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Fungal contamination of markets in Warri Metropolis: A threat to food security and human health

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Abstract

There is always population surge towards physical market because it is a major outlet for purchase of food items and other human needs. Biological contamination of air is one of the serious issues of the environment varying among geographic areas and sampling heights. The aeromycology of three major markets in Warri metropolis which include Effurun market, Igbudu market and Main market using open plate method was evaluated. The study was conducted for the period of six (6) months (April to September, 2017) at two heights: human height (1.5m) and building height (3.5m) and three different locations (foodstuffs, clothing and abattoir sections) in each of these markets. Petri dishes containing PDA medium were exposed for 5 mins and incubated in the laboratory for 2–3 days. Developed fungal colonies were counted and sub-cultured to fresh PDA medium for identification by morphological and microscopic examination using standard identification keys. A total of 6145 colonies with 35 species were isolated and identified. Main fungi identified with their percentage frequency of occurrence include *Aspergillus niger* 699(11.37%), *Mucor mucedo* 459(7.47%), *Penicillium candidum* 404(6.57%), *P. digitatum* 395(6.43%), *Monilia* sp 324(5.27%) among others. Off these fungi, members of the Deuteromycotina contributed 46.58%, Ascomycotina 38.76% and Zygomycotina 14.66%. The population of fungal colonies varied from month to month as follows: July>August>June>September>May>April. Human height has 4285(60.73%) colonies while building height was 1860(30.27) colonies. Igbudu market, Main market and Effurun market have 2412, 2030 and 1702 fungal colonies respectively. There are strong indications that these market environments are heavily contaminated with airborne fungal spores which may pose a serious threat to food security and human health. Continuous clean-up exercise of these markets is imperative.

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Introduction

The air, depending on the constituents of biological or nonbiological particles regulates the quality of the environment (Mahadeo and Kelpit, 2017). Biological contamination of air can be evaluated by an indoor (intramural) or outdoor (extramural) studies. Their composition and concentration vary greatly with respect to geographical location, human activities, natural sources, meteorological factors, sampling heights and techniques among others (Ginn-Gofron and Bosiacka, 2015: Makut *et al.,* 2014: Mahedeo and Kelpit, 2017: Ghosh *et al.,* 2011).

Atmosphere of market air contains varied fungal spores that are hazardous to human health of which about 80% have been linked with respiratory disorders (Khan and Fatema, 2015; Bhajbhuje and Akare, 2018). Various allergic diseases including Asthma, Aspergilosis, Mycoses, Sinusitis among others have been attributed to inhalation of airborne fungal spores (Ahire and Sangale, 2012; Khan and Fatema, 2015; Hernandez and Martinez, 2018). As opined by Hagale and Patil (2008), airborne fungi have been regarded as indicator of certain level of atmospheric biopollution. Similarly, these fungal spores can settle on surface of food items causing their deterioration thereby reducing the market and nutritive values on one hand and on the other may be toxic to humans when consumed (Okigbo *et al.,* 2008; Atando *et al.,* 2009; Djeri *et al.,* 2010; Fagbohun *et al.,* 2010). On the whole, food security and human health are threatened.

Markets are the major outlet for purchase or sell of food items, agricultural produce and other human needs. To this effect, there is always influx of people in and out of market environment. This study was conducted with the aim to (i) Isolate and identify fungal species of three market environments in Warri metropolis (ii) Study their occurrence in relation to different locations, meteorological data and sampling heights. It is hoped that the result of this study will sensitize the general public on the impact of fungal spores on their health and environment.

Materials and methods

Study Area

The study was carried out at three major markets (Effurun, Igbudu and Main market) in Wari, Warri South Local Government Area of Delta State. Warri is located within Latitude 5°31N and Longitude 5°45E (Fig. 1). The area is characterized by tropical equatorial climate with mean annual temperature of 32±8°C and annual rainfall of 2673.8mm (Abotulu and Ojeh, 2013).

Sample Collection

Culture plate exposure method (Kakde and Kakde, 2012) was adopted and Potato Dextrose Agar (PDA) medium was used. Samples were collected at building height (3.5m) and human height (1.5m) from different sections (clothing, foodstuff and slaughter) of the markets. Sterile petridishes containing 20ml molten PDA was exposed for 3 mins in triplicates at each section. This was done in the morning hours between 8.00–10.00am when market activities were at peak, at weekly intervals for six months, April to September, 2017. The exposed petridishes were sealed with celotape and taken in a pre-sterilized polyethylene bag to the laboratory for incubation. The meteorological data during the period of study was provided by the meteorological station (NIMET), Warri, Delta State.

Laboratory Studies

Laboratory studies were done in Department of Botany Laboratory, Campus II of Delta State University, Abraka. The exposed petridishes were incubated for colony development at room temperature 30±2°C for 2-5 days. Fungal colonies growing on the agar surface were counted and recorded on the basis of morphological characteristics. The fungi were sub-cultured from the mix-colonies to obtain pure cultures for identification (Ilondu, 2016) suing compound microscope and standard mycological keys by Barnett and Hunter (1999) and Ellis *et al.* (2007). Percentage frequency of occurrence (PFO) was determined by the formula of Prasad *et al.* (2015) as:

$$\text{PFO} = \frac{\text{Number of observation in which a species occurred}}{\text{Total number of observations of all species}} \times \frac{100}{1}$$

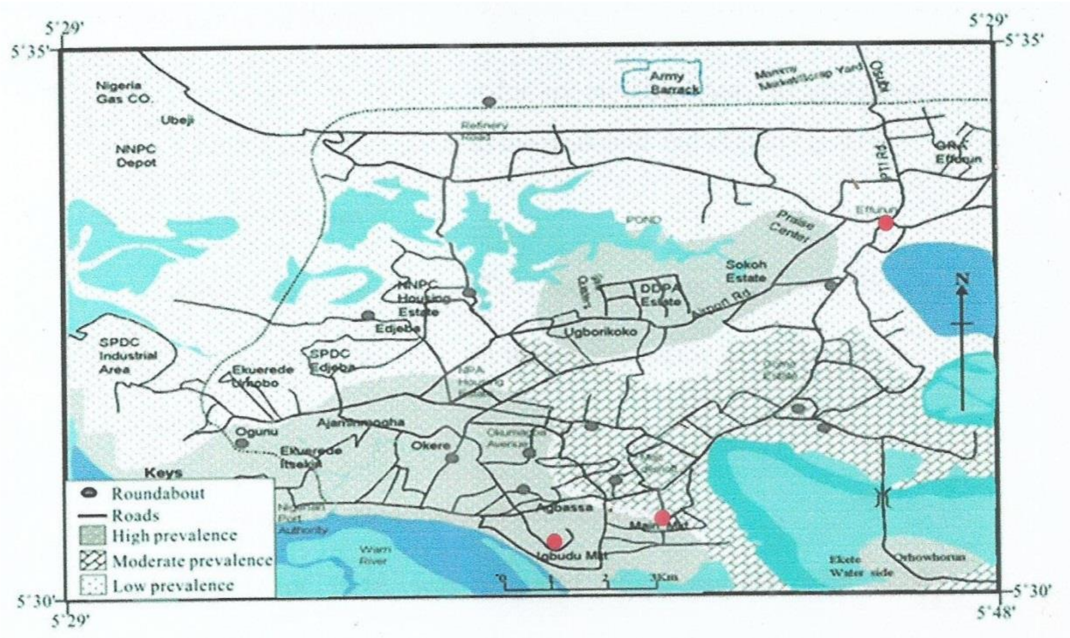

Fig. 1. Map of Warri showing the three sampl locations.
Source: Efe and Ojoh (2013).

Results

This study revealed a total of 6145 fungal colonies with 35 fungal spores types in 22 genera were present in various market environments in Warri metropolis. Main fungal spore types identified with their frequency of occurrence were *Aspergillus niger* 699(11.37), *Mucor mucedo* 459(7.47%), *Penicillium candidum* 404(6.57%), *P. digitatum* 395(6.43%), *Monilia* 324(5.27%) and *Alternaria* 320(5.21%) among others (Table 1). All the fungi islated and total number of colonies in different months throughout the period of investigation is present in Table 2. *Aspergillus terrus, Drechslera* sp and *Penicillum citrinum* were absent in April, May and September, *Botrytis* sp and *P. chrysogenium* were absent in the month of April and May, *Fusarium moniliforme* and *Neurospora sitophilia* were absent in the month of April, while *Chaetomium* sp was only recorded in the month of September (7(0.11%) and absent in the rest of the months of study. On the whole, the number of fungal colonies was recorded as follows: July>August>June>September>May>April (Fig. 2).

Table 1. Fungi isolated in the three sections of different markets.

Fungal groups	Fungi isolated	Effurun market			Igbudu market			Main market			Total	Frequency of occurrence (%)
		C	F	S	C	F	S	C	F	S		
Ascomycotina	*Aspergillus flavus*	20	33	48	22	44	49	17	25	36	294	4.78
	Aspergillus fumigates	4	10	16	0	18	28	0	13	28	117	1.90
	Aspergillus nidulans	0	4	14	0	4	18	0	5	11	56	0.91
	Aspergillus niger	27	57	95	47	99	150	35	61	128	699	11.37
	Aspergillus parasiticus	0	9	16	0	11	22	0	13	19	90	1.46
	Aspergillus terrus	0	2	4	0	4	4	0	8	2	24	0.39
	Chaetomium sp.	0	0	0	0	2	5	0	0	0	7	0.11
	Neurospora sitophilia	0	0	0	0	0	14	0	3	17	34	0.55
	Penicillium candidum	24	39	56	35	24	83	32	42	69	404	6.57
	Penicillium chrysogenum	0	0	0	0	29	0	0	27	0	56	0.91
	Penicillium citrinum	0	0	0	0	0	0	0	8	18	26	0.42
	Penicillium digitamum	22	36	70	33	61	79	16	32	46	395	6.43
	Trichoderma sp.	11	11	23	9	26	34	13	27	26	180	2.93
Deuteromycotina	*Alternaria alternate*	17	22	31	27	39	65	22	45	52	320	5.21
	Botryodiplodia theobromae	0	8	6	1	7	11	0	9	4	46	0.75
	Botrytis sp.	0	0	0	0	7	4	0	5	12	28	0.46
	Candida albican	0	0	11	0	0	22	0	0	18	51	0.93
	Cercospora sp.	16	23	24	17	32	38	13	19	27	209	3.40
	Cladosporium sp.	0	14	18	2	16	34	6	15	20	125	2.03

Fungal groups	Fungi isolated	Effurun market C	Effurun market F	Effurun market S	Igbudu market C	Igbudu market F	Igbudu market S	Main market C	Main market F	Main market S	Total	Frequency of occurrence (%)
	Curvularia lunata	9	22	30	13	30	43	14	29	37	227	3.69
	Curvularia pallescens	15	27	31	21	36	46	15	29	31	251	4.08
	Cylindrosporium sp	22	34	42	20	39	56	22	27	38	300	4.88
	Drechsllera sp.	0	6	0	0	8	0	0	9	0	23	0.37
	Fusarium moniliforme	0	18	21	0	30	16	0	17	16	118	2.05
	Fusarium oxysporium	0	16	19	0	19	34	0	13	25	126	1.92
	Fusarium solani	0	25	27	0	36	33	0	38	26	185	3.01
	Geotrichum candidum	6	24	35	9	31	54	16	31	44	250	4.07
	Gloeosporium sp	3	14	17	4	15	19	7	22	22	123	2.00
	Helminthosporium sp.	20	0	0	26	0	0	10	14	15	85	1.38
	Monilina sp.	16	25	45	24	44	62	20	31	57	324	5.27
	Pestalotia sp.	0	10	15	0	11	19	0	6	10	71	1.16
Zygom-yotina	*Absida corymbifera*	12	18	27	13	16	30	14	10	25	165	2.69
	Mucor mucedo	31	37	67	40	58	74	27	59	66	459	7.47
	Rhizopus stolonifer	2	24	29	7	25	49	5	28	30	199	1.27
	Rhizopus nigricans	0	20	0	0	14	12	3	27	2	78	3.24

Table 2. Fungi isolated in different months.

S/N	Fungi Isolated	April	May	June	July	August	September	Total	Frequency of Occurrence (%)
1	*Absida corymbifera*	15	25	28	36	32	29	165	2.69
2	*Alternaria alternate*	31	39	62	67	64	57	320	5.21
3	*Aspergillus flavus*	27	44	51	71	45	56	294	4.78
4	*Aspergillus fumigates*	10	18	24	20	28	17	117	1.90
5	*Aspergillus nidulans*	6	4	12	14	12	8	56	0.91
6	*Aspergillus niger*	74	90	117	179	134	105	699	11.37
7	*Aspergillus parasiticus*	7	9	13	20	23	18	90	1.46
8	*Aspergillus terrus*	0	0	8	6	10	0	24	0.39
9	*Botryodiplodia theobromae*	5	3	10	9	13	6	46	0.75
10	*Botrytis* sp.	0	0	4	14	7	3	28	0.46
11	*Candida albican*	4	8	10	12	7	10	51	0.93
12	*Cercospora* sp.	23	23	36	55	40	32	209	3.40
13	*Chaetomium* sp.	0	0	7	0	0	0	7	0.11
14	*Cladosporium* sp.	14	16	25	18	34	18	125	2.03
15	*Curvularia lunata*	26	37	36	49	39	31	227	3.69
16	*Curvularia pallescens*	30	32	43	58	43	45	251	4.08
17	*Cylindrosporium* sp	45	58	46	53	57	41	300	4.88
18	*Drechsllera* sp.	0	0	9	6	8	0	23	0.37
19	*Fusarium moniliforme*	0	3	30	39	35	11	118	2.05
20	*Fusarium oxysporium*	8	29	14	35	10	30	126	1.92
21	*Fusarium solani*	25	25	27	38	31	39	185	3.01
22	*Geotrichum candidum*	29	36	42	52	47	44	250	4.07
23	*Gloeosporium* sp	5	13	33	38	19	15	123	2.00
24	*Helminthosporium* sp.	9	13	13	24	15	11	85	1.38
25	*Monilina* sp.	36	54	50	69	61	54	324	5.27
26	*Mucor mucedo*	64	79	87	71	93	65	459	7.47
27	*Neurospora sitophilia*	0	4	10	6	10	4	34	0.55
28	*Penicillium candidum*	64	67	76	61	78	58	404	6.57
29	*Penicillium chrysogenum*	0	0	25	10	19	2	56	0.91
30	*Penicillium citrinum*	0	0	6	10	10	0	26	0.42
31	*Penicillium digitamum*	42	27	67	101	86	72	395	6.43
32	*Pestalotia* sp.	7	8	10	18	22	6	71	1.16
33	*Rhizopus nigricans*	7	12	15	13	14	17	78	3.24
34	*Rhizopus stolonifer*	34	21	40	37	44	23	199	1.27
35	*Trichoderma* sp.	18	27	23	43	33	36	180	2.93
	Total	664	824	1109	1352	1223	973	6145	100

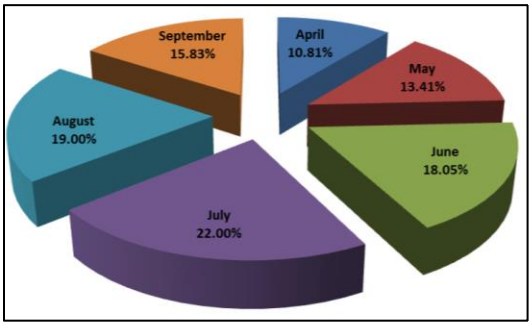

Fig. 2. Frequency of occurrence of all fungi throughout the period of study.

Table 3 showed the number of fungal colonies isolated from the three major markets under investigation. *Botrytis* sp, *Neurospora sitophilia* and *Penicillium chrysogenium* were absent in Effurun market, *P. citrinum* were absent in Effurun and Igbudu markets while *Chaetonium* sp was only present in Igbudu market. Igbudu market recorded the highest number of fungal colonies with 2412 as against main market with 2030 and Effurun market with 1702 fungal colonies (Fig. 3).

The total number of fungal colonies recorded from each section of the markets (clothing, food item and slaughter) is presented in Table 4. From the records, S>F>C (Fig. 4). Fungal colonies obtained at human height has a higher percentage frequency with a total of 4285 compared to building height with 1860 colonies (Table 5, Fig. 5). The fungal species identified were categorized into the fungal group which includes Ascomycotina, Deuteromycotina and Zygomycotina. Members of the Deuteromycotina contributed 46.58% of all the fungal spores encountered followed by Ascomycotina 38.76% and Zygomycotina 14.66% (Table 6). The meteorological data of Warri for the period of study was recorded (Table 7). Mean relative humidity was highest in July and lowest in April; mean temperature was highest in the month of April and lowest in July while rainfall data was highest in July and lowest in August.

Table 3. Total fungi isolated in different markets.

S/N	Fungi Isolated	Effurun Market	Igbudu Market	Main Market	Total	Frequency of Occurrence (%)
1	*Absida corymbifera*	57	59	49	165	2.69
2	*Alternaria alternate*	70	131	119	320	5.21
3	*Aspergillus flavus*	101	115	78	294	4.78
4	*Aspergillus fumigates*	30	46	41	117	1.90
5	*Aspergillus nidulans*	18	22	16	56	0.91
6	*Aspergillus niger*	179	296	224	699	11.37
7	*Aspergillus parasiticus*	25	33	31	90	1.46
8	*Aspergillus terrus*	6	8	10	24	0.39
9	*Botryodiplodia theobromae*	14	19	13	46	0.75
10	*Botrytis* sp.	0	11	17	28	0.46
11	*Candida albican*	11	22	18	51	0.93
12	*Cercospora* sp.	63	87	59	209	3.40
13	*Chaetomium* sp.	0	7	0	7	0.11
14	*Cladosporium* sp.	32	52	41	125	2.03
15	*Curvularia lunata*	61	86	80	227	3.69
16	*Curvularia pallescens*	73	103	75	251	4.08
17	*Cylindrosporium* sp	98	115	87	300	4.88
18	*Drechsllera* sp.	6	8	9	23	0.37
19	*Fusarium moniliforme*	35	50	33	118	2.05
20	*Fusarium oxysporium*	39	49	38	126	1.92
21	*Fusarium solani*	52	69	64	185	3.01
22	*Geotrichum candidum*	65	94	91	250	4.07
23	*Gloeosporium* sp	34	38	51	123	2.00
24	*Helminthosporium* sp.	20	26	39	85	1.38
25	*Monilina* sp.	86	130	108	324	5.27
26	*Mucor mucedo*	135	172	152	459	7.47
27	*Neurospora sitophilia*	0	14	20	34	0.55
28	*Penicillium candidum*	119	142	143	404	6.57
29	*Penicillium chrysogenum*	0	29	27	56	0.91
30	*Penicillium citrinum*	0	0	26	26	0.42
31	*Penicillium digitamum*	128	173	94	395	6.43
32	*Pestalotia* sp.	25	30	16	71	1.16
33	*Rhizopus nigricans*	20	26	32	78	3.24
34	*Rhizopus stolonifer*	55	81	63	199	1.27
35	*Trichoderma* sp.	45	69	66	180	2.93
	Total	1702	2412	2030	6145	100

Table 4. Total fungi (colony) isolated from sections of the markets.

S/N	Fungi Isolated	Sections		
		Clothing	Foodstuffs	Slaughter
1	*Absida corymbifera*	39	44	82
2	*Alternaria alternate*	66	106	148
3	*Aspergillus flavus*	59	102	133
4	*Aspergillus fumigates*	4	41	72
5	*Aspergillus nidulans*	0	13	43
6	*Aspergillus niger*	109	217	373
7	*Aspergillus parasiticus*	0	33	57
8	*Aspergillus terrus*	0	14	10
9	*Botryodiplodia theobromae*	1	24	21
10	*Botrytis* sp.	0	12	16
11	*Candida albican*	0	0	51
12	*Cercospora* sp.	46	74	89
13	*Chaetomium* sp.	0	2	5
14	*Cladosporium* sp.	8	45	72

15	*Curvularia lunata*	36	81	110
16	*Curvularia pallescens*	51	92	108
17	*Cylindrosporium* sp	64	100	136
18	*Drechsllera* sp.	0	23	0
19	*Fusarium moniliforme*	0	65	53
20	*Fusarium oxysporium*	0	48	78
21	*Fusarium solani*	0	99	86
22	*Geotrichum candidum*	31	86	133
23	*Gloeosporium* sp	14	51	58
24	*Helminthosporium* sp.	56	14	15
25	*Monilina* sp.	60	100	164
26	*Mucor mucedo*	98	154	207
27	*Neurospora sitophilia*	0	3	31
28	*Penicillium candidum*	91	105	208
29	*Penicillium chrysogenum*	0	56	0
30	*Penicillium citrinum*	0	8	18
31	*Penicillium digitamum*	71	129	195
32	*Pestalotia* sp.	0	27	44
33	*Rhizopus nigricans*	3	61	14
34	*Rhizopus stolonifer*	14	77	108
35	*Trichoderma* sp.	33	64	83
	Total	954	2170	3021

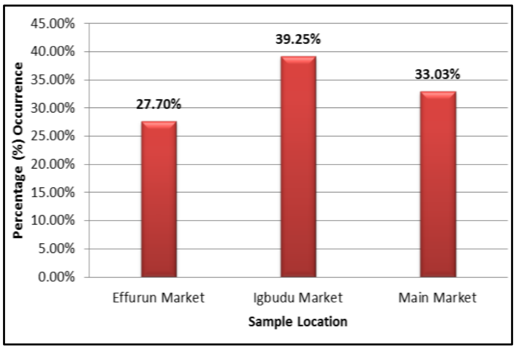

Fig. 3. Percentage occurrence of fungi at the various markets.

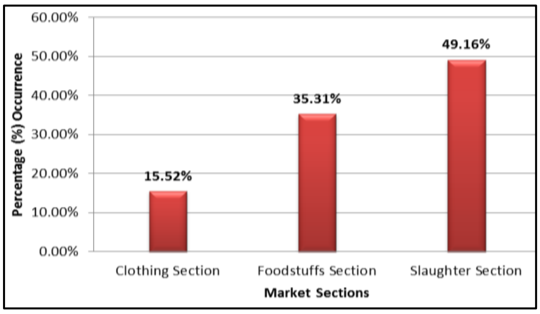

Fig. 4. Frequency of occurrence of spores in different sections of the market.

Table 5. Total number of spores obtained from various heights in the markets.

Month of Study	Human Height	Building Height
April	472(11.02%)	192(10.32%)
May	616(14.38%)	208(11.18%)
June	757(17.67%)	352(18.92%)
July	925(21.59%)	427(22.96%)
August	838(19.56%)	385(20.70%)
September	677(15.80%)	296(15.91%)
Total	4285(69.73%)	1860(30.27%)

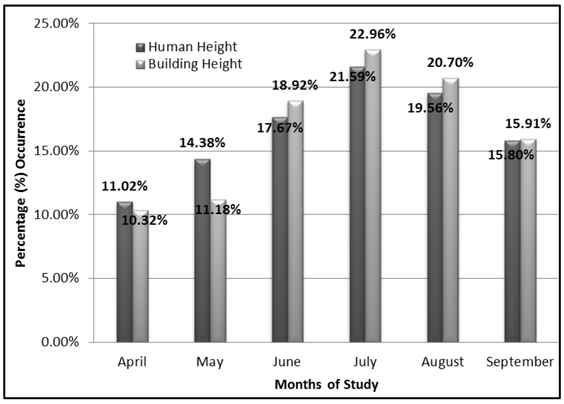

Fig. 5. Comparison of fungal spores in human and building height across the months of study.

Table 6. Total number of spores found in each group of fungi.

Group of Fungi	Total No. of Spore Types	No. of Spores	Frequency (%)
Ascomycotina	13	2382	38.76
Deuteromycotina	18	2862	46.58
Zygomycotina	4	901	14.66
Total	35	6145	100

Table 7. Meteorological data of Warri for the period of study.

Month	Relative Humidity (%)	Mean Temp (°C)	Rainfall (mm)
April	87.11	27.73667	13.54667
May	90.5129	26.55161	9.196774
June	93.3	25.4	9.252381
July	95.15161	23.96774	13.6871
August	92.32903	24.1	8.025806
September	93.99	24.77667	13.11667

Discussion

This study has shown that the three market environments in Warri metropolis were contaminated by abundant fungal spores. Major spore types include those of *Aspergillus niger, Mucor mucedo, Penicillium candidum, Monilia* sp., *Alternaria alternate, Aspergillus flavus, P. digitatum* and *Curvularia pallescens*. Most of these fungi have been documented by other researchers in markets (Hogale and Patil, 2008; Ahire and Sangale, 2012; Kakde and Kakde, 2012; Khan and Fatema, 2015) and other environment (Makut *et al.,* 2014; Prasad *et al.,* 2015; Ilondu and Nweke, 2016; Mahadeo and Kalpit, 2017; Bhajbhuje and Akare, 2018; Njokuocha and Aguru, 2007, Ghosh *et al.,* 2011). *Aspergillus* species were the most abundant in this study. Similar occurrence was recorded by Kakde and Kakde (2012), Khan and Fatema (2015); Ilondu and Nweke (2016), Ilondu (2017). Some of these fungi are known to cause allergic reactions in human, skin infections, food spoilage and diseases of plant in the field.

As the market environment get contaminated by these spores, health challenges like Asthma, Aspergillosis, Eczema, Mycoses, Sinusitis among others become eminent. Generally, *Alternaria, Aspergillus, Curvularia, Penicillium* and *Cladosporium* have the history of being allergenic in nature (Hogale and Patil, 2008; Khan and Fatema, 2015) and have been proven to be biodeteriogens (Reddy, 2018). *Mucor, Rhizopus* and *Absidia* cause mucormycosis in man and animals, a species of *Cercospora* has been a cause of face lesions in man. *Candida albican* being implicated for various types of candidiasis in man while *Geotrichum candidum* is known to cause Geotricosis (Sharma, 1989; Hernandez and Martinez, 2018). The involvement of *Curvilaria lunatus* in human pneumonia has been reported and as opined by Louis *et al.* (2017), by year 2047, may have been evolved to a phenotype that will make disease management difficult.

Botryodiplodia theobromae, Curvularia lunatus, Cercospora, Alternaria cause leafspot disease of many crops (Ilondu, 2013a; 2013b; Metrotra and Agawal, 2004; Shahzady *et al.,* 2017). Accumulation of some of these fungal spores on food has been reported by Okigbo *et al.* (2008), Ilondu (2017). Species of *Aspergillus, Alternaria* and *Fusarium* have been associated with toxin production in stored food (Atanda *et al.,* 2009; Adebayo-Tayo *et al.,* 2009; Djeri *et al.,* 2010; Fagbohun *et al.,* 2010) which may be carcinogenic when consumed. Among all identified spore types, Deuteromycotina was the most abundant group. This is in conformity with the reports of Kakde and Kakde (2012), Ahire and Sangale (2012), Mahadeo and Kalpit (2017). Moreso, Ascomycotina and Deuteromycotina have been shown to contain allergic microfungi (Bhajbhuje and Akare, 2018).

This investigation also revealed that population of fungal colonies varies from month to month, the highest being recorded in the month of July. High humidity and rainfall with low temperature recorded in this month may have favoured the growth, sporulation and spore discharge into the market atmosphere. Availability of natural sources like dead and decaying market waste may have contributed to inoculum upsurge. The lowest concentration of spores observed in the month of April may be as a result of high temperature that does not favour the growth of fungi in the atmosphere. Similar results with regards to variation in the meteorological data were documented by Ahire and Sangole (2012), Grinn-Gofron and Basiacka (2015). Since fungi may react simultaneously to a combination of factors, it may not be easy to separate the influence of individual meteorological factors on the occurrence of these spores (Grinn-Gofron and Basiacka, 2015).

The highest number of fungal colonies was recorded in Igbudu market compared to others. It could be due to overcrowding, poor sanitation and other human activities as suggested by Ayanbimpe *et al.* (2010) that population density affect the quality of environment. More so, lack of basic facilities for waste disposal may favour fungal proliferation. Fungal colonies recorded in building height were less in number compared to human height. Khattab and Estelle (2008) indicated that spore types decreased logarithmically with increase in height from the ground, while more airborne spores at human height may be due to proximity to natural sources at ground level and favourable meteorological conditions which aid release and dispersal of the spores. Meanwhile, market wastes have been indicated as one key source of fungal spores (Khan and Fatema, 2015).

The slaughter section of the markets harboured highest number of fungal colonies, in comparison with foodstuff and clothing sections. It is possible that vigorous activities including dressing of carcass may have led to spread of mycoflora contaminants into the air (Syed and Sarangi, 2013). Nevertheless, the higher colony count in the foodstuff section must have been contributed by decaying and rottening of vegetables and other food items in that section (Khan and Fatema, 2015; Meraj-ul-Haque and Patil, 2016). Similarly, least number of fungal spores recorded in the clothing sections could be as a result of frequent cleaning and some level of hygienic practices observed there (Khan and Fatema, 2015). Therefore the effect of these fungi on human health and food security cannot be over emphasized.

Conclusion and recommendation

This study reveals numerous fungal spores encountered in some markets in Warri metropolis. Market environment may serve as reservoir of human and plant pathogens due to wastes and debris dumped there that support the growth and proliferation of fungal spores. When these spores are inhaled by people may lead to different types of respiratory diseases. Infections of spores can also increase chances of mycotoxin contamination of food and other agricultural commodities sold in the market.

Therefore, this study can find significant application in human health because monitoring airborne spores can be helpful in preventing fungal allergic diseases. Wearing nose mask may help to reduce allergenic spore inhalation. It will also be useful for the control of postharvest disease of food items in the markets. Effective solid waste disposal, frequent cleaning and extreme hygienic conditions should be enforced to reduce the fungal spore load in the air thereby improving air quality of the market environment as cleanliness is next to Godliness.

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