

Population dynamics of aeromycoflora at shopping malls of Raipur (C.G.)

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Abstract

The airborne mycoflora of three shopping malls were studied with main emphasis on its percentage frequency and occurrence diversity for three seasons by employing culture plate exposure method. Shopping malls are fully air conditioned and controlled with better sanitization than an open area and environment is adequate with low temperature. Beside these, the numbers of fungal spores are isolated from malls environment.

Total numbers of 63 fungal species belonging to 22 genera (1526 fungal colonies) were recorded from three malls of Raipur city. Out of 63 fungal species, the highest percentage occurrence was attributed to *Rhizopus stolonifer* with 65.62% of total fungal spores count, followed by *Cladosporium cladosporoides* (35.66%), *Mucor racemosus* (27.08%), *Aspergillus fumigatus* (28.58%), *Aspergillus niger* (16.33%), *Fusarium palledaroseum* (11.18%) respectively. *Cheatomium sp.* (0.22%), *Emericella nidulans* (0.22%) contribution in the total fungal spores count was established as the lowest in occurrence. The result revealed that lowest count during summer season (34 fungal sps.), maximum during winter season (51 fungal sps.) and moderate during rainy season (38 fungal sp.). *Aspergillus niger*, *A. fumigatus*, *A. flavus* were quite abundant in all the environment surveyed. Ranges of fungal spores were present throughout the year and impact of environment on the percentage of spore contribution in different seasons. Inside mall aeroallergens mycoflora were isolated which causes asthma, allergy, skin rashes etc. So air monitoring is useful in controlling and preventing the air borne diseases well in advance.

Air consists of gases, water vapors, solid waste particles, fungal spores, microorganisms and pollen grains. These microorganisms present in air extramural or intramural

environments are now well recognized and repeated exposure to these microorganisms are closely associated with wide range of adverse health effects like allergic ailments like

rhinitis, bronchial asthma, hypersensitive pneumonitis, Allergic broncho pulmonary aspergillosis (ABPA), *etc.* In most of the environment such as hospital, animal shed, clean room, pharmaceutical facilities, rain and spacecraft, the presence of bioaerosols can compromise normal activities making efficient monitoring crucial^{9,22,23}.

Shopping Malls are the modern version of the basic shops. They have good sanitization, low temperature, proper air flow and healthy environment. All the above good quality is not a commitment for the purity of environment. The air of mall possesses all impurities of natural air. Sources of indoor air pollution are contaminated from outdoor air, air conditioners or office equipment, grocery, furnishing, human activity or other accidental events^{18,21}.

The present study was conducted in three Shopping malls of Raipur. The malls are located at North, Central and South part of Raipur city (C.G.). PDA media was prepared aseptically and plates were exposed to air for 10 minutes in the environment of shopping malls. Air sampling was carried out by gravity petri plate method^{13,20,30}. The exposed plates were brought in the lab. Air samples were collected at 15 days intervals from March 2013 to Feb. 2014. After Incubation period (3-6 days) with $25 \pm 1^\circ\text{C}$ temperature, fungal colonies were counted, isolated and identified with the help of literature⁴, Agarkar research institute, Pune and National Center for Fungal Taxonomy Delhi. Percentage frequency, Percentage contribution (Abundance) of mycoflora was calculated by following formula^{7,25,28,29}.

Percentage
frequency = $\frac{\text{Number of the observations in which a species appeared}}{\text{Total number of observations}} \times 100$

Percentage
contribution = $\frac{\text{Total no of colonies of individual species in all Petriplates}}{\text{Total no of colonies of all species in all Petri plates}} \times 100$

The main objectives of the present study was to analyze the percentage frequency and percentage abundance of airborne fungal spores, their seasonal variations and effect of meteorological parameters in indoor environment of shopping malls. During the investigation period, the distributional pattern of fungal flora was different in different months.

During present aerobiological investigation period, overall 1526 fungal colonies under 63 species belonging to 23 genera and 7 sterile mycelium were recorded during March 2013 to Feb 2014. Out of total aeromycoflora, 4 species from Zygomycotina, 29 species from Ascomycotina, 30 species from Deuteromycotina and 7 species from sterile Mycelium were recorded.

The aeromycoflora of winter season showed presence of 649 fungal colonies and 57 species belonging to 23 genera. During this season, Zygomycotina, Ascomycotina, Deuteromycotina, sterile Mycelium were 64, 325, 239 and 21 colonies respectively. Maximum 35 fungal species were recorded in January, while minimum 20 in month of November.

Out of total fungal species *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus*

niger, *Cladosporium cladosporoides*, *Chaetomium globosum* were present throughout the winter season. Fungal species *Aspergillus awamori*, *A. carneus*, *Penicillium frequentus*, *Emerciella nidulans*, *Phoma eupyryna*, *Nigrospora oryzae* were present only in the month of February while *Acremonium persicum* was recorded only in December.

During summer season, total 418 fungal colonies belonging to 38 species 18 genera were recorded. During summer season, the number of Zygomycotina, Deuteromycotina, Ascomycotina and sterile mycelium colonies was 17, 269, 110 and 22 respectively. Maximum number of colonies was 133 in May and minimum was 81 in June. Maximum fungal species were recorded in March (21) and April (21) and minimum 15 species in June. *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger* were dominant species. *Aspergillus carneus* was recorded in April and *Eurotium amestelodidum* in June only. (Table-1).

During rainy season total number of 459 fungal colonies belonging to 43 species and 19 genera were isolated. Zygomycotina, Deuteromycotina, Ascomycotina and sterile mycelium colonies were recorded 15, 312, 80 and 52 respectively. Maximum fungal species were 23 in September and October and minimum 15 species in July. Out of total fungal species, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus ochraceus* *Aspergillus sydowii* and sterile mycelium were recorded throughout the rainy season. Fungal species *Aspergillus nidulans*, *Aspergillus ustus*, *Aspergillus parasiticus*, *Penicillium frequentus*, *Penicillium citrinum*, *Penicillium* sp. *Torula* sp. were recorded in October. *Diplococceum*

sp. was recorded in September only; similarly *Sytalidium lignicola* was recorded in August only.

The result indicated that some fungi were common in all the three seasons. These were *Aspergillus fumigatus*, *Aspergillus niger*, *Cladosporium cladosporoides*, *Rhizopus stolonifer*, *Fusarium palledaroseum*, and white sterile mycelium. Some were observed only in one season. *Aspergillus terreus*, *Circinella* sp., *Aspergillus awamori*, *Aspergillus tamari*, *Penicillium citrinum*, *Cheatomium* sp., *Syncephallastrum* sp., *Diplococceum* sp. and *Torula* sp. were recorded in rainy season only, *Alternaria tenuissima*. in summer season only. *Dreschlera hawaiiensis* and *Dreschlera specifer* were observed in winter, *Fusarium solani*, *Fusarium graminearum*, *Fusarium moniliformae*, *Nigrospora oryzae* in winter only.

In these airborne mycoflora, maximum percentage abundance was showed by *Rhizopus stolonifer* (65.62%), followed by *Cladosporium cladosporoides* (35.66%) *Aspergillus fumigatus* (28.58%), *Mucor recemosus* (27.08%), *Aspergillus niger* (6.38%) and *Aspergillus fumigatus*, *Aspergillus niger*, *Cladosporium cladosporoides*, *Rhizopus stolonifer* were most dominant aeromycoflora at experimental site. Similar findings were of^{6,14,17,27}.

The most occurring and contributing fungal spores were *Aspergillus fumigatus*, *Cladosporium cladosporoides*, *Rhizopus stolonifer*. These airborne fungal floras were responsible for wide range of adverse health effects.

The percentage abundance of aeromy-

coflora of shopping malls for complete season was recorded. (Table-1). Out of total percentage abundance of aeromycoflora, seasonwise percentage abundance was also recorded. In summer season Zygomycotina was 4.06%, Ascomycotina 64.36%, Deuteromycotina 26.31%, Mycellia sterlia 5.26% abundance was recorded. (Table-3, Fig 1). The percentage abundance in rainy season Zygomycotina 3.26%, Ascomycotina 67.97%, Deuteromycotina 17.42% and Mycellia sterlia 11.32%. were recorded. (Table-3, Fig. 2). Similarly the percentage abundance in winter season was 9.82%, 50.15%, 36.88%, 3.23%. was recorded from Zygomycotina Ascomycotina Deuteromycotina sterile mycelium respectively. (Table-3, Fig. 3) Maximum fungal species were 21 recorded in March and April and minimum 15 in June. During summer, month wise percentage abundance were observed.

The total percentage abundance of total aeromycoflora of each class was also observed. The percentage abundance of Zygomycotina was 6.29%, Ascomycotina 59.37%, Deuteromycotina 28.11% and sterile mycelium 6.22% was reported during study period. (Table-3).

Monthwise average percentage abundance of total aeromycoflora of each class in particular months was also observed. (Table-4) Maximum percentage abundance of Zygomycotina was observed in February (16.84%), Minimum in the month of April (1.85%), Maximum percentage abundance of class Ascomycotina in the month of April (76.85%), Minimum in the month of January (38.34%). similarly Deuteromycotina Maximum in the month of January (47.66%) and Minimum in July (6.49%).

Class wise percentage abundance of aeromycoflora was recorded as Zygomycotina 17.70%, Ascomycotina 29.69%, Deuteromycotina 25.64%, Sterile Mycellia 23.15%. During rainy season classwise percentage abundance of Zygomycotina 15.62%, Ascomycotina 34.43%, Deuteromycotina 18.64%, and sterile mycelium 54.73%. and in winter season, class wise percentage abundance of Zygomycotina 66.66%, Ascomycotina 35.87%, Deuteromycotina 55.71%, sterile mycelium 21.87% were recorded (Table-2).

The highest frequent species were *Aspergillus fumigatus* and *Aspergillus niger* (100%); followed by *Aspergillus flavus*, Sterile Mycelium (91.66%); *Aspergillus sydowii*, *Rhizopus stolonifer* (75%); *Cladosporium cladosporoides*, *Fusarium Oxysporium*, *Fusarium palledaroseum*, *Aspergillus ochraceus* (66.66%)^{2,16,26,32}. (Table-1).

Variations in temperature, humidity and other meteorological factors effects aeromycoflora of any particular area and clear differences were evident by study. Many researchers have reported effects of meteorological factors in airspora¹. In summer season fungal spore contribution was minimum, due to high temperature and minimum relative humidity^{2,10,12,30}. In this study *Aspergillus fumigatus*, *Aspergillus niger* and *Cladosporium cladosporoides* were common fungi in the environment of Raipur. Bajwa *et al.*,³ and Nazir *et al.*²⁴ also recorded similar findings of common dominant fungi. Fungi are allergens reported to cause aspergillosis, keratitis, necrotizing otitis in people. *Cladosporium cladosporoides* are most common inhalant

Table-1. Showing Percentage Abundance of Total Aeromycoflora Of Shopping Mall During Sessionmarch 2013 To February 2014

S. No.	Name of fungi	Summer season				Rainy Season				Winter Season				Grand Total %
		Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
1	<i>Circinella</i> sp.								—	40	—	—	—	2.08
2	<i>Mucor racemosus</i>						33.33	44.44	—	—	100	66.66	—	27.08
3	<i>Rhizopus stolonifer</i>		100	100	100			44.44	—	60	—	33.33	100	65.62
4	<i>Syncephallastrum</i>						66.66	11.11	—	—	—	—	—	5.2
5	<i>Aspergillus awamori</i>	—	—	—	—	—	—	—	—	—	—	—	4.54	.55
6	<i>A. carneus</i>	—	1.20	—	—	—	1.68	2.15	—	—	—	—	.90	.66
7	<i>A. Neosartory fischeri</i>	3.92	3.61	4.16	—	5.66	1.68	—	—	—	—	1.35	8.18	2.4
8	<i>A. flavus</i>	9.80	7.22	1.04	5.12	20.7	11.76	2.15	—	13.33	1.23	2.70	4.54	6.29
9	<i>A. f umigatous</i>	31.37	43.36	67.70	12.82	37.73	51.26	17.20	21.27	21.66	8.64	2.70	7.27	28.58
10	<i>A. niger</i>	15.68	6.02	17.70	64.10	9.43	4.20	20.43	8.51	15	11.11	18.91	25.45	16.33
11	<i>A. nidulans</i>	—	13.25	—	—	—	4.20	—	—	—	1.23	10.81	2.72	3.09
12	<i>A. ochraceous</i>	—	8.43	—	5.12	18.86	3.36	3.22	2.12	—	6.17	—	.90	3.64
13	<i>A. oryzae</i>	1.96	7.22	4.16	—	3.77	—	4.30	19.14	—	—	4.05	—	3.20
14	<i>A. stellatus</i>	—	—	—	—	—	—	—	—	—	—	6.75	.90	.66
15	<i>A. sydowii</i>	7.84	—	1.04	—	1.88	19.32	44.08	6.38	6.66	1.23	1.35	—	8.71
16	<i>A. terreus</i>	—	—	—	—	—	—	—	—	—	6.17	—	—	.55
17	<i>A. tamarii</i>	—	—	—	—	—	—	2.15	—	—	—	—	—	.22
18	<i>A. versicolor</i>	1.96	2.40	1.04	—	1.88	—	—	—	—	—	21.62	—	2.31
19	<i>A. ustus</i>	—	—	—	—	—	—	—	8.51	3.33	53.08	9.45	—	6.11
20	<i>A. parasiticus</i>	—	—	1.04	—	—	—	—	4.25	—	1.23	1.35	—	.55
21	<i>Aspergillus</i> sp.	—	—	1.04	—	—	.84	—	—	—	2.46	—	—	.44
22	<i>Aspergillus</i> sp.	—	—	—	—	—	—	2.15	—	3.33	—	—	8.18	1.43
23	<i>Penicillium chrysogenum</i>	—	—	—	—	—	—	2.15	6.38	23.33	—	2.70	3.63	2.75
24	<i>P. frequentus</i>	—	—	—	—	—	—	—	8.51	—	—	—	2.72	.77
25	<i>P. citrinum</i>	—	—	—	—	—	—	—	8.51	—	—	—	—	.44
26	<i>Penicillium</i> sp.	5.88	—	—	—	—	—	—	—	6.66	2.46	—	2.72	1.32
27	<i>Penicillium</i> sp.	—	7.22	—	—	—	—	—	6.38	—	—	5.40	11.81	2.86
28	<i>Emerciella nidulans</i>	—	—	—	—	—	—	—	—	—	—	—	1.81	.22
29	<i>Eurotium amestealodium</i>	—	—	—	5.12	—	—	—	—	—	—	—	—	.22
30	<i>Chaetomium globosum</i>	17.64	—	—	—	—	1.68	—	—	3.33	2.46	9.45	11.81	3.86
31	<i>Chaetomium</i> sp.	—	—	—	7.69	—	—	—	—	—	—	1.35	1.81	.66
32	<i>Chaetomium</i> sp.	—	—	—	—	—	—	—	—	—	2.46	—	—	.22
33	<i>Monilia</i>	3.92	—	1.04	—	—	1.68	—	—	3.33	—	—	—	.77

34	<i>Acremonium persicum</i>	—	—	—	—	—	—	—	—	—	1.92	—	—	.23
35	<i>Alternaria alternata</i>	4.87	—	—	—	—	4.76	—	—	—	3.84	1.08	—	1.39
36	<i>A. tenuissima</i>	7.31	14.28	—	—	—	—	—	—	—	—	—	—	1.39
37	<i>Alternaria</i> sp.	7.31	—	—	—	—	—	—	—	—	—	—	—	.69
38	<i>Byssoclamus niveus</i>	—	—	—	6.66	—	—	—	—	—	—	1.08	—	.69
39	<i>Cladosporium cladosporoides</i>	14.63	9.52	—	—	—	14.28	—	60	47.91	63.46	48.91	36.17	35.66
40	<i>C. oxysporium</i>	4.87	—	—	—	—	—	35.71	5	—	—	1.08	17.02	4.19
41	<i>C. sphearospermum</i>	—	—	—	—	—	—	—	—	—	21.15	15.21	—	5.82
42	<i>Cladosporium</i> sp.	—	—	—	—	40	9.52	—	—	—	—	13.04	25.53	6.52
43	<i>Curvularia clavata</i>	—	4.76	5.55	—	—	28.57	28.57	2.5	—	3.84	—	—	3.49
44	<i>C. eragrostidis</i>	—	—	—	—	—	—	—	2.5	4.16	—	—	—	.69
45	<i>C. lunata</i>	—	—	—	—	2.0	—	—	15	—	—	—	—	1.63
46	<i>C. pallescens</i>	—	—	—	—	—	—	—	7.5	10.41	—	—	—	1.86
47	<i>Dreschlera hawaiiensis</i>	—	—	—	—	—	—	—	—	—	—	2.17	—	.46
48	<i>D. specifer</i>	—	—	—	—	—	—	—	—	—	—	1.08	—	.23
49	<i>Dreschlera</i> sp.	—	—	—	6.66	—	—	—	—	—	1.92	—	—	.69
50	<i>Diplococceum</i> sp.	—	—	—	—	—	—	14.28	—	—	—	—	—	.46
51	<i>Fusarium oxysporium</i>	14.63	—	11.11	20	40	—	—	2.5	—	3.84	5.43	4.25	6.06
52	<i>F. palledaroseum</i>	36.58	19.04	—	46.66	—	33.33	7.14	2.5	10.41	—	1.08	—	11.18
53	<i>F. solani</i>	—	—	—	—	—	—	—	—	—	—	2.17	4.25	.93
54	<i>F. graminearum</i>	—	—	—	—	—	—	—	—	—	—	2.17	4.25	.93
55	<i>F. moniliformae</i>	—	—	—	—	—	—	—	—	—	—	2.17	—	.46
56	<i>Fusarium</i> sp.	—	4.76	—	—	—	—	7.14	2.5	—	—	2.17	—	1.16
57	<i>Fusarium</i> sp.	—	9.52	83.33	3.33	—	—	—	—	—	—	—	2.12	4.42
58	<i>Nigrospora oryzae</i>	—	—	—	—	—	—	—	—	—	—	—	6.38	.69
59	<i>Phoma eupyrima</i>	—	28.57	—	—	—	—	—	—	27.08	—	—	—	4.42
60	<i>P. exigua</i>	4.87	—	—	16.66	—	—	—	—	—	—	—	—	1.63
61	<i>P. glomerata</i>	4.87	9.52	—	—	—	—	—	—	—	—	1.08	—	1.16
62	<i>Syralidium lignicola</i>	—	—	—	—	—	9.52	—	—	—	—	—	—	.46
63	<i>Torula</i> sp.	—	—	—	—	—	—	7.14	-	—	—	—	—	.23
64	White mycellium	50	50	71.42	—	52.63	66.66	25	78.57	75	80	83.33	100	64.21
65	Earthen mycellium	—	—	14.28	50	42.10	—	25	—	—	20	—	—	13.68
66	Transparent mycellium	—	—	—	—	—	—	—	—	—	—	16.66	—	1.05
67	Brown mycellium	50	50	7.14	—	—	—	—	1	—	—	—	—	5.26
68	Black mycellium	—	—	7.14	50	5.26	26.66	—	21.42	12.5	—	—	—	11.57
69	Dematious mycellium	—	—	—	—	—	6.66	25	—	—	—	16.66	—	3.15
70	Green mycellium	—	—	—	—	—	—	25	—	—	—	—	—	1.05

Table-2. Classwise Distribution Percentage of total Aeromycoflora of Shopping Malls in all Season

S.No.	Name of fungi	Summer Season	Rainy Season	Winter Season
1	Zygomycotina	17.70	15.62	66.66
2	Ascomycotina	29.69	34.43	35.87
3	Deuteromycotina	25.64	18.64	55.71
4	Sterile Mycellium	23.15	54.73	21.87

Table-3. Season wise Average Percentage Abundance of total Aeromycoflora of Shopping Malls (March 2013 to February 2014)

S. No.	Name of fungi	Summer season	Rainy season	Winter season	TOTAL
1	Zygomycotina	4.06	3.26	9.82	6.29
2	Ascomycotina	64.36	67.97	50.15	59.37
3	Deuteromycotina	26.31	17.42	36.88	28.11
4	Sterile mycelium	5.26	11.32	3.23	6.22

Table Iv— Monthwise Average Percentage Abundance Of Total Aeromycoflora of Shopping Malls of Raipur (March 2013 to February 2014).

S. No.	Class	Summer				Rainy				Winter				Grand Total
		Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
		%	%	%	%	%	%	%	%	%	%	%	%	%
1	Zygomycotina	—	1.85	3.75	12.34	—	3.72	7.5	—	4.13	4.16	10.88	16.84	6.29
2	Ascomycotina	53.12	76.85	72.18	48.14	68.83	73.91	77.5	46.53	49.58	56.25	38.34	57.89	59.37
3	Deuteromycotina	42.70	19.44	13.53	37.03	6.49	13.04	11.66	39.60	39.66	36.11	47.66	24.73	28.11
4	Sterile mycelium	4.16	1.85	10.52	2.46	24.67	9.31	3.33	13.86	6.61	3.47	3.10	.52	6.22

Fig I: SEASONWISE (SUMMER SEASON) PERCENTAGE ABUNDANCE OF EACH CLASS DISTRIBUTION OF AEROMYCOFLORA OF SHOPPING MALLS

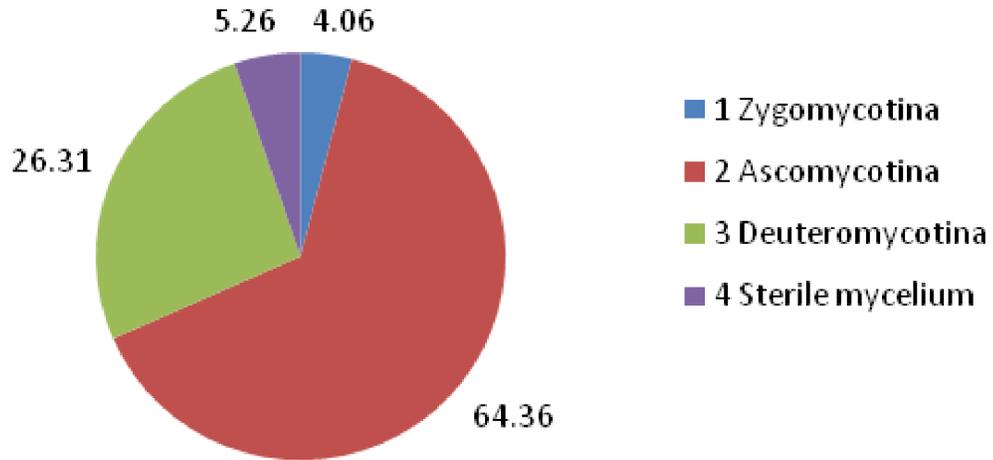
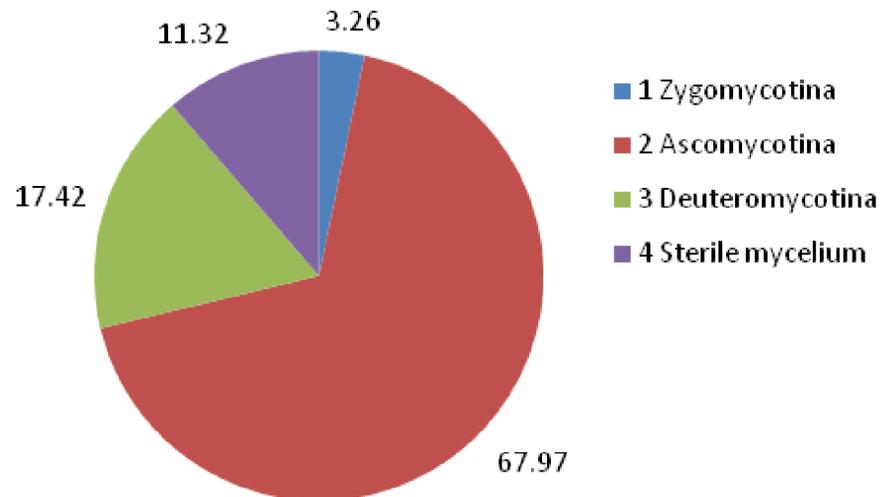
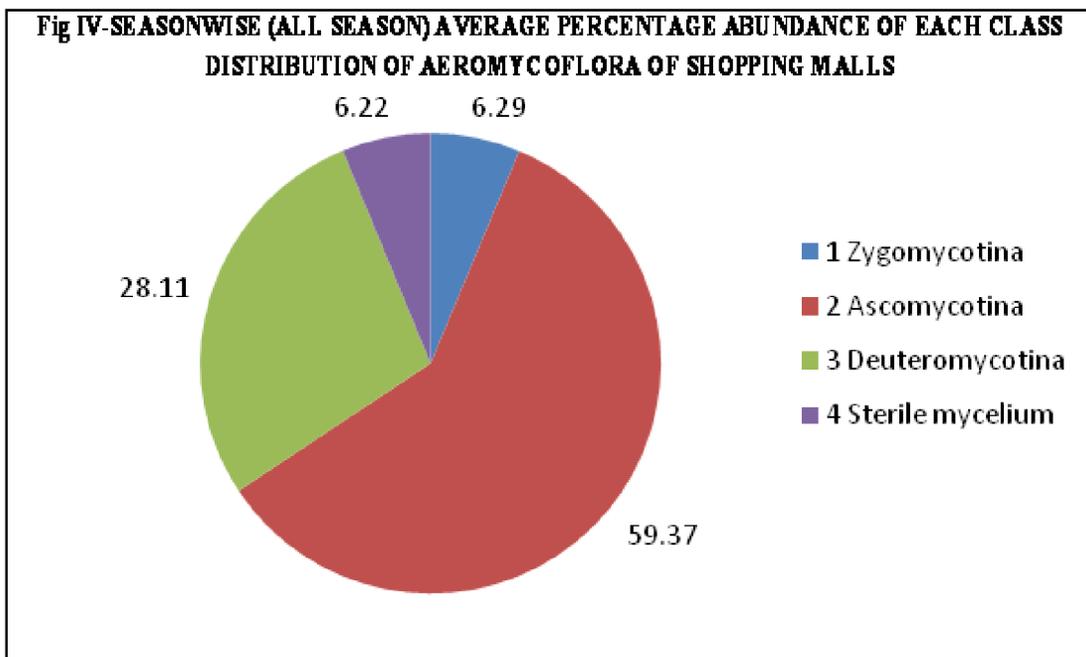
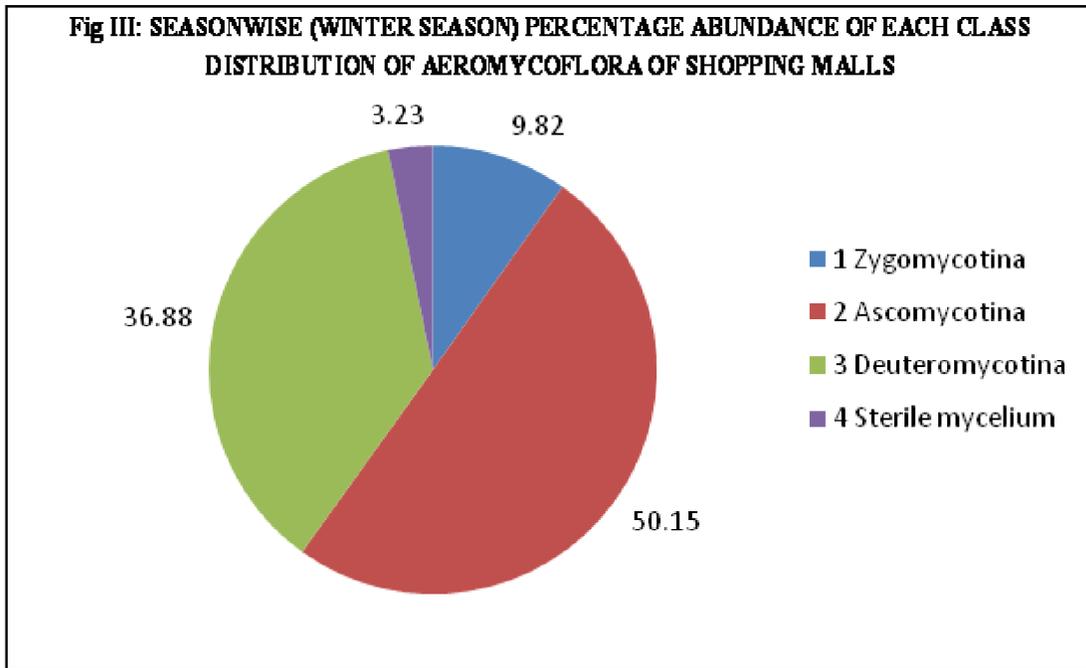


Fig II : SEASONWISE (RAINY SEASON) PERCENTAGE ABUNDANCE OF EACH CLASS DISTRIBUTION OF AEROMYCOFLORA OF SHOPPING MALLS





fungi as responsible for asthma⁵. All the above results showed that good sanitization, aeration, ventilation is not confirmation for prevention to allergenic and disease causing spores. Allergenic and disease causing fungal flora are present in Shopping Mall throughout the year¹⁹.

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