b).

In zinc sulphate after 8 days of incubation, *A. terricola* showed maximum growth with 1.727 (OD) and minimum growth rate was observed in *A. oryzae* with 0.191 (OD) (Table 7a). Fresh weights of the fungi were also maximum in *A. conicus* (1.46 mg/g) and minimum of fresh weight was observed in *P.citrinum* (0.12 mg/g). Dry weights of the fungi were also maximum *A. terricola* (0.43 mg/g) and minimum of dry weight was observed in *A. flavus*, *P. citrinum*, *P. janthinellum* (0.10 mg/g) (Table 7b).

Various researchers (Gourdon *et al.*, 1990) have studied the mechanism of heavy metal biosorption and reported involvement of different mechanism such as intracellular uptake and storage via active cationic transport system, surface binding and other undefined machanisms. Since most metal microbes interactions are initiated at the level of uptake, the uptake machanism is likely to be closely linked to the machanism of metal resistance in the microorganisms (Yilmaz, 2003).

Table 1. Growth and morphological characteristics of fungun various media

(The values are represented in mm in diameter).

S.No	Name of the fungi	PDA	SDA	CMA	CZA	MA	RBA	OMA
1	<i>Rhizopus nigricans</i>	73	24	52	36	82	39	47
2	<i>R. oryzae</i>	63	20	51	31	33	45	35
3	<i>R. stolonifer</i>	72	63	15	19	59	79	28
4	<i>Mucor</i> sp.	72	39	40	33	35	83	59
5	<i>Neurospora crassa</i>	49	80	68	73	53	78	83
6	<i>Aspergillus candidus</i>	51	23	19	19	20	31	26
7	<i>A. carbonarius</i>	25	32	12	15	31	10	16
8	<i>A.clavatus</i>	16	18	15	25	14	13	19
9	<i>A. conicus</i>	34	38	40	26	23	18	23
10	<i>A. erythrocephalus</i>	38	29	41	36	34	33	41
11	<i>A. flavus</i>	46	35	45	24	31	38	18
12	<i>A. fumigatus</i>	18	26	31	21	21	15	16
13	<i>A. funiculosus</i>	25	22	30	32	39	14	18
14	<i>A. luchuensis</i>	39	33	34	26	72	31	61
15	<i>A. nidulans</i>	17	13	11	11	13	10	12
16	<i>A. niger</i>	40	51	29	35	35	18	21
17	<i>A.ochraceus</i>	43	65	29	21	30	31	55
18	<i>A. oryzae</i>	54	21	42	45	29	28	32
19	<i>A.sacchari</i>	28	31	35	23	39	19	40
20	<i>A.sulphureus</i>	27	13	29	18	28	09	34
21	<i>A. sydowi</i>	46	24	41	27	13	19	22
22	<i>A. terreus</i>	10	20	09	23	12	09	14
23	<i>A. terricola</i>	61	32	39	31	15	29	41
24	<i>A. ustus</i>	24	29	21	18	14	33	14
25	<i>A. versicolor</i>	39	29	27	23	36	15	42
26	<i>A. wentii</i>	11	16	10	21	14	14	16
27	<i>Pencillium citrinum</i>	12	19	10	32	13	30	12
28	<i>P. janthinellum</i>	13	15	23	30	22	23	14
29	<i>P. rubrum</i>	14	13	17	27	15	27	29
30	<i>C. britannicum</i>	12	19	11	22	09	22	20
31	<i>Fusarium semitectum</i>	85	57	83	67	50	77	60

Table 2. Effect of biomass of dominant species of fungi

(The values are represented in OD at 600 nm)

S.No	Name of the fungi	8days	Fresh & Dry weights in mg/g (After 8 days)	
			Fresh	Dry
1	<i>Rhizopus nigricans</i>	1.840	0.95	0.31
2	<i>R. oryzae</i>	1.859	2.82	0.20
3	<i>R. stolonifer</i>	1.524	5.47	0.28
4	<i>Mucor</i> sp.	1.755	2.04	0.41
5	<i>Neurospora crassa</i>	0.410	1.66	0.56
6	<i>Aspergillus candidus</i>	0.763	6.47	1.38
7	<i>A. carbonarius</i>	1.299	5.61	0.78
8	<i>A. clavatus</i>	0.389	4.83	1.03
9	<i>A. conicus</i>	1.203	4.91	0.59
10	<i>A. erythrocephalus</i>	1.852	5.01	2.41
11	<i>A. flavus</i>	1.873	7.80	2.41
12	<i>A. fumigatus</i>	0.821	4.54	0.83
13	<i>A. funiculosus</i>	1.269	5.95	1.23
14	<i>A. luchuensis</i>	0.421	6.98	2.72
15	<i>A.nidulans</i>	1.493	2.0	0.88
16	<i>A. niger</i>	1.883	4.99	2.09
17	<i>A. ochraceus</i>	1.929	7.68	2.17
18	<i>A. oryzae</i>	1.955	9.28	3.02
19	<i>A. sacchari</i>	1.159	4.16	0.36
20	<i>A. sulphureus</i>	1.200	5.84	1.66
21	<i>A. sydowi</i>	1.934	8.08	2.1
22	<i>A. terreus</i>	0.809	1.75	0.35
23	<i>A. terricola</i>	1.315	4.91	1.31
24	<i>A. ustus</i>	1.243	4.71	1.56
25	<i>A. versicolor</i>	1.307	3.02	1.52
26	<i>A. wentii</i>	1.805	4.53	2.24
27	<i>Pencillium citrinum</i>	1.851	1.62	0.20
28	<i>P. janthinellum</i>	1.825	0.79	0.26
29	<i>P. rubrum</i>	0.899	0.39	0.26
30	<i>Cladosporium britannicum</i>	1.539	1.94	0.27
31	<i>Fusarium semitectum</i>	1.847	0.98	0.44

Table 3a. Effect of pH on fungal growth
(The values are represented in OD at 600 nm)

S.No	Name of the fungi	5	6	7	8	9
1	<i>Rhizopus nigricans</i>	0.981	1.040	0.836	2.314	1.362
2	<i>R. oryzae</i>	0.823	0.931	0.971	0.998	0.451
3	<i>R. stolonifer</i>	0.761	0.942	0.725	1.424	0.540
4	<i>Mucor</i> sp.	0.368	0.763	0.802	1.657	0.648
5	<i>Neurospora crassa</i>	1.564	1.646	1.236	1.993	1.127
6	<i>Aspergillus candidus</i>	0.695	1.273	1.158	1.315	0.602
7	<i>A. carbonarius</i>	0.929	1.217	0.658	2.041	1.153
8	<i>A. clavatus</i>	1.063	1.177	1.009	1.518	1.174
9	<i>A. conicus</i>	0.668	0.641	0.607	0.782	0.697
10	<i>A. erythrocephalus</i>	1.237	1.200	1.402	1.480	1.231
11	<i>A. flavus</i>	0.899	1.215	0.877	1.272	1.174
12	<i>A. fumigatus</i>	1.022	0.944	1.297	1.581	1.330
13	<i>A. funiculosus</i>	0.543	0.592	0.588	0.635	0.597
14	<i>A. luchuensis</i>	2.148	1.876	1.587	2.876	2.174
15	<i>A. nidulans</i>	0.807	0.537	0.367	0.933	0.852
16	<i>A. niger</i>	1.922	2.157	0.594	2.223	2.004
17	<i>A. ochraceus</i>	1.106	0.784	1.465	1.717	1.510
18	<i>A. oryzae</i>	0.952	0.320	1.228	1.265	1.104
19	<i>A. sacchari</i>	1.394	0.973	1.274	1.815	0.501
20	<i>A. sulphureus</i>	1.394	1.506	1.071	1.918	1.403
21	<i>A. sydowi</i>	0.677	0.918	0.771	1.445	0.872
22	<i>A. terreus</i>	0.743	0.491	0.766	0.987	0.809
23	<i>A. terricola</i>	0.616	1.419	1.915	1.988	1.667
24	<i>A. ustus</i>	0.734	0.301	0.501	0.774	0.571
25	<i>A.versicolor</i>	0.805	1.491	1.171	1.787	0.720
26	<i>A. wentii</i>	0.655	0.602	0.558	1.425	0.630
27	<i>Pencillium citrinum</i>	1.807	1.212	1.795	1.925	1.109
28	<i>P. janthinellum</i>	1.667	1.263	1.639	1.714	1.004
29	<i>P. rubrum</i>	1.660	1.510	1.745	1.813	1.601
30	<i>Cladosporium britannicum</i>	0.738	1.318	1.364	1.917	1.226
31	<i>Fusarium semitectum</i>	1.449	1.452	1.447	2.157	1.885

Table 3b. Effect of pH on fresh weight of fungal growth

(The values are represented in mg/g)

S.No	Name of the fungi	5	6	7	8	9
1	<i>Rhizopus nigricans</i>	1.06	1.01	0.65	1.19	1.19
2	<i>R. oryzae</i>	1.15	1.30	0.96	1.72	1.07
3	<i>R. stolonifer</i>	0.79	0.80	0.78	1.25	0.90
4	<i>Mucor sp.</i>	1.10	0.96	0.88	1.26	1.20
5	<i>Neurospora crassa</i>	0.84	1.13	0.50	1.15	0.91
6	<i>Aspergillus candidus</i>	1.01	0.97	1.56	1.78	1.02
7	<i>A. carbonarius</i>	1.10	0.70	0.28	2.18	2.43
8	<i>A. clavatus</i>	1.05	1.18	1.10	1.27	1.17
9	<i>A. conicus</i>	1.92	1.80	1.72	2.11	1.76
10	<i>A. erythrocephalus</i>	2.08	2.79	2.35	2.97	2.66
11	<i>A. flavus</i>	1.83	2.01	2.65	2.97	2.21
12	<i>A. fumigatus</i>	1.24	1.42	1.59	2.86	1.40
13	<i>A. funiculosus</i>	1.60	1.54	2.02	2.59	2.23
14	<i>A. luchuensis</i>	1.88	2.16	2.15	2.31	1.60
15	<i>A. nidulans</i>	1.45	2.16	2.04	2.75	2.04
16	<i>A. niger</i>	1.98	2.20	2.43	2.85	1.63
17	<i>A. ochraceus</i>	1.82	1.92	1.97	2.09	1.74
18	<i>A. oryzae</i>	2.40	1.31	1.92	2.75	1.88
19	<i>A. sacchari</i>	1.10	1.40	1.18	1.52	1.03
20	<i>A. sulphureus</i>	2.16	2.16	2.48	2.52	2.15
21	<i>A. sydowi</i>	0.25	0.97	1.08	1.11	0.76
22	<i>A. terreus</i>	1.35	1.41	1.74	1.89	1.39
23	<i>A. terricola</i>	2.09	1.88	1.94	2.16	1.77
24	<i>A. ustus</i>	2.07	2.35	2.01	2.56	1.50
25	<i>A. versicolor</i>	1.22	1.21	0.59	1.29	1.42
26	<i>A. wentii</i>	1.52	1.70	2.01	2.09	1.99
27	<i>Pencillium citrinum</i>	0.72	1.07	0.96	1.77	1.17
28	<i>P. janthinellum</i>	1.56	1.15	0.71	1.87	1.19
29	<i>P. rubrum</i>	0.29	0.58	0.23	1.0	0.36
30	<i>Cladosporium britannicum</i>	1.16	1.16	1.20	1.11	1.04
31	<i>Fusarium semitectum</i>	0.75	1.26	0.58	1.98	1.02

Table 3c. Effect of pH on dry weight of fungal growth
(The values are represented in mg/ g)

S.No	Name of the fungi	5	6	7	8	9
1	<i>Rhizopus nigricans</i>	0.06	0.10	0.05	0.19	0.10
2	<i>R. oryzae</i>	0.07	0.10	0.07	0.16	0.14
3	<i>R. stolonifer</i>	0.47	0.80	0.08	0.90	0.13
4	<i>Mucor</i> sp.	0.08	0.09	0.09	0.29	0.12
5	<i>Neurospora crassa</i>	0.06	0.10	0.07	0.11	0.08
6	<i>Aspergillus candidus</i>	0.03	0.01	0.03	0.04	0.03
7	<i>A. carbonarius</i>	0.09	0.02	0.05	0.14	0.04
8	<i>A. clavatus</i>	0.01	0.05	0.04	0.18	0.01
9	<i>A. conicus</i>	0.08	0.18	0.07	0.24	0.02
10	<i>A. erythrocephalus</i>	0.10	0.17	0.05	0.24	0.04
11	<i>A. flavus</i>	0.02	0.12	0.25	0.28	0.08
12	<i>A. fumigatus</i>	0.01	0.04	0.02	0.08	0.06
13	<i>A. funiculosus</i>	0.01	0.02	0.11	0.21	0.01
14	<i>A. luchuensis</i>	0.04	0.01	0.03	0.21	0.01
15	<i>A. nidulans</i>	0.04	0.09	0.06	0.14	0.09
16	<i>A. niger</i>	0.06	0.06	0.07	0.15	0.06
17	<i>A. ochraceus</i>	0.02	0.01	0.02	0.20	0.03
18	<i>A. oryzae</i>	0.06	0.04	0.05	0.13	0.02
19	<i>A. sacchari</i>	0.01	0.05	0.06	0.14	0.02
20	<i>A. sulphureus</i>	0.01	0.07	0.01	0.16	0.08
21	<i>A. sydowi</i>	0.05	0.05	0.03	0.07	0.05
22	<i>A. terreus</i>	0.05	0.04	0.10	0.15	0.03
23	<i>A. terricola</i>	0.06	0.04	0.08	0.10	0.07
24	<i>A. ustus</i>	0.02	0.07	0.04	0.12	0.02
25	<i>A. versicolor</i>	0.02	0.04	0.04	0.06	0.01
26	<i>A. wentii</i>	0.06	0.15	0.08	0.16	0.03
27	<i>Pencillium citrinum</i>	0.06	0.09	0.06	0.18	0.13
28	<i>P. janthinellum</i>	0.12	0.12	0.08	0.18	0.12
29	<i>P. rubrum</i>	0.04	0.10	0.07	0.12	0.05
30	<i>Cladosporium britannicum</i>	0.08	0.08	0.09	0.49	0.08
31	<i>Fusarium semitectum</i>	0.04	0.11	0.06	0.68	0.09

Table 4a. Effect of temperature on fungal growth

(The values are represented in OD at 600 nm)

S.No	Name of the fungi	20°C	30°C	40°C	50°C	60°C
1	<i>Rhizopus nigricans</i>	1.310	1.731	1.044	0.324	0.494
2	<i>R. oryzae</i>	1.146	1.481	1.162	1.313	0.694
3	<i>R. stolonifer</i>	1.307	1.722	1.287	0.177	0.608
4	<i>Mucor</i> sp.	0.504	1.291	1.025	0.238	0.381
5	<i>Neurospora crassa</i>	0.968	2.546	0.717	2.092	1.791
6	<i>Aspergillus candidus</i>	1.655	1.738	1.093	0.855	1.041
7	<i>A. carbonarius</i>	1.676	1.717	1.301	0.955	0.516
8	<i>A. clavatus</i>	1.866	1.904	1.611	1.600	1.262
9	<i>A. conicus</i>	1.213	1.314	1.046	1.311	1.173
10	<i>A. erythrocephalus</i>	1.432	1.835	1.526	1.041	1.340
11	<i>A. flavus</i>	1.272	2.645	1.920	2.176	1.454
12	<i>A. fumigatus</i>	2.012	2.136	1.640	1.331	2.00
13	<i>A. funiculosus</i>	1.173	2.448	1.454	0.968	0.869
14	<i>A. luchuensis</i>	1.317	1.733	1.529	0.632	0.700
15	<i>A. nidulans</i>	1.455	1.528	1.331	1.390	0.908
16	<i>A. niger</i>	1.170	2.109	1.770	1.221	1.031
17	<i>A. ochraceus</i>	1.473	1.620	1.249	0.653	0.281
18	<i>A. oryzae</i>	1.676	1.987	1.246	1.954	1.813
19	<i>A. sacchari</i>	1.470	1.637	1.611	1.153	0.327
20	<i>A. sulphureus</i>	1.352	1.594	1.211	0.795	0.869
21	<i>A. sydowi</i>	1.835	1.920	1.644	1.304	0.276
22	<i>A. terreus</i>	1.824	1.894	1.262	0.975	1.159
23	<i>A. terricola</i>	1.757	1.763	1.483	1.293	0.795
24	<i>A. ustus</i>	1.676	2.613	1.615	1.136	2.321
25	<i>A. versicolor</i>	1.328	1.715	1.484	1.188	0.491
26	<i>A. wentii</i>	1.613	1.852	0.686	1.835	0.739
27	<i>Pencillium citrinum</i>	0.161	1.069	1.430	0.445	0.442
28	<i>P. janthinellum</i>	0.745	1.009	0.761	0.455	0.551
29	<i>P. rubrum</i>	1.156	1.921	0.730	0.453	0.283
30	<i>Cladosporium britannicum</i>	0.093	1.627	0.440	0.560	0.397
31	<i>Fusarium semitectum</i>	0.806	1.732	1.007	0.407	0.744

Table 4b Effect of temperature on fresh weight of fungal growth
(The values are represented in mg/ g)

S.No	Name of the fungi	20°C	30°C	40°C	50°C	60°C
1	<i>Rhizopus nigricans</i>	0.48	0.89	0.65	0.75	0.53
2	<i>R. oryzae</i>	0.89	0.94	0.65	0.63	0.77
3	<i>R. stolonifer</i>	0.70	0.97	0.54	0.49	0.77
4	<i>Mucor</i> sp.	0.60	0.82	0.57	0.76	0.64
5	<i>Neurospora crassa</i>	0.72	0.80	0.79	0.78	0.71
6	<i>Aspergillus candidus</i>	0.71	0.84	0.76	0.79	0.77
7	<i>A. carbonarius</i>	0.98	1.27	1.11	0.61	0.94
8	<i>A. clavatus</i>	0.28	0.67	0.57	0.59	0.50
9	<i>A. conicus</i>	0.36	1.71	0.85	0.83	1.03
10	<i>A. erythrocephalus</i>	0.19	0.47	0.41	0.12	0.42
11	<i>A. flavus</i>	0.97	1.27	1.17	0.95	0.99
12	<i>A. fumigatus</i>	0.70	1.53	1.08	1.03	0.46
13	<i>A. funiculosus</i>	0.09	0.32	0.53	0.53	0.42
14	<i>A. luchuensis</i>	0.40	0.74	0.19	0.44	0.40
15	<i>A. nidulans</i>	0.93	1.01	1.00	0.97	1.02
16	<i>A. niger</i>	0.32	1.27	1.21	0.34	0.56
17	<i>A. ochraceus</i>	0.28	0.60	0.51	0.53	0.37
18	<i>A. oryzae</i>	0.59	0.94	0.69	0.41	0.78
19	<i>A. sacchari</i>	0.69	0.93	0.60	0.84	0.76
20	<i>A. sulphureus</i>	0.29	0.55	0.52	0.37	0.42
21	<i>A. sydowi</i>	0.61	0.93	0.90	0.72	0.78
22	<i>A. terreus</i>	0.76	0.80	0.75	0.78	0.79
23	<i>A. terricola</i>	0.56	1.04	0.67	0.87	0.90
24	<i>A. ustus</i>	0.27	0.68	0.49	0.66	0.51
25	<i>A. versicolor</i>	0.56	0.67	0.61	0.36	0.35
26	<i>A. wentii</i>	0.86	0.98	1.07	0.60	0.74
27	<i>Penicillium citrinum</i>	0.53	0.67	0.64	0.60	0.57
28	<i>P. janthinellum</i>	0.67	0.88	0.76	0.83	0.55
29	<i>P. rubrum</i>	0.67	1.65	1.13	0.49	0.58
30	<i>Cladosporium britannicum</i>	0.74	1.58	0.43	0.79	0.67
31	<i>Fusarium semitectum</i>	0.87	1.05	0.71	1.0	0.62

Table 4c. Effect of temperature on Dry weight of fungal growth

(The values are represented in mg/ g)

S.No	Name of the fungi	20°C	30°C	40°C	50°C	60°C
1	<i>Rhizopus nigricans</i>	0.07	0.18	0.07	0.11	0.06
2	<i>R. oryzae</i>	0.11	0.19	0.10	0.10	0.08
3	<i>R. stolonifer</i>	0.10	0.19	0.09	0.09	0.08
4	<i>Mucor</i> sp.	0.08	0.17	0.09	0.10	0.08
5	<i>Neurospora crassa</i>	0.09	0.16	0.08	0.10	0.10
6	<i>Aspergillus candidus</i>	0.22	0.31	0.22	0.07	0.02
7	<i>A. carbonarius</i>	0.23	0.32	0.28	0.09	0.04
8	<i>A. clavatus</i>	0.11	0.22	0.16	0.19	0.13
9	<i>A. conicus</i>	0.11	0.11	0.03	0.05	0.11
10	<i>A. erythrocephalus</i>	0.13	0.25	0.32	0.21	0.23
11	<i>A. flavus</i>	0.21	0.41	0.24	0.21	0.05
12	<i>A. fumigatus</i>	0.21	0.32	0.13	0.06	0.04
13	<i>A. funiculosus</i>	0.04	0.22	0.20	0.21	0.12
14	<i>A. luchuensis</i>	0.10	0.11	0.03	0.09	0.03
15	<i>A. nidulans</i>	0.21	0.41	0.23	0.21	0.06
16	<i>A. niger</i>	0.11	0.51	0.24	0.22	0.03
17	<i>A. ochraceus</i>	0.11	0.26	0.13	0.21	0.11
18	<i>A. oryzae</i>	0.22	0.34	0.21	0.32	0.21
19	<i>A. sacchari</i>	0.03	0.45	0.33	0.38	0.30
20	<i>A. sulphureus</i>	0.06	0.31	0.22	0.31	0.13
21	<i>A. sydowi</i>	0.21	0.41	0.34	0.21	0.03
22	<i>A. terreus</i>	0.28	0.55	0.21	0.11	0.06
23	<i>A. terricola</i>	0.21	0.31	0.25	0.17	0.09
24	<i>A. ustus</i>	0.12	0.36	0.32	0.11	0.11
25	<i>A.versicolor</i>	0.22	0.41	0.25	0.11	0.04
26	<i>A. wentii</i>	0.21	0.41	0.22	0.21	0.09
27	<i>Pencillium citrinum</i>	0.07	0.12	0.09	0.12	0.08
28	<i>P. janthinellum</i>	0.06	0.18	0.07	0.11	0.08
29	<i>P. rubrum</i>	0.10	0.18	0.11	0.08	0.09
30	<i>Cladosporium britannicum</i>	0.08	0.28	0.07	0.11	0.06
31	<i>Fusarium semitectum</i>	0.09	0.17	0.09	0.10	0.08

Table 5a. Effect of salinity on fungal growth

(The values are represented in OD at 600 nm)

S.No	Name of the fungi	5%	10%	20%	30%	40%
1	<i>Rhizopus nigricans</i>	0.560	0.551	0.374	0.390	0.403
2	<i>R. oryzae</i>	1.405	0.695	0.347	0.474	0.411
3	<i>R. stolonifer</i>	1.154	0.620	0.381	0.423	0.376
4	<i>Mucor sp.</i>	0.593	0.508	0.354	0.427	0.402
5	<i>Neurospora crassa</i>	0.497	0.429	0.404	0.493	0.421
6	<i>Aspergillus candidus</i>	0.675	0.661	0.420	0.290	0.275
7	<i>A. carbonarius</i>	1.788	1.058	0.516	0.345	0.180
8	<i>A. clavatus</i>	0.987	0.909	0.892	0.449	0.404
9	<i>A. conicus</i>	0.765	0.693	0.475	0.390	0.220
10	<i>A. erythrocephalus</i>	1.292	1.082	0.835	0.806	0.117
11	<i>A. flavus</i>	1.986	1.205	1.106	0.255	0.220
12	<i>A. fumigatus</i>	0.974	0.835	0.336	0.244	0.159
13	<i>A. funiculosus</i>	1.092	0.858	0.560	0.320	0.250
14	<i>A. luchuensis</i>	0.826	0.353	0.556	0.187	0.167
15	<i>A. nidulans</i>	1.007	1.001	0.523	0.288	0.132
16	<i>A. niger</i>	2.773	1.761	0.440	0.255	0.210
17	<i>A. ochraceus</i>	1.136	1.072	0.713	0.457	0.320
18	<i>A. oryzae</i>	1.662	1.415	1.568	0.533	0.172
19	<i>A. sacchari</i>	1.375	1.650	1.116	0.280	0.109
20	<i>A. sulphureus</i>	0.648	0.641	0.532	0.489	0.400
21	<i>A. sydowi</i>	0.942	0.835	0.761	0.273	0.253
22	<i>A. terreus</i>	1.406	1.034	1.012	0.274	0.187
23	<i>A. terricola</i>	0.738	0.684	0.503	0.277	0.275
24	<i>A. ustus</i>	0.892	0.815	0.810	0.705	0.563
25	<i>A. versicolor</i>	0.798	0.727	0.545	0.327	0.213
26	<i>A. wentii</i>	0.996	0.846	0.682	0.271	0.260
27	<i>Pencillium citrinum</i>	1.644	0.829	0.361	0.164	0.147
28	<i>P. janthinellum</i>	0.671	0.479	0.349	0.306	0.205
29	<i>P. rubrum</i>	0.694	0.529	0.494	0.493	0.421
30	<i>Cladsporium britannicum</i>	0.924	0.458	0.376	0.356	0.212
31	<i>Fusarium semitectum</i>	0.947	0.674	0.475	0.457	0.361

Table 5b. Effect of salinity on fresh weight of fungal growth
(The values are represented in mg/ g)

S.No	Name of the fungi	5%	10%	20%	30%	40%
1	<i>Rhizopus .nigricans</i>	1.73	1.04	0.94	0.97	0.94
2	<i>R. oryzae</i>	1.72	1.03	1.07	1.25	1.11
3	<i>R. stolonifer</i>	1.61	0.87	1.03	1.57	1.29
4	<i>Mucor sp.</i>	1.76	0.88	0.77	1.17	1.15
5	<i>Neurospora crassa</i>	1.37	0.75	0.70	1.27	1.04
6	<i>Aspergillus candidus</i>	2.21	2.08	1.82	1.68	0.93
7	<i>A. carbonarius</i>	2.03	1.99	1.96	1.90	1.80
8	<i>A. clavatus</i>	1.40	1.84	1.79	1.68	1.04
9	<i>A. conicus</i>	2.06	1.70	1.59	1.57	0.66
10	<i>A. erythrocephalus</i>	2.18	2.10	1.92	1.92	1.01
11	<i>A. flavus</i>	1.90	1.86	1.78	1.57	1.10
12	<i>A. fumigatus</i>	1.85	1.49	1.41	1.09	1.08
13	<i>A. funiculosus</i>	1.96	1.80	1.14	0.61	0.80
14	<i>A. luchuensis</i>	2.96	2.86	2.16	2.08	1.96
15	<i>A. nidulans</i>	1.86	1.67	1.67	1.48	1.06
16	<i>A.niger</i>	1.81	1.40	1.09	1.07	0.88
17	<i>A.ochraceus</i>	2.01	1.98	1.69	1.90	2.04
18	<i>A. oryzae</i>	2.31	1.58	1.58	2.10	2.23
19	<i>A. sacchari</i>	1.71	1.62	1.59	1.40	1.14
20	<i>A. sulphureus</i>	2.05	1.64	1.71	1.81	1.96
21	<i>A. sydowi</i>	1.66	1.47	1.49	1.48	1.00
22	<i>A. terreus</i>	1.83	1.57	1.38	1.04	1.00
23	<i>A.terricola</i>	1.82	1.73	1.25	1.14	1.01
24	<i>A. ustus</i>	1.61	1.56	1.52	1.47	1.92
25	<i>A.versicolor</i>	2.40	2.23	1.30	1.30	1.02
26	<i>A. wentii</i>	1.86	1.46	1.46	1.24	1.14
27	<i>Penicillium citrinum</i>	1.72	0.91	0.93	0.95	0.89
28	<i>P. janthinellum</i>	1.91	1.71	1.65	1.41	1.25
29	<i>P. rubrum</i>	1.92	1.86	0.79	0.78	0.69
30	<i>Cladosporium britannicum</i>	1.75	0.93	0.85	0.67	0.53
31	<i>Fusarium semitectum</i>	1.96	1.90	1.05	0.96	0.90

**Table 5c. Effect of salinity on dry weight of fungal growth
(The values are represented in mg/ g)**

S.No	Name of the fungi	5%	10%	20%	30%	40%
1	<i>Rhizopus nigricans</i>	0.46	0.40	0.30	0.29	0.13
2	<i>R. oryzae</i>	0.47	0.44	0.28	0.25	0.13
3	<i>R. stolonifer</i>	0.53	0.25	0.19	0.16	0.09
4	<i>Mucor</i> sp.	0.43	0.40	0.29	0.27	0.12
5	<i>Neurospora crassa</i>	0.45	0.40	0.29	0.18	0.12
6	<i>Aspergillus candidus</i>	0.88	0.79	0.22	0.21	0.20
7	<i>A. carbonarius</i>	0.64	0.33	0.32	0.31	0.27
8	<i>A. clavatus</i>	0.46	0.44	0.39	0.38	0.34
9	<i>A. conicus</i>	0.79	0.47	0.43	0.24	0.12
10	<i>A. erythrocephalus</i>	0.65	0.64	0.52	0.52	0.47
11	<i>A. flavus</i>	0.43	0.32	0.28	0.25	0.18
12	<i>A. fumigatus</i>	0.44	0.28	0.27	0.22	0.22
13	<i>A. funiculosus</i>	0.68	0.60	0.15	0.09	0.05
14	<i>A. luchuensis</i>	0.47	0.43	0.39	0.39	0.36
15	<i>A. nidulans</i>	0.36	0.32	0.29	0.18	0.11
16	<i>A. niger</i>	0.50	0.24	0.21	0.13	0.12
17	<i>A. ochraceus</i>	0.37	0.29	0.27	0.26	0.22
18	<i>A. oryzae</i>	0.45	0.34	0.34	0.31	0.28
19	<i>A. sacchari</i>	0.50	0.36	0.34	0.29	0.18
20	<i>A. sulphureus</i>	0.57	0.42	0.37	0.34	0.34
21	<i>A. sydowi</i>	0.41	0.40	0.40	0.35	0.29
22	<i>A. terreus</i>	0.40	0.37	0.31	0.30	0.20
23	<i>A. terricola</i>	0.53	0.33	0.30	0.26	0.24
24	<i>A. ustus</i>	0.35	0.35	0.28	0.28	0.25
25	<i>A. versicolor</i>	0.43	0.26	0.24	0.24	0.24
26	<i>A. wentii</i>	0.35	0.34	0.30	0.26	0.21
27	<i>Pencillium citrinum</i>	0.40	0.36	0.30	0.26	0.15
28	<i>P. janthinellum</i>	0.49	0.42	0.37	0.22	0.20
29	<i>P. rubrum</i>	0.60	0.42	0.39	0.24	0.18
30	<i>Cladosporium britannicum</i>	0.47	0.32	0.30	0.26	0.13
31	<i>Fusarium semitectum</i>	0.45	0.38	0.34	0.21	0.16

Table 6a. Effect of carbon and nitrogen sources on fungal growth

(The values are represented in OD at 600 nm)

S.No	Name of the fungi	CMC (1%)	Starch (1%)	Mannitol (1%)	Amm.Nitrate (1%)	Cal.Nitrate (1%)
1	<i>Rhizopus stolonifer</i>	1.689	1.648	0.324	0.968	0.876
2	<i>R. oryzae</i>	1.908	1.843	0.802	2.030	0.808
3	<i>R. nigricans</i>	1.929	1.240	1.840	1.906	1.417
4	<i>Mucor</i> sp.	2.359	0.362	1.968	0.287	0.270
5	<i>Neurospora crassa</i>	1.687	0.340	0.990	0.202	0.146
6	<i>Aspergillus candidus</i>	2.118	2.109	1.928	1.644	1.173
7	<i>A. carbonarius</i>	2.551	2.106	1.854	1.819	0.978
8	<i>A. clavatus</i>	2.871	1.882	2.159	1.402	0.835
9	<i>A. conicus</i>	2.318	2.145	2.130	1.534	0.793
10	<i>A. erythrocephalus</i>	1.809	0.985	1.712	1.490	1.426
11	<i>A. flavus</i>	2.132	1.478	1.743	1.670	1.301
12	<i>A. fumigatus</i>	2.229	2.181	2.046	1.417	0.988
13	<i>A. funiculosus</i>	1.821	1.255	1.044	1.318	1.013
14	<i>A. luchuensis</i>	1.999	1.255	1.982	1.414	1.032
15	<i>A. nidulans</i>	2.256	2.011	2.190	1.933	1.552
16	<i>A. niger</i>	2.239	1.460	1.840	1.653	1.332
17	<i>A. ochraceus</i>	2.340	2.204	2.039	2.014	0.682
18	<i>A. oryzae</i>	2.122	1.819	1.734	1.591	1.143
19	<i>A. sacchari</i>	2.344	1.340	1.728	1.544	1.231
20	<i>A. sulphureus</i>	2.931	2.168	1.988	1.637	1.129
21	<i>A. sydowi</i>	2.204	1.738	2.029	1.791	1.374
22	<i>A. terreus</i>	2.911	2.029	2.204	1.372	1.180
23	<i>A. terricola</i>	2.738	2.159	2.136	1.314	0.983
24	<i>A. ustus</i>	2.673	2.269	2.245	1.307	0.732
25	<i>A. versicolor</i>	2.204	1.754	1.692	1.829	1.279
26	<i>A. wentii</i>	2.456	1.988	2.023	1.743	1.373
27	<i>Pencillium citrinum</i>	1.446	1.177	0.538	0.758	0.694
28	<i>P. janthinellum</i>	1.678	1.138	1.072	1.695	1.230
29	<i>P. rubrum</i>	2.253	1.667	2.520	0.813	0.553
30	<i>C. britannicum</i>	1.393	0.484	0.835	1.294	0.760
31	<i>Fusarium semitectum</i>	1.421	1.405	1.012	1.738	0.641

Table 6b. Effect of carbon and nitrogen sources on fresh weight of fungal growth
(The values are represented in mg/ g)

S.No	Name of the fungi	CMC (1%)	Starch (1%)	Mannitol (1%)	Amm. Nitrate (1%)	Cal. Nitrate (1%)
1	<i>Rhizopus nigricans</i>	0.77	0.59	0.72	0.75	0.72
2	<i>R. oryzae</i>	0.98	0.89	0.66	0.81	0.53
3	<i>R. stolonifer</i>	0.69	0.61	0.49	1.82	1.21
4	<i>Mucor sp.</i>	0.75	0.48	0.70	0.91	0.57
5	<i>Neurospora crassa</i>	0.87	0.87	0.76	0.98	0.90
6	<i>Aspergillus candidus</i>	1.99	1.28	1.62	1.35	1.54
7	<i>A. carbonarius</i>	1.84	1.42	1.06	1.91	1.02
8	<i>A. clavatus</i>	1.21	1.15	1.23	1.45	1.36
9	<i>A.conicus</i>	1.53	1.07	1.40	1.15	0.95
10	<i>A.erythrocephalus</i>	0.89	0.61	0.71	1.24	1.18
11	<i>A. flavus</i>	1.95	1.28	1.83	1.68	1.50
12	<i>A. fumigatus</i>	1.21	1.04	1.21	1.73	1.23
13	<i>A. funiculosus</i>	1.07	1.00	1.04	1.57	1.43
14	<i>A. luchuensis</i>	0.98	0.75	0.83	1.22	1.02
15	<i>A. nidulans</i>	1.15	0.95	1.10	1.05	0.95
16	<i>A. niger</i>	1.72	1.51	1.25	1.38	1.31
17	<i>A. ochraceus</i>	1.45	1.22	1.20	1.03	0.97
18	<i>A. oryzae</i>	1.03	0.95	0.95	1.11	1.05
19	<i>A. sacchari</i>	1.76	1.10	0.87	1.20	1.12
20	<i>A. sulphureus</i>	0.79	0.48	0.54	1.24	1.22
21	<i>A. sydowi</i>	1.97	1.43	1.23	1.31	1.53
22	<i>A. terreus</i>	1.29	0.98	1.18	1.24	1.06
23	<i>A. terricola</i>	1.79	1.07	0.98	1.30	1.21
24	<i>A. ustus</i>	1.33	1.19	1.24	1.44	1.40
25	<i>A. versicolor</i>	1.83	1.15	1.07	1.29	1.12
26	<i>A. wentii</i>	1.68	1.32	1.23	1.29	1.24
27	<i>Pencillium citrinum</i>	0.86	0.46	0.74	0.91	0.57
28	<i>P. janthinellum</i>	0.76	0.66	0.72	1.67	1.20
29	<i>P. rubrum</i>	0.58	0.55	0.55	1.68	1.52
30	<i>C. britannicum</i>	0.65	0.61	0.51	0.88	0.60
31	<i>Fusarium semitectum</i>	0.89	0.73	0.89	1.86	1.07

Table 6c. Effect of carbon and nitrogen sources on dry weight of fungal growth

(The values are represented in mg/ g)

S.No	Name of the fungi	CMC (1%)	Starch (1%)	Mannitol (1%)	Amm. Nitrate (1%)	Cal. Nitrate (1%)
1	<i>Rhizopus nigricans</i>	0.28	0.11	0.09	0.13	0.06
2	<i>R. oryzae</i>	0.19	0.11	0.13	0.13	0.10
3	<i>R. stolonifer</i>	0.19	0.11	0.11	0.18	0.15
4	<i>Mucor</i> sp.	0.29	0.07	0.10	0.04	0.06
5	<i>Neurospora crassa</i>	0.27	0.15	0.10	0.13	0.12
6	<i>Aspergillus candidus</i>	0.15	0.12	0.13	0.26	0.16
7	<i>A. carbonarius</i>	0.18	0.11	0.09	0.13	0.12
8	<i>A. clavatus</i>	0.12	0.12	0.07	0.14	0.13
9	<i>A. conicus</i>	0.17	0.09	0.09	0.19	0.11
10	<i>A. erythrocephalus</i>	0.13	0.12	0.12	0.26	0.15
11	<i>A. flavus</i>	0.15	0.12	0.14	0.36	0.26
12	<i>A. fumigatus</i>	0.09	0.09	0.09	0.21	0.12
13	<i>A. funiculosus</i>	0.16	0.11	0.11	0.18	0.17
14	<i>A. luchuensis</i>	0.10	0.09	0.08	0.18	0.16
15	<i>A. nidulans</i>	0.13	0.07	0.07	0.19	0.12
16	<i>A. niger</i>	0.19	0.11	0.08	0.23	0.16
17	<i>A. ochraceus</i>	0.15	0.12	0.09	0.19	0.13
18	<i>A. oryzae</i>	0.12	0.10	0.09	0.15	0.13
19	<i>A. sacchari</i>	0.19	0.03	0.18	0.23	0.16
20	<i>A. sulphureus</i>	0.09	0.07	0.07	0.19	0.16
21	<i>A. sydowi</i>	0.15	0.15	0.10	0.23	0.18
22	<i>A. terreus</i>	0.10	0.08	0.10	0.32	0.22
23	<i>A. terricola</i>	0.08	0.08	0.07	0.29	0.15
24	<i>A. ustus</i>	0.16	0.10	0.09	0.22	0.19
25	<i>A. versicolor</i>	0.10	0.07	0.07	0.21	0.13
26	<i>A. wentii</i>	0.32	0.11	0.27	0.31	0.13
27	<i>Pencillium citrinum</i>	0.19	0.10	0.13	0.15	0.10
28	<i>P. janthinellum</i>	0.17	0.12	0.08	0.11	0.09
29	<i>P. rubrum</i>	0.19	0.14	0.14	0.26	0.21
30	<i>C. britannicum</i>	0.14	0.09	0.14	0.20	0.15
31	<i>F. semitectum</i>	0.19	0.10	0.09	0.22	0.10

Table 7a. Effect of metals on fungal growth
(The values are represented in OD at 610 nm)

S.No	Name of the fungi	FeSo4 (1 %)	Zn So4 (1%)
1	<i>Rhizopus nigricans</i>	1.384	0.925
2	<i>R. oryzae</i>	2.069	0.964
3	<i>R. stolonifer</i>	1.701	1.284
4	<i>Mucor</i> sp.	1.087	0.375
5	<i>Neurospora crassa</i>	1.349	0.864
6	<i>Aspergillus candidus</i>	1.616	0.982
7	<i>A. carbonarius</i>	1.466	0.879
8	<i>A. clavatus</i>	1.425	1.000
9	<i>A. conicus</i>	1.136	0.874
10	<i>A. erythrocephalus</i>	1.573	1.358
11	<i>A. flavus</i>	1.433	0.574
12	<i>A. fumigatus</i>	1.046	1.359
13	<i>A. funiculosus</i>	1.443	0.654
14	<i>A. luchuensis</i>	1.321	0.709
15	<i>A. nidulans</i>	1.423	0.696
16	<i>A. niger</i>	1.358	0.752
17	<i>A. ochraceus</i>	1.607	0.677
18	<i>A. oryzae</i>	1.536	0.191
19	<i>A. sacchari</i>	1.464	0.769
20	<i>A. sulphureus</i>	1.598	1.009
21	<i>A. sydowi</i>	1.324	0.559
22	<i>A. terreus</i>	1.467	0.873
23	<i>A. terricola</i>	1.656	1.727
24	<i>A. ustus</i>	1.552	0.698
25	<i>A. versicolor</i>	1.459	0.509
26	<i>A. wentii</i>	1.667	0.749
27	<i>Penicillium citrinum</i>	1.817	0.760
28	<i>P. janthinellum</i>	1.563	0.697
29	<i>P. rubrum</i>	1.587	1.598
30	<i>Cladosporium britannicum</i>	2.069	0.857
31	<i>Fusarium semitectum</i>	1.269	0.792

Table 7b. Effect of metals on dry and fresh weight of fungal growth

(The values are represented in mg/ g)

S.No	Name of the fungi	FeSo4 (1%)		ZnSo4(1%)	
		FW	DW	FW	DW
1	<i>Rhizopus nigricans</i>	1.34	1.04	0.28	0.11
2	<i>R. oryzae</i>	1.39	1.12	0.15	0.14
3	<i>R. stolonifer</i>	0.96	0.78	0.15	0.12
4	<i>Mucor</i> sp.	1.29	0.87	0.16	0.15
5	<i>Neurospora crassa</i>	1.71	0.96	0.16	0.15
6	<i>Aspergillus candidus</i>	1.36	0.21	1.01	0.33
7	<i>A. carbonarius</i>	1.41	0.12	0.92	0.41
8	<i>A. clavatus</i>	1.10	0.15	1.15	0.13
9	<i>A. conicus</i>	1.19	0.21	1.46	0.22
10	<i>A. erythrocephalus</i>	1.15	0.12	0.59	0.21
11	<i>A. flavus</i>	1.13	0.11	1.42	0.10
12	<i>A. fumigatus</i>	1.25	0.11	1.29	0.11
13	<i>A. funiculosus</i>	0.81	0.31	0.59	0.31
14	<i>A. luchuensis</i>	1.06	0.22	0.79	0.32
15	<i>A. nidulans</i>	1.48	0.11	1.12	0.31
16	<i>A. niger</i>	1.52	0.22	1.11	0.21
17	<i>A. ochraceus</i>	0.67	0.31	0.81	0.31
18	<i>A. oryzae</i>	1.28	0.23	0.91	0.21
19	<i>A. sacchari</i>	1.13	0.12	0.93	0.33
20	<i>A. sulphureus</i>	0.96	0.41	0.80	0.31
21	<i>A. sydowi</i>	1.20	0.25	0.80	0.34
22	<i>A. terreus</i>	1.29	0.31	0.82	0.21
23	<i>A. terricola</i>	1.06	0.33	0.81	0.43
24	<i>A. ustus</i>	1.07	0.10	0.87	0.21
25	<i>A. versicolor</i>	1.17	0.14	0.96	0.15
26	<i>A. wentii</i>	1.20	0.22	0.87	0.32
27	<i>Pencillium citrinum</i>	1.333	0.62	0.12	0.10
28	<i>P. janthinellum</i>	1.35	1.03	0.17	0.10
29	<i>P. rubrum</i>	0.94	0.45	0.14	0.11
30	<i>Cladosporium britannicum</i>	1.19	1.16	0.15	0.11
31	<i>Fusarium semitectum</i>	1.45	0.85	0.14	0.13

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