



Research Article

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ANNUAL FUNGAL DIVERSITY OF ACC JAMUL FACTORY AREA OF BHILAI, DISTRICT DURG, CHHATTISGARH, INDIA

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ABSTRACT

Fungi are ubiquitous in nature. Fungal spores are present in outdoor air throughout the year, still airborne diversity is poorly characterised. The diversity of fungal spores is however not known. The present paper deals with the study of fungal diversity of ACC Jamul. ACC (Associated Cement Companies) Jamul factory area is the main environment where air is very polluted from cement dust and soot. In this study, Potato dextrose agar media was used. The period of study was one year that was from July 2013 to June 2014. During the period of investigation, overall 68 fungal species (1371 fungal colonies) belonging to 30 genera of fungi were observed in ACC factory area.

Keywords: Potato dextrose agar media, fungi and ACC Factory.

INTRODUCTION

It is known to everyone that the air is not free from microorganism. It contains microorganisms viz Fungi, bacteria etc. Airborne fungal spores are one of the important components of microbial population of ambient air. The term 'Aerobiology' was initially employed in 1930's as a collective term for studies of aerospora like air borne flora spores, pollen grains and alternative microorganisms. It's a knowledge based branch of science that is in intersection with alternative disciplines like Botany, Biology, Ecology, Meteorology, Biology and Medicines etc. it's conjointly a study of supply, dispersion, and effects of mobile biological materials, like spores, and alternative microorganisms. Fungal spores have long been known as one of the important environmental bio-particles causing dermatitis, respiratory and cardiac diseases along with allergic manifestation in human beings¹.

Many workers reported that indoor air with natural ventilation to the ambient atmosphere contain seasonally occurring pollen grains and fungal spores^{2,3}. Therefore, a preliminary study on airborne fungi has been conducted in ACC cement factory Jamul Industrial town of Bhilai which is one of the biggest industrial towns in the country.

MATERIAL AND METHOD

Survey of aeromycoflora

For study of aeromycoflora, ten sterilized Petri plates containing PDA media were exposed 5 to 10 min. in ACC. These exposed Petri plates brought into the laboratory and incubated at 28±1°C for incubation period. At the end of incubation period fungal colonies were counted, isolated and identified with the help of available literature and finally identified by the authentic authority. Targeted fungi were got identified by authentic centre TFR (Tropical Forest Research Institute) Jabalpur. (M.P)

Culture Media

Potato dextrose agar media; Dextrose - 20 gm, Potato - 250 gm, Agar - 15 gm, Distilled water - 1000 ml

Seasonal Variation

Seasonal variation of the aeromycoflora over Jamul Cement factory area and non-polluted area of Jamul.

Monthly variation of the aeromycoflora over the Jamul factory area and non-polluted area of Jamul.

Ecological studies

For ecological studies, at the end of the incubation period of the indoor and outdoor Aeromycoflora, percentage frequency and percentage contribution of fungal flora were calculated.

% Frequency = No. of observations (plates) in which a species appeared / Total no. of Observations) X 100

% Contribution = Total No. of colonies of a species in all the observations taken together / Total No. of colonies in all the species X 100

Mycobial survey

The present investigation deals with the ACC Jamul factory area by using gravity petriplate (containing PDA medium) method from July 2013 to June 2014. In present study air samples were collected for isolation of mycoflora.

During the period of investigation, overall 68 fungal species (1371 fungal colonies) belonging to 30 genera of fungi were observed in ACC factory area

Survey of ACC Jamul factory area for aeromycoflora

In ACC Jamul factory area, out of 68 fungal species, 7 species (59 fungal colonies) of 5 genera from Zygomycotina, 2 species (5 fungal colonies) of 2 genera from Basidiomycotina, 04

species (26 fungal colonies) of 4 genera from Ascomycotina, 53 fungal species (1217 fungal colonies) of 18 genera from Anamorphic fungi, 2 species (64 fungal colonies) from Mycelia sterilia were observed.

From Zygomycotina, 07 fungal species i.e. *Choanephora cucurbitarum*, *Cunninghamella echinulata*, *Mucor hemalis*, *Mucor racemosus*, *Mucor varians*, *Rhizopus stolonifer* and *Syncephalastrum racemosum* were recorded. From Basidiomycotina, 04 fungal species i.e. *Alysidium resinae*, *Sporotrichum* were recorded. From Ascomycotina, 04 fungal species i.e. *Chaetomium globosum*, *Eupenicillium sheartii*, *Hypocrea* sp., *Thielaviaterricola* were recorded. From Anamorphic fungi, 53 fungal species were recorded, out of which, 02 fungal species of *Acremonium*, *Acremonium fusidioides*, *Acremonium roseum*, 03 species of *Alternaria*, i.e. *Alternaria alternata*, *A. citri*, *A. raphani*, 17 species of *Aspergillus* i.e. *Aspergillus awamoori*, *A. carneus*, *A. clavatus*, *A. flavus*, *A. fumigatus*, *A. japonicus*, *A. luchensis*, *A. niger*, *A.*

nidulans, *A. neoniveus*, *A. niveus*, *Aspergillus parasiticus*, *A. sclerotiorum*, *A. sulphureus*, *A. tamaritii*, *A. terreus*, *A. versicolor*. 01 species of *Basidiospora alba*, 02 species of *Cladosporium* i.e. *Cladosporium cladosporioides*, *C. oxysporum*. 03 species of *Curvularia* i.e. *Curvularia lunata*, *C. oryzae*, *C. bicolor*, 04 species of *Drechslera*, *Drechslera rostrata*, *Drechslera specifer*, *Drechslera tetramera*, *Drechslera tuberculata*, 04 species of *Fusarium*, *F. chlamydospora*, *Fusarium oxysporum*, *F. moniliformae* and *F. pallidroseum*, 01 species of *Helminthosporium* species, 01 species of *Monilia* sp., 08 species of *Penicillium* i.e. *Penicillium chrysogenum*, *P. citrinum*, *P. herbarum*, *P. italicum* and *P. leveillei*, *P. oxalicum*, *P. rubrum*, *P. sclerotiorum*, 01 species of *Phoma* i.e. *Phoma exigua*, 01 species of *Pithomyces chartarum*, 01 species of *Stachybotrys triselegans*, 01 species of *Spilodochium veroniae*, 01 species of *Torula*, 01 species of *Trichoderma harzianum*, 01 species of *Trichoderma viridae*, 02 species of *Mycelia sterilia* fungi were recorded.

Fungal distribution of Aeromycoflora in ACC factory area in Jamul during July 2013- June 2014

Name of the Fungal Species	Rainy season					Winter season					Summer season					Grand Total No. of Fungal Colonies	% frequency	% contribution
	Jul	Aug	Sep	Oct	Total	Nov	Dec	Jan	Feb	Total	Mar	April	May	June	Total			
ZYCOMYCOTINA																		
<i>Choanephora cucurbitarum</i>	-	1	3	1	5	-	-	-	-	-	-	-	-	-	-	5	25	0.36
<i>Cunninghamella echinulata</i>	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-	4	8.33	0.29
<i>Mucor hiemalis</i>	1	-	2	-	3	1	1	1	-	3	-	-	1	-	1	7	50	0.51
<i>Mucor racemosus</i>	1	-	1	-	2	1	-	-	3	4	2	-	-	1	3	9	50	0.65
<i>Mucor varians</i>	1	1	1	-	3	1	-	-	5	6	4	-	-	6	10	19	58.33	1.38
<i>Rhizopus stolonifer</i>	2	1	-	-	3	1	-	-	3	4	2	-	-	-	2	9	50	0.65
<i>Syncephalastrum racemosum</i>	-	1	-	-	1	3	-	2	-	5	-	-	-	-	-	6	25	0.43
Total Number of Fungal Colonies	5	4	7	1	17	11	1	3	11	26	8	-	1	7	16	59	-	4.30
Total Number of Fungal Species	4	4	4	1	6	6	1	2	3	6	3	-	1	2	4	7	-	10.29
Total Number of Fungal Genera	2	4	2	1	4	4	1	2	2	4	2	-	1	1	2	5	-	16.66
BASIDIOMYCOTINA																		
<i>Absidium resiniae</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Sporotrichum</i>	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	8.33	0.21
Total Number of Fungal Colonies	-	-	-	-	-	5	-	-	-	5	-	-	-	-	-	5	-	0.36
Total Number of Fungal Species	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	2	-	2.94
Total Number of Fungal Genera	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	2	-	6.66

Name of the Fungal Species	Rainy season					Winter season				Summer season						Grand Total No. of Fungal Colonies	% frequency	% contribution
	Jul	Aug	Sep	Oct	Total	Nov	Dec	Jan	Feb	Total	Mar	Apr	May	Jun	Total			
ASCOMYCOTINA																		
<i>Chaetomium globosum</i>	-	-	-	-	-	4	4	-	-	8	-	-	-	-	-	8	16.66	0.58
<i>Eupenicillium shearii</i>	-	-	-	-	-	3	5	-	-	8	-	-	-	-	-	8	16.66	0.58
<i>Hypocrea</i> sp.	-	-	-	-	-	3	2	-	-	5	-	-	-	-	-	5	16.66	0.36
<i>Thielaviatericola</i>	3	1	1	-	5	-	-	-	-	-	-	-	-	-	-	5	25	0.36
Total Number of Fungal Colonies	3	1	1	-	5	10	11	-	-	21	-	-	-	-	-	26	-	1.89
Total Number of Fungal Species	1	1	1	-	1	3	3	-	-	3	-	-	-	-	-	4	-	5.88
Total Number of Fungal Genera	1	1	1	-	1	3	3	-	-	3	-	-	-	-	-	4	-	13.33
ANAMORPHIC FUNGI																		
<i>Acremonium fusidioides</i>	-	-	-	-	-	-	1	1	-	2	-	-	-	-	-	2	8.33	0.14
<i>A. roseum</i>	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Alternaria alternate</i>	1	-	2	7	10	3	-	-	13	16	6	5	-	-	11	37	58.33	2.69
<i>A. citri</i>	-	-	2	-	2	-	-	3	12	15	7	-	-	3	10	27	41.66	1.96
<i>A. raphani</i>	-	-	-	-	-	-	2	7	9	18	6	4	-	-	10	28	41.66	2.04
<i>Aspergillus awamoori</i>	1	-	-	1	2	-	-	-	1	1	-	-	-	-	-	3	25	0.21
<i>A. carneus</i>	2	-	-	1	3	1	-	-	-	1	-	-	-	-	-	4	25	0.29
<i>A. clavatus</i>	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Aspergillus flavus</i>	2	1	6	6	15	12	1	4	5	22	12	6	6	10	34	71	100	5.17
<i>Aspergillus fumigatus</i>	-	1	3	8	12	-	2	-	2	4	3	2	-	-	5	21	58.33	1.53
<i>Aspergillus japonicus</i>	1	-	-	2	3	-	-	-	2	2	2	1	12	8	23	28	58.33	2.04
<i>Aspergillus luchensis</i>	4	3	9	6	22	-	-	-	12	12	2	-	-	12	14	48	58.33	3.50

<i>A. niger</i>	6	7	12	19	44	16	8	11	19	54	28	16	27	20	91	189	100	13.78
<i>A. nidulans</i>	1	-	-	2	3	-	-	-	1	1	-	2	16	10	28	32	50	2.33
<i>Aspergillus neoniveus</i>	1	2	-	3	6	-	1	2	1	4	1	-	-	-	1	11	58.33	0.80
<i>Aspergillus niveus</i>	2	-	-	2	4	-	-	1	-	1	2	-	-	-	2	7	33.33	0.51
<i>Aspergillus parasiticus</i>	1	4	-	3	8	8	1	2	2	13	1	-	-	-	1	22	66.66	1.60
<i>A. sclerotiorum</i>	1	-	-	1	2	-	-	-	-	-	-	-	-	1	1	3	25	0.21
<i>A. sulphureus</i>	-	-	-	2	2	1	-	-	-	1	4	-	1	6	11	14	41.66	1.02

Name of the Fungal Species	Rainy season					Winter season					Summer season					Grand total No. of Fungal Colonies	% frequency	% contribution
	Jul	Aug	Sep	Oct	Total	Nov	Dec	Jan	Feb	Total	Mar	Apr	May	Jun	Total			
<i>A. tamari</i>	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	8.33	0.21
<i>A. terreus</i>	3	-	-	3	6	1	-	-	-	1	5	-	10	7	22	29	50	2.11
<i>A. versicolor</i>	3	5	2	3	13	-	-	-	-	-	2	-	-	-	2	15	41.66	1.09
<i>Basidiospora alba</i>	-	-	-	-	-	-	1	-	-	1	-	-	-	1	1	2	16.66	0.14
<i>Cladosporium cladosporioides</i>	11	-	-	2	13	-	-	3	38	41	-	-	-	-	-	54	33.33	3.93
<i>C. oxysporium</i>	-	-	-	-	-	52	59	97	26	234	15	-	-	-	15	249	41.66	18.16
<i>Curvularialunata</i>	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3	8.33	0.21
<i>C. oryzae</i>	-	-	-	-	-	-	3	5	-	8	-	-	-	-	-	8	16.66	0.58
<i>Curvularia bicolor</i>	-	-	-	6	6	4	-	1	-	5	3	-	-	-	3	14	33.33	1.02
<i>Drechslera rostrata</i>	-	-	1	1	2	-	-	-	-	-	-	-	-	-	-	2	16.66	0.14
<i>Drechsleraspecifer</i>	1	2	-	-	3	-	2	-	-	2	-	-	-	5	5	10	33.33	0.72
<i>Drechslera tetramera</i>	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	8.33	0.07
<i>D. tuberculata</i>	1	2	-	-	3	-	3	-	-	3	-	-	-	6	6	12	33.33	0.87
<i>Fusarium chlamydosporum</i>	-	-	-	2	2	-	-	1	-	1	2	-	-	-	2	5	25	0.36
<i>Fusarium oxysporum</i>	-	-	-	-	-	-	-	2	-	2	-	-	-	2	2	4	16.66	0.29
<i>F. moniliformae</i>	-	-	-	-	-	5	-	-	-	5	-	-	-	-	-	5	8.33	0.36
<i>F. pallidoroseum</i>	-	-	-	5	5	2	3	5	4	14	4	3	-	-	7	26	58.33	1.89
<i>Helminthosporiumsp.</i>	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2	8.33	0.14
<i>Moniliasp.</i>	-	-	-	-	-	-	-	-	-	-	4	-	-	19	23	23	16.66	1.67
<i>Penicillium chrysogenum</i>	1	-	-	-	1	2	-	4	-	6	12	8	-	-	20	27	41.66	1.96
<i>P. citrinum</i>	1	-	-	-	1	-	-	2	3	5	-	-	-	-	-	6	25	0.48
<i>P. herbarum</i>	-	-	-	12	12	11	-	1	12	24	-	-	1	2	3	39	50	2.84
<i>P. italicum</i>	-	-	2	13	15	13	3	2	-	18	9	9	-	-	18	51	58.33	3.71
<i>P. leveillei</i>	-	-	-	1	1	-	-	2	-	2	1	-	-	-	1	4	25	0.29
<i>P. oxalicum</i>	-	-	-	-	-	-	2	3	-	5	-	-	-	2	2	7	25	0.51
<i>P. rubrum</i>	-	-	-	5	5	10	2	1	-	13	-	-	1	2	3	21	50	1.53
<i>P. sclerotiorum</i>	-	-	-	1	1	-	-	2	-	2	1	-	-	-	1	4	25	0.29
<i>Phomaexigua</i>	-	-	-	-	-	-	3	2	-	5	-	-	-	2	2	7	25	0.51
<i>Pithomyces chartarum</i>	-	-	-	-	-	-	3	1	-	4	-	-	-	-	-	4	16.66	0.29
<i>Stachybotrysilegans</i>	2	-	-	-	2	3	4	-	-	7	-	-	-	-	-	9	25	0.65

Name of the Fungal Species	Rainy season					Winter season					Summer season					Grand Total No. of Fungal Colonies	% frequency	% contribution
	July	Aug	Sep.	Oct.	Total	Nov.	Dec.	Jan.	Feb.	Total	Mar.	April	May	June	Total			
ZYGYMOTINA																		
<i>Choanephora cucurbitarum</i>	-	1	3	1	5	-	-	-	-	-	-	-	-	-	-	5	25	0.36
<i>Cunninghameaechimulata</i>	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-	4	8.33	0.29
<i>Mucor hiemalis</i>	1	-	2	-	3	1	1	1	-	3	-	-	1	-	1	7	50	0.51
<i>Mucor racemosus</i>	1	-	1	-	2	1	-	-	3	4	2	-	-	1	3	9	50	0.65
<i>Mucor varians</i>	1	1	1	-	3	1	-	-	5	6	4	-	-	6	10	19	58.33	1.38
<i>Rhizopus stolonifer</i>	2	1	-	-	3	1	-	-	3	4	2	-	-	-	2	9	50	0.65
<i>Syncephalastrum racemosum</i>	-	1	-	-	1	3	-	2	-	5	-	-	-	-	-	6	25	0.43
Total Number of Fungal Colonies	5	4	7	1	17	11	1	3	11	26	8	-	1	7	16	59	-	4.30
Total Number of Fungal Species	4	4	4	1	6	6	1	2	3	6	3	-	1	2	4	7	-	10.29
Total Number of Fungal Genera	2	4	2	1	4	4	1	2	2	4	2	-	1	1	2	5	-	16.66
BASIDIOMYCOTINA																		
<i>Alsidium resinae</i>	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Sporotrichum</i>	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	8.33	0.21
Total Number of Fungal Colonies	-	-	-	-	-	5	-	-	-	5	-	-	-	-	-	5	-	0.36
Total Number of Fungal Species	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	2	-	2.94
Total Number of Fungal Genera	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	2	-	6.66

Name of the Fungal Species	Rainy season					Winter season					Summer season					Grand Total No. of Fungal Colonies	% frequency	% contribution
	July	Aug	Sep	Oct.	Total	Nov	Dec	Jan.	Feb.	Total	Mar.	April	May	Jun	Total			
ASCOMYCOTINA																		
<i>Chaetomium globosum</i>	-	-	-	-	-	4	4	-	-	8	-	-	-	-	-	8	16.66	0.58
<i>Eupenicillium shearii</i>	-	-	-	-	-	3	5	-	-	8	-	-	-	-	-	8	16.66	0.58
<i>Hypocrealessp</i>	-	-	-	-	-	3	2	-	-	5	-	-	-	-	-	5	16.66	0.36
<i>Thielaviatericola</i>	3	1	1	-	5	-	-	-	-	-	-	-	-	-	-	5	25	0.36
Total Number of Fungal Colonies	3	1	1	-	5	10	11	-	-	21	-	-	-	-	-	26	-	1.89
Total Number of Fungal Species	1	1	1	-	1	3	3	-	-	3	-	-	-	-	-	4	-	5.88
Total Number of Fungal Genera	1	1	1	-	1	3	3	-	-	3	-	-	-	-	-	4	-	13.33
ANAMORPHIC FUNGI																		
<i>Acremonium fusidioides</i>	-	-	-	-	-	-	1	1	-	2	-	-	-	-	-	2	8.33	0.14
<i>A. roseum</i>	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Alternaria alternate</i>	1	-	2	7	10	3	-	-	13	16	6	5	-	11	37	58.33	2.69	
<i>A. citri</i>	-	-	2	-	2	-	-	3	12	15	7	-	-	3	10	27	41.66	1.96
<i>A. raphani</i>	-	-	-	-	-	-	2	7	9	18	6	4	-	-	10	28	41.66	2.04
<i>Aspergillus awamoori</i>	1	-	-	1	2	-	-	-	1	1	-	-	-	-	3	25	0.21	
<i>A. carneus</i>	2	-	-	1	3	1	-	-	-	1	-	-	-	-	4	25	0.29	
<i>A. clavatus</i>	-	-	-	-	-	-	2	-	-	2	-	-	-	-	2	8.33	0.14	
<i>Aspergillus flavus</i>	2	1	6	6	15	12	1	4	5	22	12	6	6	10	34	71	100	5.17
<i>Aspergillus fumigates</i>	-	1	3	8	12	-	2	-	2	4	3	2	-	-	5	21	58.33	1.53
<i>Aspergillus japonicus</i>	1	-	-	2	3	-	-	-	2	2	2	1	12	8	23	28	58.33	2.04
<i>Aspergillus luchensis</i>	4	3	9	6	22	-	-	-	12	12	2	-	-	12	14	48	58.33	3.50
<i>A. niger</i>	6	7	12	19	44	16	8	11	19	54	28	16	27	20	91	189	100	13.78
<i>A. nidulans</i>	1	-	-	2	3	-	-	-	1	1	-	2	16	10	28	32	50	2.33
<i>Aspergillus neoniveus</i>	1	2	-	3	6	-	1	2	1	4	1	-	-	-	1	11	58.33	0.80
<i>Aspergillus niveus</i>	2	-	-	2	4	-	-	1	-	1	2	-	-	-	2	7	33.33	0.51
<i>Aspergillus parasiticus</i>	1	4	-	3	8	8	1	2	2	13	1	-	8	-	1	22	66.66	1.60
<i>A. sclerotiorum</i>	1	-	-	1	2	-	-	-	-	-	-	-	-	1	1	3	25	0.21
<i>A. sulphureus</i>	-	-	-	2	2	1	-	-	-	1	4	-	1	6	11	14	41.66	1.02

Name of the Fungal Species	Rainy season					Winter season					Summer season					Grand Total No. of Fungal Colonies	% frequency	% contribution
	July	Aug.	Sep.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar.	April	May	June	Total			
<i>Spilodochium verononiae</i>	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	3	8.33	0.21
<i>Torulasp.</i>	-	-	-	-	-	3	6	1	-	10	-	-	-	-	-	10	25	0.72
<i>Trichoderma harzian</i>	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	2	8.33	0.14
<i>Trichoderma viridae</i>	-	-	-	-	-	-	5	-	-	5	-	-	-	-	-	5	8.33	0.36
Total Number of Fungal Colonies	46	27	41	120	234	150	125	166	162	603	132	56	74	118	380	1217	-	88.76
Total Number of Fungal Species	20	9	10	27	34	18	26	26	17	47	23	10	8	17	33	53	-	77.94
Total Number of Fungal Genera	6	2	5	7	9	8	16	10	5	15	7	4	2	7	10	18	-	60
MYCELIA STERILA																		
Mycelia sterilia (white)	16	4	3	-	23	3	5	4	-	12	3	4	-	9	16	51	75	3.71
Mycelia sterilia (black)	-	1	3	2	6	2	-	2	-	4	3	-	1	-	3	13	58.33	0.94
Total Number of Fungal Colonies	16	5	6	2	29	5	5	6	-	16	6	4	-	9	19	64	-	4.66
Total Number of Fungal Species	1	2	2	1	2	2	1	2	-	2	2	1	-	1	2	2	-	2.94
Total Number of Fungal Genera	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	-	3.33
Grand Total Number of Fungal Colonies	70	37	55	123	285	181	142	175	173	671	146	60	76	134	415	1371	-	-
Grand Total Number of Fungal Species	26	16	17	29	43	31	31	30	20	60	28	11	10	20	39	68	-	-
Grand Total Number of Fungal Genera	10	8	9	9	15	18	21	13	7	25	10	5	3	9	13	30	-	-

RESULT AND DISCUSSION

Aeromycoflora of ACC area during rainy season

In rainy season, a total of 43 fungal species (285 fungal colonies) were observed. Out of total 43 species, 06 species (17 fungal colonies) of 04 genera from Zygomycotina, 02 species (05 fungal colonies) of 02 genera from Basidiomycotina, 01 species (05 fungal colonies) of 01 genus from Ascomycotina, 34 species (234 fungal colonies) of 9 genera from Anamorphic fungi and 02 species (29 fungal colonies) of 01 genus from Mycelia sterilia were observed

Monthly seasonal variations of fungal species and fungal colonies of ACC factory area aeromycoflora were also recorded during investigation period

During the month of July, a total 26 fungal species (70 fungal colonies) of 10 genera were observed in ACC factory area. Out of 26 fungal species, 2 genera, 04 species (05 fungal colonies) from Zygomycotina, 01 species (03 fungal colonies) of 01 genus from Ascomycotina 6 genera, 20 species (46 fungal colonies) from Anamorphic fungi and 01 species (16 fungal colonies) from Mycelia sterilia were observed. The group of Ascomycotina and Basidiomycotina were not found in rainy season

During the month of August, a total 16 fungal species (37 colonies) of 8 genera were recorded. Out of 16 fungal species, 04 species, 04 genera (04 colony) from Zygomycotina, 01 species (01 colony) from Ascomycotina, 9 species, 02 genera (27 fungal colonies) from Anamorphic fungi and 02 species (05 fungal colonies) from Mycelia sterilia were recorded. No member of Basidiomycotina was found throughout the study period.

In the month of September, a total 17 fungal species (55 fungal colonies) of 9 genera were observed. Out of 17 fungal species, 04 species, 02 genera (07 colony) from Zygomycotina, 01 species (01 colony) from Ascomycotina, 10 species, 05 genera (41 colonies) from Anamorphic fungi and 02 species (06 colonies) from Mycelia sterilia were recorded. No member of Basidiomycotina was found throughout the period.

During the month of October, a total of 29 fungal species (123 colonies) of 9 genera were recorded. Out of 29 fungal species, 01 species (01 colony) 01 genus from Zygomycotina, 27 species (120 colonies) 07 genera from Anamorphic fungi and 01 species (02 colonies) from Mycelia sterilia were recorded. Group Ascomycotina was totally absent.

Aeromycoflora of ACC area during winter season

In winter season, a total of 60 fungal species (671 fungal colonies) of 25 genera were recorded. Out of total 60 fungal species, 06 species (26 fungal colonies) of 04 genera from Zygomycotina, 02 species (5 fungal colonies) of 02 genera from Basidiomycotina, 03 species (21 fungal colonies) of 03 genera from Ascomycotina, 47 species (603 fungal colonies) of 15 genera from Anamorphic fungi, 02 species (16 fungal colonies) of 01 genus from Mycelia sterilia were recorded during winter season in ACC factory area.

During November, a total of 31 fungal species (181 colonies) of 18 genera were recorded. Out of 31 fungal species, 06 species, 04 genera (11 fungal colonies) from Zygomycotina, 02 species (5 fungal colonies) of 02 genera from Basidiomycotina 03 species 3 genera (10 fungal colonies) from Ascomycotina and 18 species, 08 genera (150 fungal colonies) from Anamorphic fungi, 02 species of 01 genus from Mycelia sterilia were recorded .

31 fungal species (142 fungal colonies) of 21 genera were recorded during the month of December. Out of 31 fungal species, 01 species, 01 genus (01 fungal colony) from Zygomycotina, 03 species, 03 genera (11 fungal colonies) from Ascomycotina, 26 species, 16 genera (125 fungal colonies) from Anamorphic fungi, 01 species, 01 genus (05 fungal colonies) from Mycelia sterilia were recorded. The group Basidiomycotina was totally absent

In January, a total of 30 fungal species (175 fungal colonies) of 13 genera were observed. Out of 30 fungal species, 02 species, 02 genera (03 fungal colonies) from Zygomycotina, 26 species, 10 genera (166 fungal colonies) from Anamorphic fungi, 02 species (06 fungal colonies) from Mycelia sterilia were observed. The members of both Basidiomycotina and Ascomycotina were found to be absent.

In the month of February, a total of 20 fungal species (173 fungal colonies) of 7 genera were recorded. Out of 20 fungal species, 03 species, 2 genera (11 fungal colonies) from Zygomycotina 17 species, 05 genera (162 fungal colonies) from Anamorphic fungi were observed. The groups Basidiomycotina, Ascomycotina and Mycelia sterilia were absent during the month of February

Aeromycoflora of ACC area during summer season

In summer season, a total of 39 fungal species (415 fungal colonies) of 13 genera were observed. Out of 39 fungal species, 04 species of 2 genera (16 fungal colonies) from Zygomycotina, 33 species ,10 genera (380 fungal colonies) from Anamorphic fungi and 01 species, 01 genus (02 fungal colonies) from Mycelia sterilia were observed.

During March, a total of 28 fungal species (146 fungal colonies) of 10 genera were recorded. Out of 28 fungal species, 03 species, 02 genera (08 colonies) from Zygomycotina and 23 species, 07 genera (132 fungal colonies) from Anamorphic fungi, 02 species, 01 genus (06 fungal colonies) from Mycelia sterilia were observed. The members of Basidiomycotina and Ascomycotina were not observed.

In the month of April 11 fungal species, 05 genera (60 colonies) were observed. Out of 11 fungal species 10 species, 04 genera (56 fungal colonies) from anamorphic fungi, 01 species (06 fungal colonies) from Mycelia sterilia were observed. The group of Zygomycotina, Basidiomycotina, and Ascomycotina were not present.

9 fungal species (76 fungal colonies) of 3 genera were observed during the month of May. Out of 09 fungal species 01 species, 01 genus (01 fungal colony) from Zygomycotina, 8 species, 02 genera (74 fungal colonies) from Anamorphic fungi and 1 genera 1 species and 1 colony from Mycelia sterilia were observed. The group of Basidiomycotina and Ascomycotina were totally absent.

In the month of June a total of 20 fungal species, 09 genera (133 fungal colonies) were recorded. Out of 20 fungal species, 02 species, 01 genus (07 colonies) from Zygomycotina and 17 species, 07 genera (117 fungal colonies) from Anamorphic fungi, 01 fungal species (09 fungal colonies) from Mycelia sterilia were observed. The members of Basidiomycotina and Ascomycotina were totally absent.

During monthly variation of ACC Jamul factory area aeromycoflora maximum 31 fungal species were observed in the

month of November and December and minimum 9 fungal species were recorded in May.

In study period some fungal species were present in all seasons of ACC Jamul factory area i.e. *Mucorhiemalis*, *Mucor racemosus*, *Mucor varians*, *Alternaria alternata*, *A. citri*, *A. raphani*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus japonicus*, *A. luchensis*, *A. niger*, *A. nidulans*, *Aspergillus parasiticus*, *A. sulphureus*, *A. versicolor*, *Cladosporium cladosporioides*, *C. oxysporum*, *C. sphaerospermum*, *Curvularia oryzae*, *C. pallescens*, *Fusarium pallidoroseum*, *Penicillium chrysogenum*, *P. citrinum*, *Phoma exigua*, *P. herbarum*, *P. italicum*, *P. leveillei*, *P. rubrum*, *P. sclerotiorum*.

Some fungal species were present more than one season but not in all season such as *Choanephora cucurbitarum*, *Thielaviatericola*, *Aspergillus awamoori*, *A. carneus*, *Aspergillus neoniveus*, *Cladosporium cladosporioides*, *Drechslera strata*, *Curvularia lunata*, *Drechslera tetramera*, *F. chlamydospora*, *Monilia* sp., *Phoma exigua*, *Torulasp. Spilodochium veroniae*.

Some fungi were present only in one season of ACC aeromycoflora i.e. *Penicillium chrysogenum*, *P. citrinum* were recorded only in rainy season. *Cunninghamia laechinulata*, *Syncephalastrum racemosum*, *Alysidium resinae*, *Sporotrichum*, *Chaetomium globosum*, *Eupenicillium sheartii*, *Hypocreales* sp were recorded only in winter season.

During investigation period it was also observed that the some fungal species i.e. *Acremonium fusidioides*, *A. roseum*, *Alysidium resinae*, *Sporotrichum*, *Chaetomium globosum*, *Eupenicillium sheartii*, *Hypocreales* sp were recorded in winter season. *Choanephora cucurbitarum*, *Thielaviater ricola* were recorded in rainy season of ACC Jamul factory area environment.

Monthly seasonal variation of ACC factory area

Rainy season

During study period some fungal species were present in all month of rainy season in ACC factory area environment i.e. *Aspergillus flavus*, *Aspergillus luchensis*, *Aspergillus niger*, *A. versicolor*. Certain fungal species i.e. *Choanephora cucurbitarum*, *Mucorhiemalis*, *Thielaviater ricola*, *Alternaria alternata*, *Aspergillus japonicus*, *A. luchensis*, *A. nidulans*, *Aspergillus parasiticus*, *A. versicolor*, *Curvularia lunata*, *Drechslera specifer*, *Penicillium chrysogenum* and Mycelia sterilia (Black) were recorded in more than one month but not in all months of rainy season.

Winter season

Aspergillus flavus, *A. niger*, *Aspergillus parasiticus*, *C. oxysporium* were recorded throughout the winter season. *Mucorhiemalis*, *Syncephalastrum racemosum*, *Hypocreales* sp, *Acremonium fusidioides*, *A. raphani*, *Cladosporium cladosporioides*, *Curvularia oryzae*, *Curvularia bicolor*, *Drechslera specifer*, *Drechslera tetramera*, *Penicillium chrysogenum*, *P. italicum*, *Spilodochium veroniae*, *Torula* sp., *Trichoderma viridae*, *Trichoderma harzian* Mycelia sterilia (Black) were observed in more than one month but not in all months of winter season.

Certain fungal species i.e. *Alysidium resinae*, *Sporotrichum* were present only in November. *Syncephalastrum racemosum* were present only in November and January. *Cladosporium*

cladosporioides, *C. oxysporium*, *Aspergillus luchensis*, *A. niger*, *A. nidulans*, *Aspergillus neoniveus*, *A. sulphureus*, *F. pallidoroseum*, *Penicillium citrinum*, *P. herbarum* were recorded in February. Mycelia sterilia was absent in February.

Summer season

Aspergillus flavus, *Aspergillus japonica* and *A. niger* were recorded in all the months of summer season. Fungal species such as, *Mucor racemosus*, *Mucor varians*, *Alternaria alternata*, *A. raphani*, *Aspergillus fumigatus*, *A. nidulans*, *Aspergillus niveus*, *A. sulphureus*, *A. terreus*, *Fusarium pallidoroseum*, *Monilia* sp., *Penicillium chrysogenum*, *P. herbarum* were recorded in more than one month but not in all the months of summer season. Some fungi as *Fusarium chlamydosporum*, *P. leveillei*, *P. sclerotiorum* were present only in the month of March. Some fungi such as, *Mucor hiemalis* recorded only in May. Fungal species such as *P. herbarum*, *P. rubrum* were observed only in May and June month, *Phoma exigua*, *A. sclerotiorum*, *Drechslera specifer*, *D. tuberculata*, *Fusarium oxysporum*, *P. oxalicum* were present only in June month.

Environmental parameters (Temperature, Relative Humidity, Rainfall, Wind speed etc.) play an important role on the distribution of fungal species in a particular area. Maximum 60 fungal species (671 fungal colonies) were observed during winter season due to suitable temperature and humidity (32.2°C, RH 86.72%, 3.3 mm rain fall) 43 fungal species (277 fungal colonies) in rainy season due to the rain fungal species are decreased as compared to winter season. (31.71°C, RH 92% ,8.8 mm average rain fall) and minimum number of fungal species 39 (415 fungal colonies) were recorded during summer season due to high temperature and low Humidity 40.3 °C, RH 40.65%, 1mm rain fall)

Studies of different polluted and non-polluted environment have been studied by various aerobiologists. Tiwari *et al.* ⁴ have recorded that maximum numbers of fungal species during winter season, Moderate in rainy season while minimum number of fungal species recorded in summer season in green house of Raipur, Similar observations was reported by many other workers. Saluja ⁵ reported on leaf surface mycoflora of *Catharanthus roseus*, Karkunand coworkers ⁶ evaluated the fungi from leaf surface of *Brassica nigra*. Similar result was also taken by Kunjam ⁷ from Rajnandgaon, Lall ⁸ from hospital area Raipur.

During the investigation period, monthly variations of aeromycoflora were also observed. Maximum numbers of fungal species 31 were observed in the month of December coincides with the optimum temperature and humidity (29.47°C and RH 87.72%) as it is favorable for the fungal growth. Minimum no. of 09 fungal species was recorded in the month of May. During summer season average temperature were (40.03°C) and humidity 40.65%. During rainy season average temperature and relative humidity (31.71°C and RH 92%) are favorable for fungal growth but due to rain the fungal spores get washed off which results in to decreased fungal growth as compared to winter season. Singh (9) recorded the maximum no. of fungal species, 22 in the month of January and minimum no. of fungal species in the month of May from leaf surface of *Mentha arvensis* Linn.

ECOLOGICAL STUDIES

Percentage frequency of different species in ACC Jamul factory area

Frequency is a main parameter which helps to know the distribution of individual species in that particular area. According to researchers frequency is the degree of dispersion of individual species in a particular area at a particular period and is usually expressed in percentage. In present study; percentage frequency and percentage contribution of different fungal sps were calculated both in factory area and non-polluted area of Jamul. Aeromycoflora of ACC factory area was observed during July 2013 to June 2014. During investigation period maximum percentage frequency were reported for *Aspergillus niger* and *Aspergillus flavus* (100%) other member exhibited comparatively lesser percentage frequency viz: *Mycelia sterilia* (white) (75%) *Aspergillus parasiticus* (66.66%), *Aspergillus neoniveus* (58.33%), *Aspergillus luchensis*, *Aspergillus fumigatus*, *A. japonicus*, (58.33%), *Alternaria alternata*, (58.33%), *Fusarium pallidoroseum* (58.33%), *P. italicum* (58.33%), *Mucor varian s*(58.33%) *Mucor hiemalis* and *Mucor racemosus* (50%), *Rhizopus stolonifera* (50%), *A. nidulans* (50%), *Penicillium herbarum* (50%), *P. rubrum* (50%), *Mycelia sterilia* (50%), *Alternaria citri* (41.66), *A. raphanin* (41.66), *Aspergillus sulphureus* (41.66), *A. versicolor* (41.66), *Cladosporium oxysporum*, (41.66%), *Penicillium chrysogenum*, (41.66%), *Aspergillus niveus* (33.33%), *Cladosporium cladosporioides* (33.33%), *Curvularia bicolor* (33.33%), *Drechslera specifer* (33.33%), *Drechslera tetramera* (33.33%), *Choanephora cucurbitarum* (25%), *Thielavia terricola* (25%), *Aspergillus awamori* (25%), *A. carneus* (25%), *A. sclerotiorum* (25%), *Fusarium chlamydosporum* (25%), *Penicillium citrinum* (25%), *P. leveillei* (25%), *P. oxalicum* (25%), *Phom aexigua* (25%), *Torula* sp. (25%), *Spilodochium verononiae*(25%), *Chaetomium globosum* (16.66%), *Eupenicillium shearii* (16.66%), *Hypocreales* sp. (16.66%), *Curvularia. oryzae* (16.66%), *Drechsleraro strata* (16.66%), *Fusarium oxysporum* (16.66%), *Monilia* sp. (16.66%), *Pithomyce schartarum* (16.66%), Minimum frequent fungal species (8.33%) were *Acremonium fusidioides*, *A. roseum*, *A clavatus*, *A. tamari*, *Basidiospora alba*, *Curvularia lunata*, *Drechslera tuberculata*, *Fusarium moniliformae*, *Helminthosporium* sp., *Stachybo triselegans*, *Trichoderma harzian* and *Trichoderma viridae*.

Aspergillus, *Cladosporium*, *Curvularia*, *Penicillium* and *Alternaria* species have been reported as most common fungal types all over the world. Similar observations were reported by other workers also like Kalkar and Tatte¹⁰ also recorded that the *Alternaria*, *Aspergillus*, *Cladosporium* and *Curvularia* are most frequent in hospital wards. Hameed *et al.*¹¹ reported that *Aspergillus niger*, *Aspergillus parasiticus*, *Alternaria*, *Cladosporium* and *Penicillium* are most frequent fungal species in the atmosphere of Giza, Egypt. Sharma¹² reported *Aspergillus niger*, *A. versicolor*, *A. flavus*, *A. fumigatus*, *Cladosporium* are the most dominant fungal species of Dongargarh.

The members of Anamorphic fungi show maximum contribution throughout the year. Similar results have been reported by various scientists i.e. Chakraborty *et al.*¹³ from West Bengal, Jothish and Nayar¹⁴ in poultry farm in Palakkad District, Kerala, Singh and Rakhi¹⁵ in Hardwar and Padmanabhan, Nayar¹⁶ from Kerala and Karkun¹⁷ from Chhattisgarh. Seema and her coworkers¹⁸ also studied aeromycoflora of ACC, Jamul of Chhattisgarh. Verma and coworker also studied aeromycoflora of district and session court of Durg. C G.

CONCLUSION

Control of microorganisms in the ACC Jamul can be done by maintaining humidity and temperature in environment. The gases used for fumigation can also be used to control the growth of fungal species. In factory area cleanliness should be maintained by avoiding the accumulation of organic substances. The chemicals may be used for checking the multiplication of aeromycoflora. The windows and different ventilators ought to be sieved so as to minimize entry of microorganisms. ACC Factory area is a place where number of human being come every day. The air of ACC factory area consists microorganisms which are harmful for human being. Therefore, it is necessary to survey the aeromycoflora of ACC Factory area. Seema Verma and Arunima Varkun studied statistical analysis of aeromycoflora of ACC Jamul factory area and non-polluted area in Jamul Bhilai dist Durg CG.

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