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Diversity and Distributional Pattern of Airborne Fungal Spores in Federal Capital Territory, Nigeria

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Abstract

Spores of fungi contain allergenic protein which elicit allergies in hypersensitive individuals causing; asthma, sneezing, runny nose, mucous production, bronchial diseases etc. Aeromycoflora study of Federal Capital Territory was investigated for twelve calendar months. The research focused on determining the airborne allergenic and pathogenic fungal spores in the ambient environment of the study area. Aerosamples were collected using modified Tauber - like pollen trap. Results revealed persistent presence of fungal spores throughout the sampling period. Dominant allergenic and pathogenic fungal spores found in the studied aeroflora were Curvularia, Tetraploa, Puccinia, Erysiphe graminis etc. Most fungal spores showed positive though not significant correlation with rainfall.

Keywords: Allergic diseases, Weather variables, Airborne fungal spores, Federal Capital Territory.

Introduction

Fungi reproduce asexually by production of spores, as in other cryptogams. The fungal spores perform related functions analogous to seeds of higher plants[1]. Studies have revealed that fungal spores are abundant and persistently present in indoors and outdoors environment and also major component of bioaerosol. Spores of fungi like pollen of higher plants are abundantly discharged into the ambient environment and their further dispersal influenced by weather parameters[2]. Inhalation of fungal spores lead to provocations of rhinitis, dermatitis / eczema, aspergillosis, conjunctivitis, rhinoconjuctivitis, asthma and other allergic respiratory diseases[3]. Airborne fungal spores have been found to be seasonal with higher concentration in rainy months and highly influenced positively by relative humidity[2].

Spores of some fungi are excitant of hay fever especially in atopic individuals and children. This is because of the possession of allergen protein in their sporoderm. Studies have revealed that among other environmental triggers of allergenic diseases, fungal spores are among the most potent, due to their abundant production and release, microscopic sizes which enhance their aerodynamism and also their respirable sizes. Some fungal spores have similar allergens with pollen; individuals who are hypersensitive to fungi could also react to pollen allergens[3]. There are variations in the period of fungal spores release. Nevertheless, some fungal spores could be persistently present in the atmosphere of a particular region, eliciting perennial symptoms in those hypersensitive to them[3]. Some airborne fungal spores parasitize agricultural crops leading to huge economic loss. The aim of this study was to determine the fungal spores morphotypes prevalent over one year in the atmosphere of Federal Capital Territory and influence of weather variables on them.

Materials and Methods

The study was carried out in Garki, Abuja. Abuja is the capital city of Nigeria. It is located in the centre of Nigeria, within the Federal Capital Territory (FCT). Tauber –like pollen trap modified to achieve a height of 5ft was used for the study. Solution made up of glycerol (50 ml), formaldehyde (10 ml) and phenol (5 ml) was prepared and poured into the trap. The trap was mounted on 1st of June and harvested on 30th of June, the solution was replaced in the trap and subsequent monthly collections were carried out for 12 calendar months. Recipient solutions were taken to the laboratory and acetolysed, following palynological protocol[4]. Temporary slides were prepared and fungal spores were identified using photomicrographs of fungal spores in books and journals. Monthly fungal spores count was expressed in frequency and analyzed using the SPSS statistical package version 20 (SPSS Inc. Chicago, Illinois USA). Correlation coefficients were generated to examine the relationship between fungal spores frequency and meteorological data.

Results and Discussion

Abundant fungal spores morphotypes were recorded in aeroflora collected in the atmosphere of Garki, Abuja. A total of 18 fungal spores were recorded. Absolute fungal spores count achieved 3,534 and highly influenced by *Tetraploa* spp. 140 (3.96 %), *Curvularia* spp. 153 (4.33 %), *Pithomyces* spp. 163 (4.61 %), *Nigrospora* spp. 224 (6.34 %), *Puccinia* spp. 294 (8.32 %), *Sporidesmium* spp. 197 (5.57 %), *Erysiphe graminis*

1235 (34.95 %) and *Hansfordiella* spp. 320 (9.05 %). Higher load of spores were recorded during the rainy season (June – September; 1342) and early dry season (October; 573). *Erysiphe graminis* dominated other fungal spores in November, accounting 93 % of its annual total. Lowest spores were recorded in February (Table-1).

In dry months, most fungal spores load declined. *Pithomyces* spp., *Nigrospora* spp., *Torula* spp., *Puccinia* spp and *Hansfordiella* spp. which were major contributors of spore load during the rainy season seldom release their spores in the dry months. The most preponderant allergenic candidates recorded include those of *Tetraploa* spp., *Helminthosporium* spp., *Curvularia* spp., *Pithomyces* spp., *Nigrospora* spp. and *Torulla* spp., their monthly concentration was higher from the month of June to October (Figure-1). Some allergenic spores which were not preponderant include *Alternaria* spp.*;* which occurred in the months of April (18), May (28), June (14), July (4) and September (6). *Fusarium* spp. were sparsely represented and recorded only in August (6) and November (20). *Cladosporium* spp. occurred more in the rainy season; June (15), July (24), early dry season; October (45), dry season; December (8) and January (4). *Curvularia*. were persistently present from July to February.

Preponderant pathogenic fungal spores recorded were *Erysiphe graminis, Hansfordiella* spp., *Puccinia* spp., *Nigrospora* spp., *Sporidesmium* spp. and *Spadicoides* spp. (Figure-2). *Erysiphe graminis* spores were the most dominant in November; other pathogenic spores prevailed more from the month of June to November.

The relationship between monthly frequency of fungal spores and weather parameters were correlated (Table-2). Most fungal spores had a positive correlation with monthly rainfall; however *Erysiphe graminis* and total fungal spores showed a negative correlation with monthly rainfall. There was a significant negative correlation of *Puccinia* spores with temperature. *Hansfordiella* also had a significant positive correlation with relative humidity. All fungal spores showed a negative though not significant correlation with the wind (Table-3).

Table-1
Frequency of airborne fungal sporesin Federal Capital Territory from June 2011 to May 2012

Fungal Spores	Months													
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	%
Alternaria spp.	14	4	0	6	0	0	0	0	0	0	18	28	70	1.98
Apiosporina spp.	0	0	0	0	2	0	0	0	0	0	0	0	2	0.06
Aspergillus spp.	0	0	2	0	0	0	1	0	0	0	0	0	3	0.08
Cercosporella spp.	3	0	0	0	0	0	0	0	0	0	0	0	3	0.08
Cladosporium spp.	15	24	0	0	45	0	8	4	0	0	0	0	96	2.72
Curvularia spp.	0	4	12	9	96	2	0	18	12	0	0	0	153	4.33
Erysiphe graminis	0	0	2	0	0	1200	24	9	0	0	0	0	1235	34.95
Fusarium spp.	0	0	6	0	0	20	0	0	0	0	0	0	26	0.74
Hansfordiella spp.	37	123	90	6	64	0	0	0	0	0	0	0	320	9.05
Helminthosporium sp.	6	0	6	30	0	6	8	0	0	0	0	0	56	1.58
Pithomyces spp.	12	15	20	20	54	6	36	0	0	0	0	0	163	4.61
Nigrospora spp.	51	6	48	12	45	12	0	6	0	24	10	10	224	6.34
Puccinia spp.	12	28	189	60	3	1	1	0	0	0	0	0	294	8.32
Spadicoides spp.	0	75	0	30	46	0	0	0	0	20	0	0	171	4.84
Sporidesmium spp.	32	0	0	0	165	0	0	0	0	0	0	0	197	5.57
Tetraploa spp.	111	3	9	3	2	0	12	0	0	0	0	0	140	3.96
Torula spp.	15	28	6	12	3	1	1	0	0	0	0	0	66	1.87
Venturia spp.	0	0	0	1	8	0	0	0	0	0	0	0	9	0.25
Indeterminate	2	2	120	21	40	24	84	0	0	0	0	0	293	8.29
Total fungal spores	310	312	510	210	573	1285	175	37	12	44	28	38	3534	

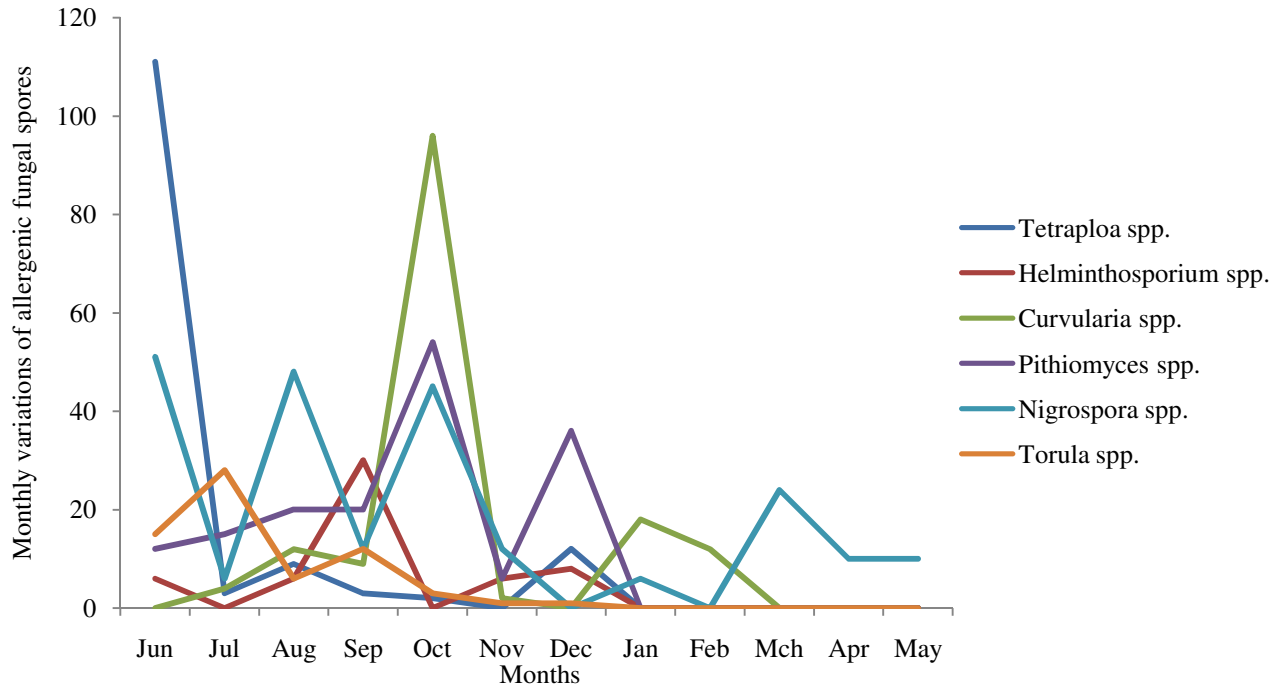

Figure-1
Monthly variations of airborne allergenic fungal spores in Federal Capital Territory from June 2011- May 2012

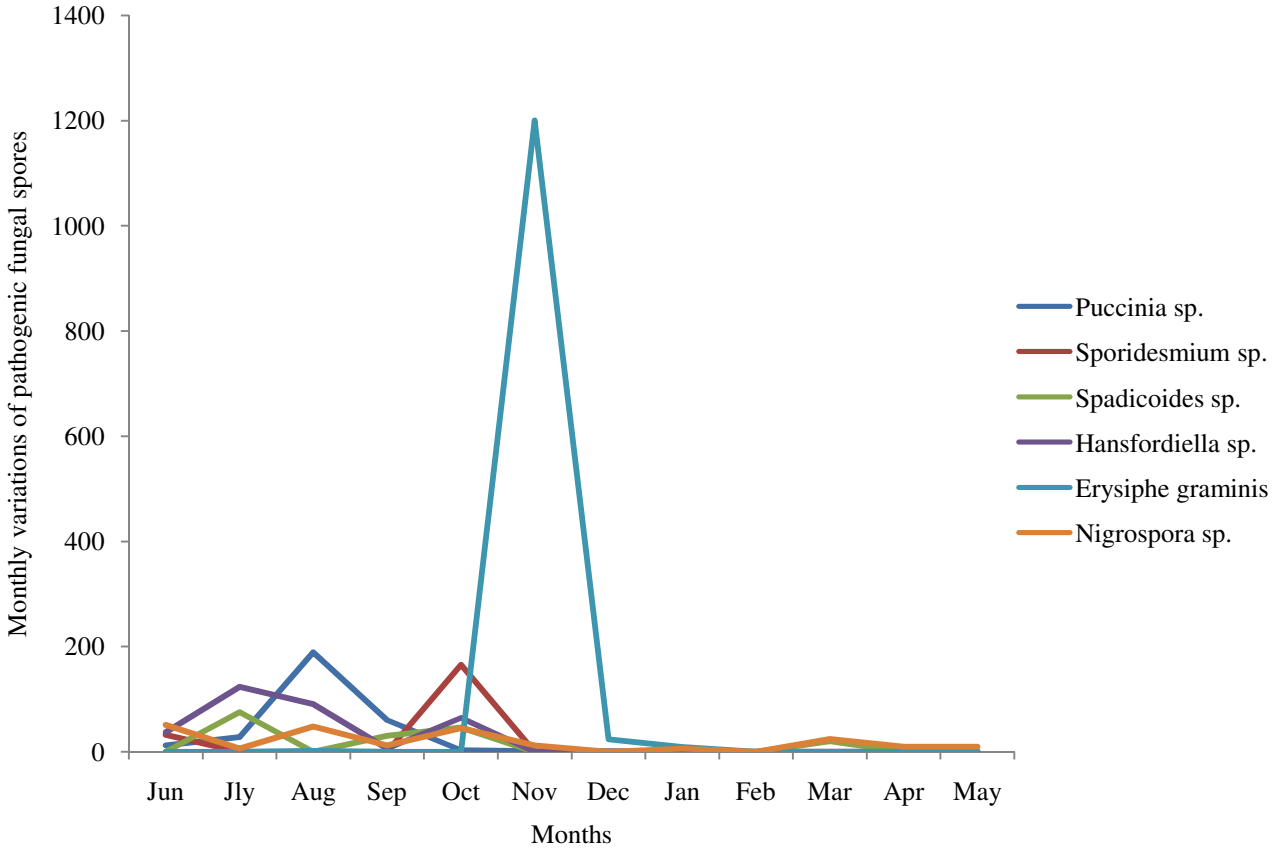

Figure-2
Monthly variations of airborne pathogenic fungal spores in Federal Capital Territory, Nigeria from June 2011- May 2012

Table-2
Meteorological data of Abuja North Central Nigeria from June 2011 to May 2012

Year	Months	AV. Temp. (^{0}C)	Rainfall (MM)	Humidity (%)	Wind Spped (KNOTS)
2011	June	26.2	128.6	83	4.1
2011	July	25.7	227.6	87	4.1
2011	August	24.7	183.5	88	3.8
2011	September	25.2	278.0	86	4.0
2011	October	25.8	130.3	83	3.7
2011	November	26.3	6.8	64	4.0
2011	December	25.3	0.0	40	4.5
2012	January	26.2	0.0	41	4.5
2012	February	29.2	20.6	52	4.2
2012	March	30.9	19.0	38	5.0
2012	April	32.6	45.2	65	6.6
2012	May	34.3	198.5	78	3.9

Source- Nigerian Meteorological Center Abuja

Table-3
Correlation coefficients between monthly frequency of fungal spores and weather variables

Spores count	R	T	R.H	W
Total fungal spores	-.021	-.324	.266	-.405
Trridentarium sp.	.094	-.058	.249	-.133
Curvularia sp.	.087	-.087	.211	-.323
Pithiomyces sp.	.236	-.317	.262	-.400
Nigrospora sp.	.279	-.507	.590	-.291
Puccinia sp.	.485	-.933**	.497	-.298
Sporidesmium sp.	.100	.010	.299	-.286
Spadicoides sp.	.550	.067	.499	-.246
Erysiphe graminis	-.312	.022	-.097	-.146
Hansfordiella sp.	.555	-.558	.654*	-.373

**Correlation is significant at the p= 0.01 level (2- tailed), *Correlation is significant at the p= 0.05 level (2- tailed), R, Rainfall (mm). T, Temperature (^{o}C). R. H, relative humidity (%). W, wind (knots).

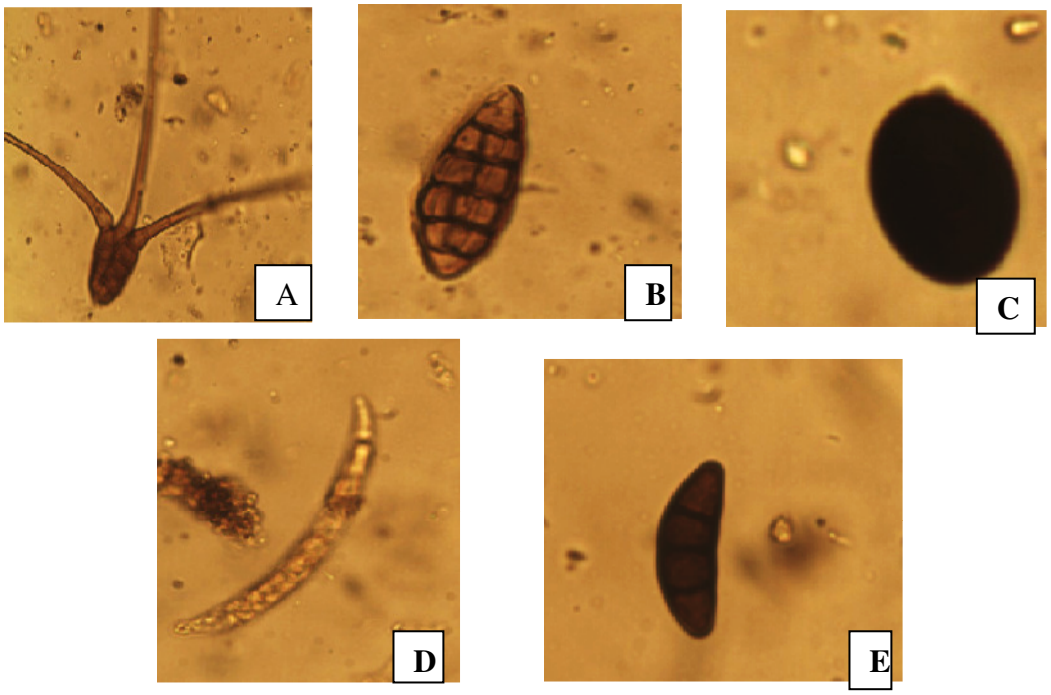

Figure-3
Photomicrographs of some fungal spores recovered from Federal Capital Territory, Nigeria
A**-** *Tetraploa*.; B- *Pithomyces*.; C - *Nigrospora*.; D- *Fusarium*.; E-, *Curvularia*

Discussion: The study revealed abundant fungal spores in the ambient environment, their spatial distribution and abundance vary greatly in the two main seasons of Nigeria (rainy and dry season), this depicted great influence of weather variables on their dispersal. There is dearth of knowledge on aeromycobiota of Nigeria. This is the first attempt to study the aeromycobiota of Federal Capital Territory using modified Tauber-like sampler. The present work found preponderant of fungal spore morphotypes during the rainy season which coincided with periods of higher records of monthly rainfall and relative humidity, indicating high sporulation of most fungi being favoured by humid than dry weather. In Federal Capital Territory exposures to fungal allergen could be higher in the rainy season (June –September) and early dry season (September-November) than dry season.

The genera belonging to Deuteromycotina significantly contributed to the total aerospora and dominated other groups, both quantitatively and qualitatively. The fungal spores which belong to Deuteromycotina, found in the study area were *Cladosporium*, *Curvularia*, *Alternaria*, *Torula*, *Nigrospora*, *Fusarium*, *Sporidesmium*, *Tetraploa*, *Helminthosporium* and *Pithomyces*. In a similar work carried out in Nsukka, (South-east Nigeria) *Cladosporium, Ustilago, Nigrospora, Drechslera /Helminthosporium and Pithomyces* were found most dominant [5]. Some of the fungal spores recorded in this work have also been found dominant in other areas. *Alternaria* and *Tetraploa* among others were found persistently present in the atmospheres of Chittagong University Campus, Chittagong[6]. *Nigrospora* spp. were found dominant among other fungal spores in Havana, Cuba[7].

Fungi classified as allergenic in this work are those whose sensitivities have been established by previous research work. Some allergenic fungi are also pathogenic as fungal propagules can serve as infective agents of plant diseases[8]. Airborne fungi are responsible for many adverse health effects, the mycotoxins which they produce affect humans and animals [6]. Their features such as microscopic size, aerodynamism etc. make them to play an important role in respiratory allergies and they cause a wide range of symptoms, including allergic rhinitis, asthma, chronic bronchitis, etc. [9]. Fungal spores have long been known as one of the important environmental bio-particles causing dermatitis and other respiratory infections[9].

Among the allergenic fungal spores, *Nigrospora* prevailed more from November to March over a temperature record of 26.2^{o}C - 30.9^{o}C and rainfall record of 6.8- 19.0 mm. *Sporidesmium, Curvularia*, *Pithomyces*, *Spadicoides* were more preponderant in September at 25.2^{o}C and rainfall record of 278.0 mm. *Tetraploa* spp. were recorded very high in June at 26^{o}C and rainfall record of 128.6 mm. No record of rainfall in December (0.0 mm) at 25.3^{o}C marked the decline of most spores, except *Erysiphe graminis*.

Alternaria spores prevailed more in rainy months. Exposures to *Alternaria alternate s*pores were found to be associated with clinical presentation of asthma[11]. Exposure to *Alternaria* has

also been shown to exacerbate symptoms of asthma and allergic rhinitis in sensitive individuals. *Altenaria alternata* antigens correlated with active asthma symptoms, persistent adult asthma and potentially fatal episodes of asthma. Epidemics of asthma caused by increased airborne *Alternaria* spores that occur during thunderstorms illustrated the association[12]. Study has also shown their airborne preponderance and negative influence on crop and human health[13].

Curvularia has been described as a pathogen of humans and animals in the last half-century, causing respiratory tract, cutaneous, and corneal infections[14]. Fungal sensitivity, particularly to *Cladosporium* species, increases the risk of adult-onset asthma. Exposures to *Cladosporium* were also found to be associated with hypersensitivity pneumonitis[15].

Puccinia spp. occurred higher at rainfall record of 183.5 mm at 24.7^{o}C. They cause stem rust disease of cereals[16]. *Erysiphe graminis* highly dominated the atmosphere of the study area in the month of November, at reduced rainfall record (6.8 mm), this fungus parasitizes on grasses both cultivated and wild species.

The present study found high sporulation of fungi in rainy season. Contrary to the present study, main concentration peak of spores in Havana, Cuba was found in dry season (November)[7]. The differences could be attributed to weather and types of mycoflora and vegetation, as vegetation in the sampling area could affect the concentration and type of fungal taxa in the atmosphere[17].

Conclusion

The present study revealed diverse fungal spores morphotypes in Abuja, FCT. The mycoflora were dominated by allergenic and pathogenic fungal spores. Their atmospheric dominance were higher in rainy, wet months than in drier months. Allergenic fungal candidates preponderant at the risk periods were; *Tetraploa*, *Curvularia*, *Pithiomyces* and *Nigrospora*. *Erysiphe graminis* dominated other fungal spores in November. Adequate protective measures should be taken on cereals growing in the study area, as they are easily parasitized by *Erysiphe graminis*. Other pathogenic fungal spores dominant were those of *Puccinia*, *Hansfordiella* and *Sporidesmium*.

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