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Analysis of indoor and outdoor aeromycoflora in two broiler farms of Barpeta, Assam, India

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Abstract

The present study was conducted from January, 2022 to June, 2022 to analyze the aeromycoflora in indoor and outdoor environment in broiler farms of Howly and Mandia, Barpeta district of Assam, India. The gravity petriplate exposure method was used for trapping of indoor and outdoor mycoflora using PDA (Potato Dextrose Agar) media. During the study period a total of 1239 and 1169 fungal colonies were isolated from the indoor and outdoor environment of Howly broiler farm respectively and a total of 941 and 887 fungal colonies were isolated from indoor and outdoor environment of Mandia broiler farm respectively. A total of 17 fungal species belonging to 9 genera and 16 fungal species belonging to 9 genera were isolated from indoor and outdoor environment of Howly broiler farm respectively while a total of 15 fungal species belonging to 9 genera and 16 fungal species belonging to 9 genera were isolated from indoor and outdoor environment of Mandia broiler farm respectively. The number and types of fungal species varied with season and farms. *Aspergillus fumigatus* was the most dominating fungal species isolated from the indoor and outdoor environment of both the farms and the least dominating fungal species isolated were *Nigrospora* sp. and *Verticillium* sp. The maximum number of fungal colonies was recorded in the month of June and the minimum was in January 2022. Meteorological factors *viz.* Temperature, relative humidity etc. play a vital role in the composition and concentrations of aeromycoflora. The isolated fungal species may produce mycotoxins which can cause occupation-related illnesses to the farm workers and the broiler chicken.

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Introduction

Air acts as a good dispersal medium for microbes and its quality is a reflection of the environment. Air represents the main reservoir of some airborne fungal pathogens such as *Aspergillus, Cladosporium, Penicillium, Rhizopus, Mucor, Fusarium, Nigrospora, Trichoderma, Curvularia and Verticillium* have been reported to be present in air. Air consists of a mixture of permanent gases and water in different proportions, solid particles, pollen-grains and fungal spores (Reddy *et al*., 2017). Aeromycoflora of the Indoor and outdoor environments is considered to be important in the fields like plant pathology, environment bio-deterioration, allergic diseases *etc*. Indoor air of poultry houses can be important source of fungi and involve high risk of occupational exposure (Reddy *et al*., 2017).

Fungal diseases of poultry include Aspergillosis, Candidiasis, Mucormycoses, Mycotoxicoses, Histoplasmosis and Cryptococcosts. Aspergillosis and Mycotoxicosis are the most important diseases in the poultry production. Fungal diseases in poultry farms usually arises periodically, either from direct infection or production of mycotoxins. Composition and concentration of air borne mycoflora depend on several factors including topography, time of day, meteorological conditions, types of vegetation, air pollution, agricultural, industrial and other human activities. Poultry farms are among the polluted areas with large quantities of different microbial components (bio-aerosols) such as bacterial and fungal cells, their spores and fragments of mycelium as well as their toxins (Karwowska, 2005; Adeoyo and Omolola, 2022). Microbial contaminants in poultry farms are assisted by contaminated feed, litter, inadequate ventilation, poultry droppings and improper personal hygiene of workers. Some poultry birds are constantly exposed to pathogenic bioaerosols when there is an infected bird in the poultry house (Radon *et al.,* 2002). Organic dust is composed by viable particulate matter (also called bioaerosols). Bioaerosols are comprised of airborne bacteria, fungi, viruses and their by-products, endotoxin and mycotoxin (Oppliger *et al*., 2008 and Just *et al*., 2009) and also by non-viable particles, generated by such things as faeces, litter, feed, feather formation. It has been reported by Sharma *et al.* (2010) that the airborne fungi are considered to be an indicator of the level of atmospheric bio-pollution and they have found that the most of the fungi are the representatives of the three major group *ie*. Zygomycotina, Anamorphic fungi and Mycelia sterilia.

Microbial survival is mainly determined by temperature and humidity of the environment. Microbial contaminant of air, litter and surfaces in poultry farms can be attributed to high flocks' number and presence of microbial sources (Witkowska and Sowińska, 2017). The presence of microorganisms such as *Alternaria* and *Cladosporium* in poultry houses indicates the microbes from environment, including soil, can spread to farm to farm buildings (Adeoyo and Omolola, 2022).

Aspergillosis is caused mainly by *Aspergillus fumigatus*, the most pathogenic fungi affecting poultry, causes high morbidity and mortality especially by young chicks. Several fungal genera have been shown to cause allergy, such as *Aspergillus, Alternaria* and *Cladosporium* and can cause allergic respiratory disease, especially asthma. Viegas *et al.* (2012) have reported that regarding the fungal load in the air, indoor concentration of mold was higher than outside air in six poultry units. Lonc and Plewa (2010) worked on the issue of seasonal microbiological pollution inside and outside two poultry houses located in different environment areas in Lower Silesia, Poland and they reported that modern poultry production is usually polluted with large quantities of different microbial components, mainly aggregation of fungal cells and their spores. Adeoyo and Omolola (2022) have studied on the evaluation of indoor and outdoor fungal flora of two poultry farms in Akungba-Akoko and they have isolated a total of 23 fungal species belonging to 14 genera such as *Aspergillus, Penicillium, Eurotium,*

Monascus, Alternaria, Cryptococcus, Curvularia, Chrysonilia, Microsporum, Cunninghamella, Bipolaris, Acremonium, Fusarium and *Trichoderma*. Seifi *et al.* (2018) studied on the isolation and characterization of mycoflora of chicken hatcheries in Mazandaran province, north of Iran and they have isolated some of the predominant fungi from setter and hatchery of incubators belonged to genus Cladosporium, *Penicillum*, *Aspegillus* sp., *Aspergillus flavus, Aspergillus fumigatus* and *Alternaria*.

Since there is no available information regarding the indoor and outdoor aeromycoflora in broiler farms of Barpeta district of Assam, hence the present study was undertaken to analyse the air borne fungal species in indoor and outdoor environment in two broiler farms located in Howly and Mandia, Barpeta, Assam, India.

Materials and methods

Sampling sites

In the present study two broiler farms were selected in Howly and in Mandia, Barpeta district of Assam, India. Air sampling was done for six months from January, 2022 to June, 2022. The microbiological work was done in the microbiology laboratory, Post Graduate Department of Botany, Madhab Choudhury College, Barpeta, Assam.

Air sample collection

Air samples for culturable fungi were collected by uncovering culture petriplates separately in indoor and outdoor environment of the two broiler farms. The gravity petriplate exposure method was used for trapping of fungal species using PDA (Potato Dextrose Agar) media supplemented with chloramphenicol at the rate of 5mg/100 ml media to inhibit bacterial growth. Three petriplates containing Potato Dextrose Agar medium were exposed for 10 minutes at a height of 1.5 meter over the ground level at 15 days interval. The sampling was done while the broiler farms were the most active during the morning hours between 10.00 a.m. to 2.00 p.m. After the exposing time the petriplates were brought to the laboratory in pre-disinfected polythene bags and incubated at 27±1°C for 5–7 days. The fungal colonies were observed after incubation and counted as well as fungus isolated sub-cultured on PDA slants and identified subsequently. Microscopic slides were prepared on lactophenol cotton blue from individual colonies and on the basis of colony characters, morphological and reproductive structures, some of the fungi were identified up to generic level and some were identified up to species level and were confirmed as per the keys of the manuals of Gilman (1957); Barnett and Hunter (1972) and Funder (1968).

Statistical analysis

The Shannon Wiener diversity index (H´) was used to determine the fungal diversity in the two farms (An *et.al.*, 1993; Kasi *et.al.*, 2021). The Wiener diversity index (H´) was computed according to the formula:

$$H' = \sum \left(\frac{X_i}{X_o}\right) \ln \left(\frac{X_i}{X_o}\right)$$

Single factor ANOVA was done to determine variation of aeromycoflora between the air of various environments (Ali and Bhattacharjya, 2022). Aeromycoflora species were taken as independent variable and total number of spores as dependent variable at P=0.05.

Results and discussion

In the present study (Table 2 & 3) a total of 17 fungal species belonging to 9 genera and 16 fungal species belonging to 9 genera were isolated from indoor and outdoor environment of Howly broiler farm respectively. The results also revealed that a total of 1239 and 1169 fungal colonies were isolated from the indoor and outdoor environment of Howly broiler farm respectively throughout the investigating period.

Similarly, the results (Table 4 & 5) showed that a total of 15 fungal species belonging to 9 genera and 16 fungal species belonging to 9 genera were isolated from indoor and outdoor environment of Mandia broiler farm respectively. From this broiler farm, a total of 941 and 887 fungal colonies were isolated from indoor and outdoor environment of Mandia broiler farm respectively.

Table 1. Meteorological data from January to June, 2022.

Months	Temperature (oc)		Relative Humidity (%)		Air Pressure(mbar)	
	Min	Max	Min	Max	Min	Max
January	9	27	43	100	1009	1022
February	10	28	31	98	1006	1021
March	15	36	21	98	1002	1018
April	20	35	49	100	999	1016
May	22	35	50	100	997	1011
June	23	34	61	100	999	1007

Source: https://www.timeanddate.com.

The most dominating fungal species isolated from the indoor aeromycoflora of Howly broiler farm were *Aspergillus fumigatus* (16.38%) followed by *Aspergillus flavus* (10.73%) and *Trichoderma viride* (8.56%), while the lowest was recorded by *Aspergillus* sp. (1.94%) and *Aspergillus clavatus* (1.94%). *Aspergillus fumigatus* (15.30%) was recorded as the most dominating fungal types isolated from the indoor environment of Mandia broiler farm which was followed by *Aspergillus flavus* (9.46%) and *Trichoderma viride* (9.03%), while *Aspergillus* sp. (2.34%) showed the lowest fungal types isolated.

Table 2. Monthly composition of aeromycoflora and Shanon Wiener diversity index in indoor environment of a broiler farm in Howly, Barpeta, Assam from January, 2022 to June, 2022 (average of 3 replica plates).

Fungal types isolated	January	February	March	April	May	June	Total	Individual % contribution	% Frequency
Alternaria sp.	2	6	8	8	10	15	49	3.95	100
Aspergillus sp.	3	--	2	6	5	8	24	1.94	83.33
Aspergillus clavatus	--	7	8	---	2	7	24	1.94	66.67
Aspergillus flavus	10	20	40	36	15	12	133	10.73	100
Aspergillus fumigatus	12	22	43	50	40	36	203	16.38	100
Aspergillus niger	7	10	10	18	23	28	96	7.75	100
Cladosporium sp.	3	5	9	12	26	30	85	6.86	100
Cladosporium cladosporoides	---	3	6	10	12	16	47	3.79	83.33
Fusarium sp.	3	5	7	10	13	12	50	4.04	100
Fusarium oxysporum	3	5	8	15	21	23	75	6.05	100
Mucor hiemalis	4	7	10	15	20	22	78	6.30	100
Nigrospora sp.	----	----	5	6	8	12	31	2.50	66.67
Penicillium sp.	3	8	10	12	18	20	71	5.73	100
Penicillium citrinum	2	---	---	---	12	18	32	2.58	50
Penicillium rubrum	---	2	5	4	15	20	46	3.71	83.33
Rhizopus stolonifer	3	7	10	16	16	20	72	5.81	100
Trichoderma viride	6	13	16	20	24	27	106	8.56	100
Unidentified sp.	5	--	3	--	5	4	17	1.37	66.67
Total no. of fungal colonies	66	120	200	238	285	330	1239		
% occurrence of fungal spores	5.33	9.69	16.14	19.21	23	26.63			

Shanon Wiener Diversity Index (H)= 2.703.

In case of outdoor aeromycoflora of Howly farm, *Aspergillus fumigatus* (17.88%) showed the most dominating fungal species followed by *Cladosporium sp.*(10.00%) and *Trichoderma viride* (9.15%) whereas in Mandia farm *Aspergillus fumigatus* (15.90%) was the most dominating fungal species isolated followed by *Trichoderma viride* (9.24%) and *Aspergillus niger* (8.91%).

Some of the least occurring fungal types isolated from both the two broiler farms throughout the study period were *Aspergillus sp., Aspergillus clavatus, Nigrospora sp., Verticillium* sp. and *Aspergillus occraceous*. Our findings are similar with the findings of Sharma *et al.* (2010) and with various work done by other workers. Singh *et al.* (2000), Sharma and Dutta (2001), Devi *et al.* (2002) isolated important fungal types *Aspergillus, Cladosporium, Alternaria,* and *Penicillium* from different poultry farms. Sharma *et al.* (2010) recorded a total of 388 fungal colonies belonging to 19 species and the major types of fungal flora were *Cladosporium sphaerospermum, Aspergillus niger, Alternaria alternata, Aspergillus flavus, Aspergillus nidulans* to the total air spore.

Table 3. Monthly composition of aeromycoflora and Shanon Wiener diversity index in outdoor environment of a broiler farm in Howly, Barpeta, Assam from January, 2022 to June, 2022 (average of 3 replica plates).

Fungal types isolated	January	February	March	April	May	June	Total	Individual % contribution	% Frequency
Aspergillus sp.	2	4	10	13	17	20	66	5.65	100
Aspergillus clavatus	---	---	4	4	3	8	19	1.63	66.67
Aspergillus flavus	2	6	12	14	16	22	72	6.16	100
Aspergillus fumigatus	10	22	35	40	50	52	209	17.88	100
Aspergillus niger	8	15	15	18	20	25	101	8.64	100
Aspergillus occraceous	---	4	6	8	---	8	26	2.22	66.67
Cladosporium sp.	5	15	18	22	27	30	117	10.00	100
Curvularia lunata	6	10	8	18	20	26	88	7.53	100
Fusarium sp.	8	12	10	16	23	27	96	8.21	100
Fusarium oxysporum	4	6	4	8	10	10	42	3.59	100
Nigrospora sp.	---	---	2	3	3	4	12	1.03	66.67
Penicillium sp.	4	10	14	18	24	27	97	8.30	100
Penicillium citrinum	2	3	---	6	6	8	25	2.14	83.33
Rhizopus stolonifer	4	6	6	12	16	20	64	5.47	100
Trichoderma viride	4	14	19	22	23	25	107	9.15	100
Verticillium sp.	---	---	2	4	4	8	18	1.54	66.67
Unidentified sp.	---	---	2	2	3	3	10	0.85	66.67
Total no. of fungal colonies	59	127	167	228	265	323	1169		
% occurrence of fungal spores	5.05	10.86	14.29	19.5	22.67	27.63			

Shanon Wiener Diversity Index (H)= 2.573.

Species diversity

Fungal species diversity was analyzed (Table 2, 3, 4 & 5) and it was found that there was not much difference in the calculated value of H´ in the four study environments. The value of H´ in the indoor environment of broiler farm in Howly was 2.703 and that of its outdoor environment was 2.573.

In Mandia it was 2.632 in the outdoor environment and 2.627 in the indoor environment.

Table 4. Monthly composition of aeromycoflora and Shanon Wiener diversity index in indoor environment of a broiler farm Mandia, Barpeta, Assam from January, 2022 to June, 2022 (average of 3 replica plates).

Fungal types isolated	January	February	March	April	May	June	Total	Individual % contribution	% Frequency
Aspergillus sp.	---	2	2	3	5	10	22	2.34	83.33
Aspergillus clavatus	---	3	5	6	6	7	27	2.87	83.33
Aspergillus flavus	4	10	24	27	12	12	89	9.46	100
Aspergillus fumigatus	8	18	32	38	26	22	144	15.3	100
Aspergillus niger	4	6	7	12	16	23	68	7.23	100
Cladosporium sp.	3	4	6	9	18	23	63	6.70	100
Cladosporium cladosporoides	---	4	6	8	10	14	42	4.46	83.33
Fusarium sp.	3	2	4	8	10	12	39	4.14	100
Fusarium oxysporum	5	5	10	12	18	20	70	7.44	100
Mucor hiemalis	6	10	10	12	15	20	73	7.76	100
Nigrospora sp.	----	4	7	6	5	10	32	3.40	83.33
Penicillium sp.	3	8	10	12	18	25	76	8.08	100
Penicillium citrinum	---	3	---	8	10	16	37	3.93	66.67
Rhizopus stolonifer	5	5	8	10	16	20	64	6.80	100
Trichoderma viride	8	6	10	15	20	26	85	9.03	100
Unidentified sp.	2	--	2	3	----	3	10	1.06	66.67
Total no. of fungal colonies	51	90	143	189	205	263	941		
% occurrence of fungal spores	5.42	9.56	15.2	20.1	21.79	27.95			

Shanon Wiener Diversity Index (H´)= 2.627.

Variation of microflora among the various environments

The analysis of variance of data obtained from the different environments showed that the aeromycoflora of the four environments do not have any significant different in their species composition and abundance. Taking null hypothesis that there is no significant difference between the means of the different groups (at P=0.05), the results obtained are given in tables. Between the indoor environments of the two study farms P= 0.302 (Table 6); between the outdoor environments of the two farms, P= 0.351 (Table 7); between the indoor and outdoor environments of Howly, P= 0.834 (Table 8); and between the indoor and outdoor environments of Mandia, P= 0.825 (Table 9).

Table 5. Monthly composition of aeromycoflora and Shanon Wiener diversity index in outdoor environment of a broiler farm in Mandia, Barpeta, Assam from January, 2022 to June, 2022 (average of 3 replica plates).

Fungal types isolated	January	February	March	April	May	June	Total	Individual % contribution	% Frequency
Aspergillus sp.	---	4	8	13	12	18	55	6.20	83.33
Aspergillus clavatus	2	---	---	6	8	8	24	2.71	66.67
Aspergillus flavus	3	6	10	14	15	20	68	7.67	100
Aspergillus fumigatus	4	12	25	30	32	38	141	15.9	100
Aspergillus niger	5	8	12	16	18	20	79	8.91	100
Aspergillus occraceous	---	---	3	3	5	5	16	1.80	66.67
Cladosporium sp.	6	9	12	15	12	20	74	8.34	100
Curvularia lunata	3	8	8	12	12	18	61	6.88	100
Fusarium sp.	3	6	10	16	16	20	71	8.00	100
Fusarium oxysporum	----	3	5	5	10	15	38	4.28	83.33
Nigrospora sp.	1	---	4	3	6	5	19	2.14	83.33
Penicillium sp.	4	7	8	10	10	12	51	5.75	100
Penicillium citrinum	---	5	---	5	6	10	26	2.93	66.67
Rhizopus stolonifer	4	4	7	13	14	20	62	6.99	100
Trichoderma viride	7	10	10	15	16	24	82	9.24	100
Verticillium sp.	1	2	2	---	4	3	12	1.35	83.33
Unidentified sp.	1	---	3	---	2	2	8	0.9	66.67
Total no. of fungal colonies	44	84	127	176	198	258	887		
% occurrence of fungal spores	4.96	9.47	14.32	19.84	22.32	29.09			

Shanon Wiener Diversity Index (H)= 2.632.

It was observed from the results (Table 2 and 3) that the number and types of indoor mycoflora found greater (1239 fungal colonies) in Howly broiler farm than Mandia farm (941 fungal colonies). Similarly, the results (Table 4 and 5) indicated that the outdoor mycoflora were also found greater (1169 fungal colonies) in Howly farm than Mandia farm 887 (fungal colonies). The presence of high fungal load in Howly farm than the Mandia farm may be due to the overall management of Howly farms was relatively poor. In term of hygiene practices, the farm was not equipped with a proper ventilation, disinfection system to maintain hygiene and to prevent diseases at the farm.

Table 6. ANOVA results of mycoflora variation between the indoor environments of Howly and Mandia.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2114.381	1	2114.381	1.091	0.302	4.084746
Within Groups	77461.24	40	1936.531			
Total	79575.62	41				

The present findings are similar with the findings of Viegas *et al.* (2012) and Adeoyo and Omolola (2022). Viegas *et al.* (2012) reported that indoor concentration of moulds was higher than outside air in six poultry units. Concerning fungal load in indoor air from the seven poultry farms, the highest mean value obtained was 14350 cfu/m3 and the lowest was 706.6 cfu/m3. They identified twenty eight species/genera of indoor fungi and eighteen species/genera of outdoor fungi.

Table 7. ANOVA results of mycoflora variation between the outdoor environments of Howly and Mandia.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1893.429	1	1893.429	0.889	0.351	4.084746
Within Groups	85178.48	40	2129.462			
Total	87071.9	41				

In our study, a heterogeneous groups of mycoflora such as *Aspergillus* sp., *Aspergillus clavatus*, *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Aspergillus occraceous, Cladosporium* sp.,*Cladosporium cladosporoides, Fusarium* sp., *Fusarium oxysporum, Mucor hiemalis, Nigrospora* sp., *Penicillium sp., Penicillium citrinum, Penicillium rubrum, Rhizopus stolonifer, Trichoderma viride* and *Verticillium* sp. were isolated from both the farms in different environments. Some of these micro fungi may produce mycotoxins which can cause occupation-related illnesses to the workers and the broiler chicken. It is known that Aspergillosis is caused mainly by *Aspergillus fumigatus*, the most pathogenic fungi affecting poultry, causes high morbidity and mortality especially in young chicks.

Several fungal genera have been shown to cause allergy, such as *Aspergillus, Alternaria* and *Cladosporium* and can cause allergic respiratory disease, especially asthma.

Table 8. ANOVA results of mycoflora variation between the indoor and outdoor environments of Howly.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	116.6667	1	116.6667	0.044	0.834	4.084746
Within Groups	106004.7	40	2650.117			
Total	106121.3	41				

Table 9. ANOVA results of mycoflora variation between the indoor and outdoor environments of Mandia.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	69.42857	1	69.42857	0.049	0.825	4.084746
Within Groups	56635.05	40	1415.876			
Total	56704.48	41				

Our results are in agreement with the findings of Jo and Kang (2005), Ajoudanifar *et al.* (2011) and Adeoyo and Omolola (2022). Jo and Kang (2005) and Ajoudanifar *et al.* (2011) reported that *Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium* are the most prevalent fungal genera isolated from poultry houses. Poultry houses with high temperature, humidity and organic material levels favour fungal growth and release of spores. Adeoyo and Omolola (2022) have studied on the evaluation of indoor and outdoor fungal flora of two poultry farms in Akungba-Akoko and they have isolated a total of 23 fungal

species belonging to 14 genera such as *Aspergillus, Penicillium, Eurotium, Monascus, Alternaria, Cryptococcus, Curvularia, Chrysonilia, Microsporum, Cunninghamella, Bipolaris, Acremonium, Fusarium* and *Trichoderma*.

They have reported that indoor fungal load was higher than the outdoor fungal load in the two poultry farms used for the study. Adeoyo and Omolola (2022) also reported that the variation of abundance of mycoflora in the two farms could be linked to lack of ventilation, high level of waste from the bird in the poultry which can cause diseases due to toxigenic potential of species like *Aspergillus fumigatus* and *Aspergillus flavus* that were found, thereby posing risk to the bird, human or the environment. Plewa *et al.*(2010) worked on the issue of seasonal microbiological pollution inside and outside two poultry houses located in different environment areas in Lower Silesia, Poland and they reported that modern poultry production is usually polluted with large quantities of different microbial components, mainly aggregation of fungal cells and their spores which are suspended as the indoor and outdoor bioaerosols that may be generated either as liquid droplets or as dry particles and transit in air individually or as clusters. It is known that long-term or repeated exposure to high concentrations of air borne microorganisms can cause respiratory damage, allergenic and immunotoxic effects. Bioaerosols initially generated indoors may disperse outdoors. Exposure to fungal spores is causally associated with development of hypersensitivity pneumonitis, organic dust toxic syndrome, and decline in lung function, severity of asthma, respiratory symptoms, and airway inflammation. Some of the most prevailing fungal species identified as *Penicillium* and *Aspergillus* sp. have been described to cause hypersensitivity reactions in humans, with clinical manifestations such as allergic rhinitis, asthma and extrinsic alveolitis. Indoor particle concentrations involves complex combinations of numerous factors, such as emissions sources, ambient conditions, building structure and materials, work activities, ventilation and air exchange rate, which also affect particle size distributions.

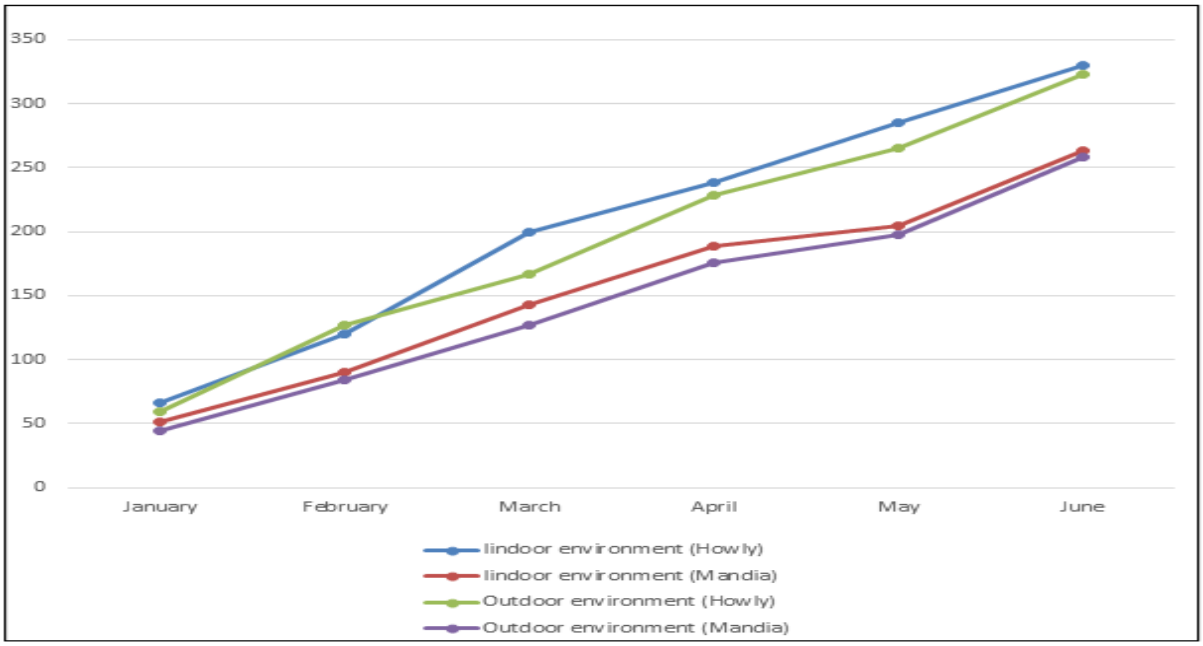

Fig. 1. Line diagram showing monthly variation of total no. of fungal colonies in the four different environments.

The results (Table 2, 3, 4 and 5; Fig. 1) reveal that the maximum number of fungal species was isolated during the month of June 2022, whereas minimum fungal species were recorded in January, 2022. *Aspergillus fumigatus* was recorded as the highest incidence and consistently occurring fungal species isolated from both the indoor and outdoor environment of the two farms for 6 months period

during study periods. Similar finding was also reported by Reddy *et al*., (2017) who isolated most of the fungal species during summer season.

It was observed that there is a gradual monthly increase in the total number of fungal colonies with the increase of temperature and relative humidity. The growth of the indoor and outdoor fungal population is influenced by season and meteorological factors such as temperature, relative humidity and pressure which play a vital part in the composition and concentrations of aeromycoflora (Table 1). Our observation was in accordance with the observation made by Jones and Harrison (2004) and Ali and Bhattacharjya (2022). It was reported that meteorological factors effect atmospheric bioaerosol concentrations. These factors affect the initial release of biological materials and their dispersal once air-borne, temperature and water availability affect the size of the source and control the release of some actively released fungal spores (Jones and Harrison, 2004). Ali and Bhattacharjya (2022) worked on the diversity of aeromycoflora in fruit and vegetable markets and they also reported that the growth of aeromycoflora is influenced by season and meteorological factors, which play a vital part in the composition and concentrations of fungal species.

Conclusion

The present study revealed that both the broiler farms are reservoirs of heterogeneous groups of fungal species. The study also showed that indoor environment was more contaminated than outdoors, which may be the result of emission of potentially pathogenic fungi and particles via aerosols from poultry units to the outdoor environment. This may post a considerable risk to public health and environmental pollution. The farm management system should be improved; and in case of hygiene practices, proper disinfection system should be strengthening to maintain personal hygiene and to prevent diseases. Feeds for the broiler should always be kept in dry conditions to prevent fungal growth. Regular management of excrement should be done in the farms. Urine and feces should be clean regularly to stop fungal growth. Waste litter materials should be removed regularly and disposed by burning. The garbage inside broiler farm must be clean in a timely manner, proper humidity should be maintained, ventilation should be adequate, disinfectants that are effective against both bacteria and fungi should be applied regularly. Such practices will provide a friendlier environment for broiler growth.

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Declaration of interest

The authors of this paper had no personal or financial conflicts of interest.

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