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Aeromycology of Industrial Area, Wadi, Nagpur (M.S.) India

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Abstract: Airborne fungal spores are known causing infections of human and animals and also play crucial role in biodeterioration and biodegradation of wastes of plant and animal origin. In the present study the Aeromycological survey has been conducted to record prevalence of diverse group of micro-fungal airspora from various sites of Industrial Area, Wadi, Nagpur in the post-winter season. The Petri-plate method based on gravity was used for sampling. Out of the total 1231 fungal colonies falls under 18 genera and 27 species have been recorded on nutrient agar jelly. Initial week of March 2021 was observed the peak period of fungal spore concentration. Deuteromycota contributed 48.4 percent aeromycoflora exhibiting nearly half of the total contribution of the viable fungal spores in the survey area from this group alone. Ascomycota contributed 46.1 percent while Zygomycota had least count of colonies. Members of Basidiomycota did not appear. *Alternaria* was reported dominant in terms of count of colonies and number of species. *Aspergillus* and *Fusarium* confined with 3 species each while *Penicillium* and *Curvularia* had 2 species each. Remaining genera, *Phytophthora, Pythium, Mucor, Chaetomium, Diplodia, Phomopsis, Phoma, Cladosporium, Drechslera, Trichoderma,* and *Trichothecium* were encountered with individual species. The distribution of viable fungal spores in air in variable concentration in post-winter season may attributed to fluctuating weather and relative humidity which supports fungal flora growth of same group of organisms and act inhibitory for others.

Keywords: Fungal isolates, Biodeterioration, Biodegradation, Aeromycoflora.

I. INTRODUCTION

Airborne fungal spores are ubiquitous in nature and can survive in both wet and dry environment [1]. Airborne pathogenic fungi are known to cause various plant diseases to crop plants while airborne saprobes are involved in biodegradation [2]. The distribution of these fungal propagules with respect to their number and type in the environment vary with time of the day, climate, and also differs from place to place [3]. They are implicated in damage of food commodities, spoilage of stored grains, fruits, food stuff, in deterioration of organic material and their high concentration of mycotoxins may cause health hazards [4,5]. These microbes are also responsible for the deterioration, books, wooden articles and buildings [6]. The parameters including temperature, humidity, wind speed, rainfall, light intensity, sand storm, and organic matter available at that place affect the quality of aeromycoflora [7]. High temperature; storms and wind helps in quite dispersal of fungal propagules along with dust particles to large distance whereas rainfall and humidity reduces quality as well as quantity of fungal propagules in the air [8].

Since diverse group of fungal species constitute the major components of airborne flora and they are the major cause of respiratory ailments of human beings, causing allergies, asthma, pathogenic infections of the respiratory tract, plant diseases and as well as important agents of degradation of cellulosic and non-cellulosic material in outdoor environment [9, 10]. Some species of medicinal plants are known to produce essential oils and aerosol have potent sporistatic, fungistatic and fungicidal activities, possibly reduces aerospora viability [11]. Increase of CO_2 concentration stimulates fungal sporulation suggesting that levels of the airspora correlate with air pollution [12]. In addition, increase of SO_2 concentration in the air can reduce airborne fungi concentration [13]. A literature survey indicated that a few is known concerning to Aeromycology of this industrial place located nearer to Wadi area, hence it seemed to be worthwhile to undertake a more comprehensive and systematic study of the diversity of aeromycoflora from environment of Industrial Area, Wadi during post-winter season.

II. MATERIALS AND METHODS

The Industrial Area, near Wadi, Nagpur, of Maharashtra state has been selected as sampling site as it is a popular business spot for various storage and warehousing facilities. The Petri-plate method based on gravity was used for sampling of airborne viable fungal propagules [14]. At the height of three feet from ground level, the petri plates containing sterile Potato Dextrose agar nutrient jelly composed of peeled potato ($200gm^{-1}$), dextrose ($20gm^{-1}$**)** and agar ($20gm^{-1}$**)** in one liter distilled water were exposed in triplicates for 20 minutes in afternoon in different sites of

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Industrial Area, Wadi in a month of March (2021). The exposed petri plates were sealed with cellophane tape and brought to laboratory and allowed to incubate.

After incubation of the exposed petri plates containing viable fungal propagules at 25 to 28^{0}C in B.O.D. incubator for 3 to 5 days, the developed colonies were counted, isolated and identified after sub-culturing on Czapek's nutrient medium in tube slants. Literature, micro- & macro morphology and reverse surface coloration of colonies on Czapek's medium were used for species identification and finally authenticated by authority.

III. RESULTS AND DISCUSSION

Airborne potent viable propagules including spores of fungal origin play an important role in plant pathology, food spoilage, also associated with unpleasant odors, discoloring and degradation of cellulosic and non-cellulosic substrate [10]. Several viable fungal spores are allergic and capable of causing allergenic responses in susceptible individuals. Epidemiological studies revealed that greater concentration of fungal spores in the air can be allergic, however in some cases very low concentration can cause serious disorders [2]. Majority of the fungal spores are activated by various gases release from industries, sensitize the dermis of the body and cause disorders to the human population of environmental polluted area [15]. The some fungal spores constituting a major component of airspora are responsible for allergy, since the spores are inhaled and deposited on sensitive mucosa [16].

Aeromycological analysis revealed prevalence of a population of altogether 1231 fungal colonies categorize under 18 genera and 27 species in the area understudy. Deuteromycota dominated with 48.4 percent airspora exhibiting greater concentration followed by Ascomycota contributing 46.1 percent. Moderate concentration was recorded with Oomycota and sterile mycelia while Zygomycota had least count. Basidiomycetous spores did not persist. Among the isolates, *Alternaria* dominated the aeromycoflora representing highest count of species followed by *Aspergillus* and *Fusarium* with three species each. *Penicillium* and *Curvularia* detected with two species each while individual species was detected for remaining genera (Table I).

Deuteromycota dominated with 596 fungal colonies representing 7 genera and 13 species of diverse nature. The dominant isolates in this group included *Alternaria* (25%), *Cladosporium* (13.6%) and *Fusarium* (6.9%). Both genera, *Curvularia* and *Drechslera* were detected in equal concentration (1.0%) while remaining *Trichoderma and Trichothecium* were confined to the frequency 0.3- 0.6 % respectively. Ascomycota had a count of 567 colonies representing 6 genera and 9 species. *Aspergilli* contributed higher colony count (19.3%) followed by *Penicilli* (11.5%) while *Chaetomium, Phoma, Phomopsis* and *Diplodia* had least colony count. Members of Oomycota appeared in 12 colonies representing 2 genera and 2 species. Both the isolates, *Phytophthora infestans* and *Pythium aphanidermatum* has been detected with equal count of colonies. Altogether 6 colonies were detected on agar jelly for Zygomycota representing single genera and single species, *Mucor pusillus.* Among other types, sterile hyphae with few chlamydospore contributed 4.1 percent of total colonies. Among these, black sterile mycelia was dominant over white sterile mycelia (Table II).

Among the isolates, *Alternaria* contributed one-third of the total colony count followed by *Aspergillus, Cladosporium, Penicillium, Fusarium, Chaetomium, Phoma* and *Phomopsis*. The genera, *Chaetomium* and *Phoma* were significant with equal count of colonies while *Penicillium* and *Fusarium* were recorded subdominant. Among these isolates, *Alternaria alternata, A. brassicicola, Aspergillus niger, Cladosporium cladosporoides* were reported most dominant followed by *two species of Penicillium* (Table I). Other isolates, *Phomopsis sp, Fusarium solani, F. moniliforme, Alternaria pori, Drechslera rostrata* contributed 1.0 - 4.5 percent airspora. *Sterile black* and *white mycelia* contributed 2.3 and 1.8 percent airspora respectively. Remaining isolates encountered on the agar jelly during the survey had least count. (Table I). *Mucor* of Zygomycota*; Aspergilli* & *Penicilli* of Ascomycota; *Alternaria, Cladosporium, Fusarium,* of Deuteromycota had comparatively greater count of colonies and also contributed greatest concentration of airspora. Moreover, members of this group are well known saprophytes involved in the biodegradation of organic substrate of cellulosic nature [17]. Major components included most frequently encountered genus *Alternaria* while minor components included *Trichoderma* less frequent and sporadic types. Other stable components recorded were *Aspergillus, Cladosporium, Penicillium, Fusarium, Chaetomium, Phoma* and *Phomopsis*. The genera *Curvularia, Dilpodia, Drechslera, Mucor, Phytophthora, Pythium, Trichoderma, Trichothecium, Sterile white mycelia* and *Sterile black mycelia* were rare in samples found prevalent only 2-4 times during sampling.

The Petri-plate method based on gravity was used for sampling of aeromycoflora as this technique has been proved to be more appropriate over others to record fungal diversity by Menghare and Bhajbhuje [18]. This is in agreement with the findings of Raushani & Namita[19, 4, 20] who reported the greatest count of fungal isolates as well as higher fungal colony count of outdoor aeromycoflora. *Alternaria* was dominant in outdoor environment of the MIDC Industrial Area, Wadi contributing 25.0% secreted Alternariolmonomethyl ether, tenuazoic acid and altertoxins can affect respiratory system, skin, and nails in humans and also induced reduction in seed germination and seedling emergence with chromosomal abnormalities in plants [4, 21]. *Aspergillus*, contributed 19.3 percent of the total colony

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count, caused a common disorder Aspergillosis in human, birds and other animals [22]. *Cladosporium Cladosporioides* contributed 13.6% of the total count. This genus is reported to be a major constituent of fungal bioaerosol [23]. Many

Table 1 : Distribution of aeromycoflora of Industrial Area Wadi, Nagpur

S. N	Fungal organism	Number of fungal colonies				Total colonies	Percent Contribution	
		Site - I	Site -II	Site -III	Site -IV		Species	Genus
A.	**Oomycota**	8 (0.6)	4 (0.3)	-	-	12	1.0	1.0
1	*Phytophthora infestans*	2	4	-	-	6	0.5	0.5
2	*Pythium aphanidermatum*	6	-	-	-	6	0.5	0.5
B.	**Zygomycota**	6	-	-	-	6	0.5	0.5
3	*Mucor pusillus*	6	-	-	-	6	0.5	0.5
C.	**Ascomycota**	240 (19.5)	85 (6.9)	159(12.9)	83 (6.7)	567	46.1	46.1
4	*Aspergillus fumigatus*	4	-	2	-	6	0.5	19.3
5	*Aspergillus niger*	94	7	90	34	225	18.3	
6	*Aspergillus ochraceous*	-	6	-	-	6	0.5	
7	*Chaetomium globosum*	07	24	16	15	62	5.0	5.0
8	*Diplodia sp*	9	-	-	-	9	0.7	0.7
9	*Penicillium citrinum*	61	2	7	5	75	6.1	11.5
10	*Penicillium oxalicum*	55	1	8	2	66	5.4	
11	*Phomopsis sp*	-	25	16	15	56	4.5	4.5
12	*Phoma glomerata*	10	20	20	12	62	5.0	5.0
D.	**Basidiomycota**	-	-	-	-	-	-	-
E.	**Deuteromycota**	158 (12.8)	202 (16.4)	122 (9.9)	114 (9.3)	596	48.4	48.4
13	*Alternaria alternata*	44	110	-	-	154	12.5	25.0
14	*Alternaria brassicicola*	12	-	60	56	128	10.4	
15	*Alternaria solani*	3	-	-	-	3	0.2	
16	*Alternaria pori*	14	1	6	2	23	1.9	
17	*Curvularia lunata*	6	-	-	-	6	0.5	1.0
18	*Curvularia ovoides*	6	-	-		6	0.5	
19	*Cladosporium cladosporioides*	16	52	46	54	168	13.6	13.6
20	*Drechslera rostrata*	12	-	-	-	12	1.0	1.0
21	*Fusarium moniliforme*	21	9	6	-	36	2.9	6.9
22	*Fusarium oxysporum*	6	-	3	2	11	0.9	
23	*Fusarium solani*	16	22	-	-	38	3.1	
24	*Trichoderma viride*	-	3	1	-	4	0.3	0.3
25	*Trichothecium roseum*	2	5	-	-	7	0.6	0.6
F.	**Other types**	9 (0.7)	21 (1.7)	9 (0.7)	11 (0.9)	50	4.1	4.1
26	*Sterile white mycelium*	6	8	4	4	22	1.8	1.8
27	*Sterile black mycelium*	3	13	5	7	28	2.3	2.3
	Genera / (species)							
	Sum of total colonies	421	312	290	208	1231	100	100
	Percent contribution	34.2	25.3	23.5	16.9	99.9		

Table 2: Division wide count of genera and species

S.N	Fungal organism	Genus	Species	Total colonies	Percent contribution
1.	Oomycota	2	2	12	1.0
2.	Zygomycota	1	1	06	0.5
3.	Ascomycota	6	9	567	46.1
4.	Deuteromycota	7	13	596	48.3
5.	Mycelia sterilia	2	2	50	4.1
Total		18	27	1231	100

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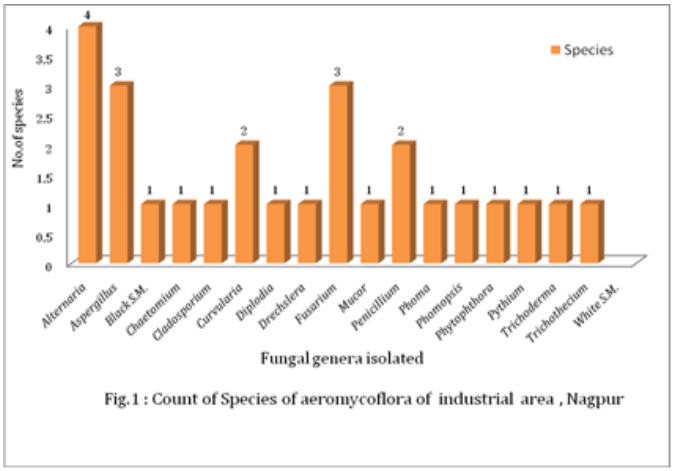

Fig.1 : Count of Species of aeromycoflora of industrial area , Nagpur

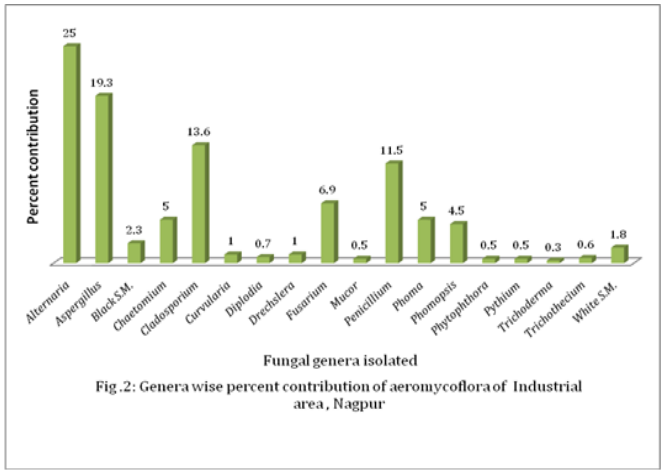

Fig.2: Genera wise percent contribution of aeromycoflora of Industrial area , Nagpur

sources of bio-aerosols are man-made, such as sewage treatment and vegetable waste disposal facilities. Dust level in an open air is relatively high, especially when the human and other activities are significant.

Aspergillus flavus also produces other toxic compounds including sterigmatocystin, cyclopiazonic acid, kojic acid, β-nitropropionic acid, aspertoxin, aflatrem, gliotoxin, and aspergillic acid [24] *A. fumigatus* grown on certain building materials can produce genotoxicandcytotoxic mycotoxins, such as gliotoxin. *A.niger* strains did produce ochratoxins A and isoflavone orobol [25]. Fungal organisms are known to produce B1, B2, G1, and G2 as a major aflatoxins. *Cladosporium cladosporioides* rarely causes infections in humans, although superficial infections have been reported. It can occasionally cause pulmonary and cutaneous phaeohyphomycosis and also induce respiratory inflammation due to the up-regulation of macrophage inflammatory protein (MIP)-2 and keratinocyte chemoattractant (KC) which are cytokinin involved in the mediation of inflammation [24]. *Fusarium* produces mycotoxins. The importance of the presence of these spores is related to their capability of provoking asthma and other respiratory diseases in humans [26].

In Industrial Area, due to industrialization, the release of gases contributed to make environment relatively hot with average maximum temperature and low humidity. This moderate climate fluctuated the fungal growth. The peak period of fungal spore concentrations was recorded for month of survey (March 2021). The moderate climatic conditions during this time with temperature ranging between 36^0C (max.) to 19^0C (min.) and relatively humidity supports for dissemination of fungal spores in the environment. Most of the fungal spores remain existed predominantly in polluted environment during post-winter season when temperature ranges confined between 20-30^{o}C and relative humidity remains 75% or above [27]. The polluted environment of the Industrial Area provides least humidity for airborne fungal spores. Main sources of fungal spores are the surrounding dirty area of Wadi where the dumping of waste food material, vegetable matter and other garbage by human population of nearby locality and by the visitors. Different environmental factors such as humidity, temperature fluctuation changes the physical and chemical properties of the Industrial Area, Wadi are conductive for the growth of fungal organisms accelerating the deterioration process.

IV. CONCLUSION

Air quality of the environment of Industrial Area has become an important issue because of the garbage all around the Industrial Area. Impact of airborne fungal spores including their release, dissemination, deposition and effect is of great significance to identify the health hazards and physiological disorders in living beings. The present report of aeromycological survey of the Industrial Area, Wadi revealed that the outdoor air has higher airspora and it acts as an origin of the airspora in indoor air. Exposure to outdoor airborne inhalant mould allergens develops respiratory symptoms, airways disorders and allergies. Thus cleanliness is most importantly required for maintenance of good health, it is therefore, necessary to regularly monitor the prevalence of fungal airspora by modern technologies. It may be convenient in the prevention of fungal allergic disorders. Effective disposal of solid waste to other area may improve the air quantity of this Industrial area.

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