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Aeromycoflora of Animal Rearing Houses of Bangalore, India

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The present study was carried out to investigate the indoor and outdoor airborne fungi in the animal rearing houses *viz.,* rabbit house, cow shed, poultry farm and swine house in Hessaraghatta village, Bangalore city was carried out by Andersen two stage sampler using an Malt Extract Agar (MEA) media were collected fortnightly from January 2011 to December 2011. In our study, fungal spores are ubiquitous and quite dominant in the indoors as against the outdoor environments, a total of 97335.13 CFU/m^3 was observed from indoor compared to outdoor 25492.11 CFU/m^3 airborne fungi recorded. The most common fungal spores in indoor environment were *Cladosporium herbarum*, *Cladosporium* sp., *C. macrocarpum*, *C. cladosporioides, Fusarium* sp., *Aspergillus* sp., *Aspergillus niger* and *Penicillium* species, Whereas in outdoor *Alternaria* sp., *Alternaria alternata, Aspergillus* sp., *Cladosporium herbarum*, *Cladosporium* sp., *C. macrocarpum*, *C. cladosporioides* and *Fusarium* species were observed. The present study helped in preparation of fungal calendars for the region, which may useful for physician to identify the cause of fungal spores related problem affecting human health of animal rearing house workers.

Keywords: Andersen; fungi; meteorological; seasonal.

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1. INTRODUCTION

Aerobiology is a scientific discipline focusing on the study of the passive transport of organisms but also with their products including viruses, cells and fungal spores or bacteria, pollen grains and impact of all these on organisms include infection, allergy, toxicosis in man, animals, infection of plants [1]. Air quality has been a concern for more than 100 years and started around 1850 during the hygienic revolution, followed by outdoor environmental issues [2]. Airborne microbial quantity and quality vary with time of day, year and location [3]. Indoor air quality is absolutely associated with ventilation, temperature, organic matter in building material and load of bioaerosols that entered from outdoor. The outdoor air quality is related to natural or anthropogenic air pollution, climatic factors, precipitation and atmospheric stability [4,5]. Since the air breathed in most often comes from the enclosed buildings, good indoor air quality is very essential and critical to human health. The present investigation on aeromycological studies of indoor and outdoor environments in different animal rearing houses were taken up with the following objectives which would help in understanding the pattern of exposure to airborne fungi on the workers health.

2. MATERIALS AND METHODS

2.1 Sampling Site

The fungal sampling was carried out in animal rearing houses viz., rabbit house, cow shed, poultry farm and swine house at Hessaraghatta village situated 10 km away from northwest of Bangalore in the State of Karnataka, India.

2.2 Sampling Procedure

Air sampling was done from January 2011 to December 2011 for a period of one year fortnightly in duplicates indoor and outdoor airborne fungal samples were collected. Using Andersen two stage viable air sampler. Sampler was placed in the center of the animal house, 1.5 meter above the ground level and sampling time was limited to 5 minutes. Malt Extract Agar (MEA) (HiMedia, India) was used as sampling media and Potato Dextrose Agar (PDA) (HiMedia, India) was used as maintenance of pure cultures.

2.3 Treatment of Samples

The air sampled plates were incubated for five to seven days at room temperature between 25ºC to 30ºC and colony morphological characteristics were observed microscopically by using manuals and references slides [6].

2.4 Calculations

The results for each stage of the sampler were expressed as Colony Forming Units per cubic meter of air (CFU/m^3) and total concentration was obtained by adding the CFU/m^3 from each plate, as per the Andersen formula.

3. RESULTS

Four animal rearing sites selected were rabbit house, cow shed, poultry farm and swine house at Hessaraghatta village, Bangalore city was selected as the site for sampling indoor and outdoor air fungal samples. Sampling was carried out fortnightly for a period of 12 months in duplication from January 2011 to December 2011.

3.1 Rabbit House

The investigation of total fungal spores from indoor 9682.79 CFU/m^3 and 9220.36 CFU/m^3 outdoor were recorded of the rabbit house. Altogether 31 species belonging to 14 genera along with unidentified fungi were isolated from indoor environment of the rabbit house, when compared to 27 species belonging to 13 genera along with unidentified from outdoor (control) environment of the rabbit house (Fig. 1). The monthly variation of total fungal spores in the indoor environment of rabbit house showed maximum spore distribution in January (1606.15 CFU/m^3) followed by December (1104.89 CFU/m^3), June (1073.12 CFU/m^3) and March (1051.94 CFU/m^3) when compared to other months of the year, whereas the monthly incidence of fungal spores of outdoor environment of rabbit house showed highest distribution during the month of August (871.91 CFU/m^3) followed by March (868.38 CFU/m^3), April (843.67 CFU/m^3) and February (808.37 CFU/m^3) compared to other months of the year. Stastical analysis by Two Way ANOVA for CFU's between various months showed no significant difference in fungal CFU's between indoor and outdoor rabbit house over the months and p-value is 0.36 (Table 1).

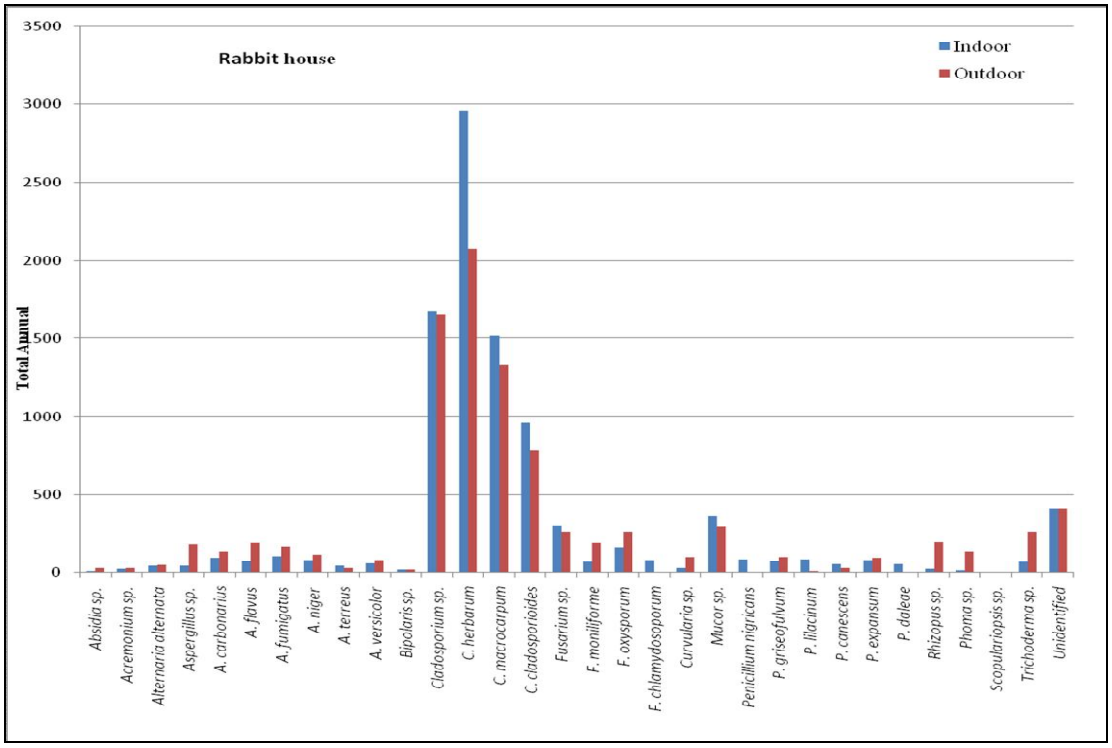

Fig. 1. Annual occurrence of fungal spores (CFU/m^3) recorded from January 2011 to December 2011 in indoor and outdoor air of the rabbit house

Table 1. Two-way ANOVA for colony and month of the rabbit house

	Two-way ANOVA				
	Sum of Squares	**Degrees**	**Mean**	**F-ratio**	**p-value**
Colony	0.89	1	0.89	0.14	0.72
Month	88.52	11	8.05	1.24	0.36
Error	71.42	11	6.49		
Total	160.84	23			

3.2 Cow Shed

The total of 7808.36 CFU/m^3 in indoor and 7610.68 CFU/m^3 in outdoor were isolated, altogether 29 species belonging to 13 genera with other unidentified fungi were recorded from indoor environment of the cow shed, when compared to 26 species belonging to 12 genera with other unidentified fungi were isolated from outdoor environment of the cow shed (Fig. 2). Monthly variation of total fungal spores in the indoor environment of the cow shed showed maximum spore distribution in May (780.13 CFU/m^3) followed by February (773.07 CFU/m^3) and January (755.42 CFU/m^3) compared to other months of the year, whereas the monthly incidence of fungal spores of outdoor (control) environment of the cow shed showed highest distribution during March (790.72 CFU/m^3) followed by June (783.66 CFU/m^3) and January (716.59 CFU/m3) when compared to other months of the year. The One Way ANOVA for CFU's of the cow shed between variation and within variation was not statistically significant in CFU's for both groups when subjected to same conditions for the entire year (Table 2).

3.3 Poultry Farm

In poultry farm, a total number of 80662.52 CFU/m^3 in indoor and the outdoor environment contributed 8849.71 CFU/m^3. Among the qualitative analysis showed altogether 22 fungal species belonging to 12 genera with other unidentified fungal form were isolated from indoor environment of poultry farm, when

compared to 18 fungal species belonging to 11 genera with other unidentified from outdoor environment of poultry farm (Fig. 3). Monthly incidence in the indoor environment of the poultry farm showed maximum spore distribution in May (886.03 CFU/m^3) followed by February (741.3 CFU/m^3) and November (702.47 CFU/m^3) when compared to other months of year, whereas the monthly incidence of fungal spores of outdoor environment of poultry farm showed maximum spore distribution during August (967.22 CFU/m^3) followed by July (921.33 CFU/m^3) and April (833.08 CFU/m^3). Based on the Two Way ANOVA for colony and month of the poultry farm, there is no significant difference in growth of CFU's in indoor and outdoor poultry farm over the months, towards late summer there is increase in growth for outdoor poultry farm (Table 3).

3.4 Swine House

The study period in swine house, a total number of 6911.74 CFU/m^3 in indoor and in outdoor 7345.93 CFU/m^3 were recorded. Among 25 fungal species belonging to 15 genera with other unidentified fungal form were isolated from indoor environment when compared to 19 fungal species belonging to 12 genera with other unidentified from outdoor environment of swine house (Fig. 4). Monthly incidence of total fungal spores in the indoor environment showed maximum spore distribution in May followed by January 893.09 CFU/m^3, December 861.32 CFU/m^3 and February 840.14 CFU/m^3 compared to other months of year, whereas the monthly incidence of fungal spores in outdoor environment of swine house showed highest distribution during March 871.91 CFU/m^3 followed by January 822.49 CFU/m^3 and February 808.37 CFU/m^3. The fungal growth decreases from January to May and then increases again in rainy between indoor and outdoor swine house. The statistically data were analysed by Two Way ANOVA for colony and month; there is a significant difference in the colony growth over months between indoor and outdoor of the swine house (Table 4).

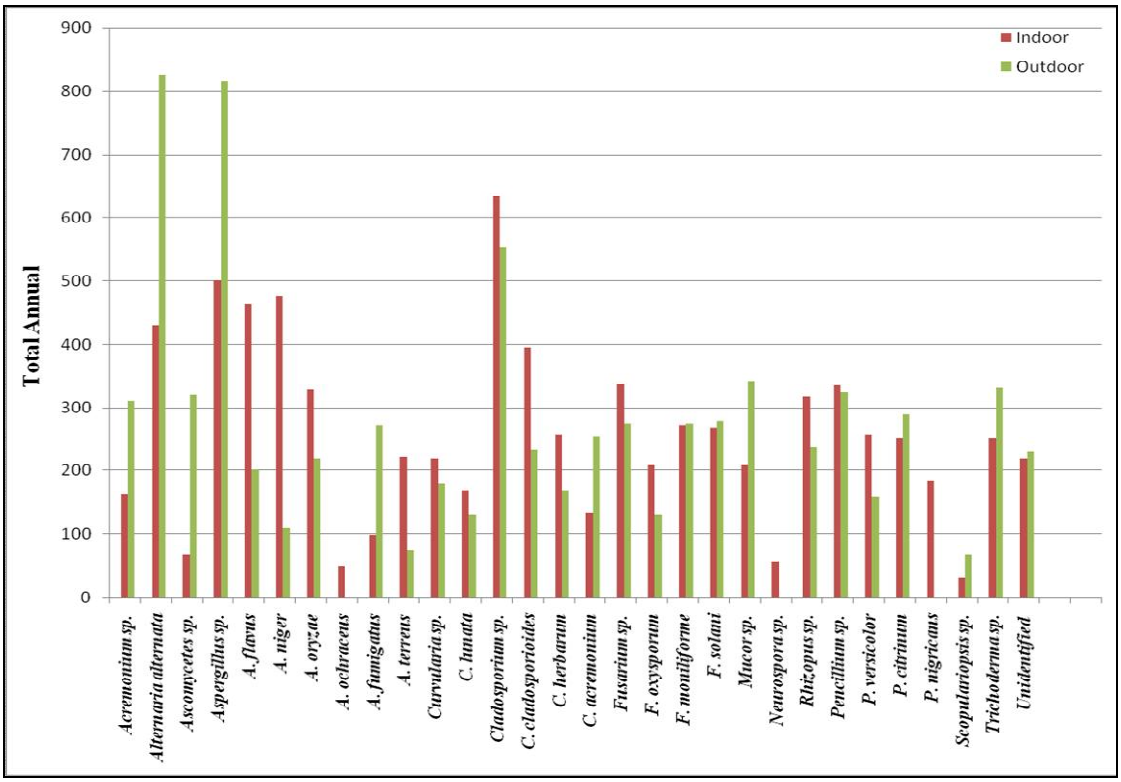

Fig. 2. Annual occurrence of fungal spores (CFU/m^3) recorded from January 2011 to December 2011 in the indoor and outdoor air of the cow shed

Table 2. One-way ANOVA for colony of the cow shed

	One-way ANOVA				
	Sum of squares	**Degrees**	**Mean**	**F-ratio**	**p-value**
Between variation	0.16	1	0.16	0.18	0.67
Within variation	19.55	22	0.88		
Total variation	19.72	23			

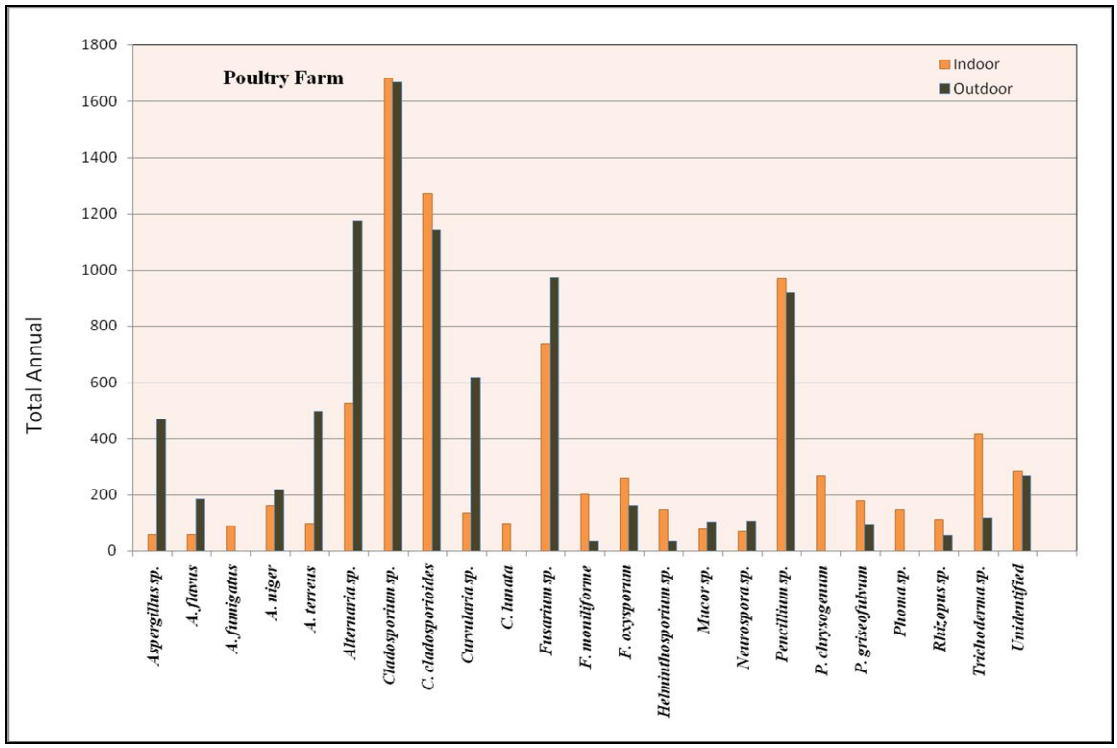

Fig. 3. Annual occurrence of fungal spores (CFU/m^3) recorded from January 2011 to December 2011 in the outdoor air of the poultry farm

Table 3. Two-way ANOVA for colony and month of the poultry farm

	Two-way ANOVA				
	Sum of squares	**Degrees**	**Mean**	**F-ratio**	**p-value**
Colony	2.58	1	2.58	1.78	0.21
Month	11.29	11	1.03	0.71	0.71
Error	15.96	11	1.45		
Total	29.84	23			

Table 4. Two-way ANOVA for colony and month of the swine house

	Two-way ANOVA				
	Sum of squares	**Degrees**	**Mean**	**F-ratio**	**p-value**
Colony	0.79	1	0.79	1.11	0.32
Month	91.69	11	8.33	11.76	0.00
Error	7.80	11	0.71		
Total	100.25	23			

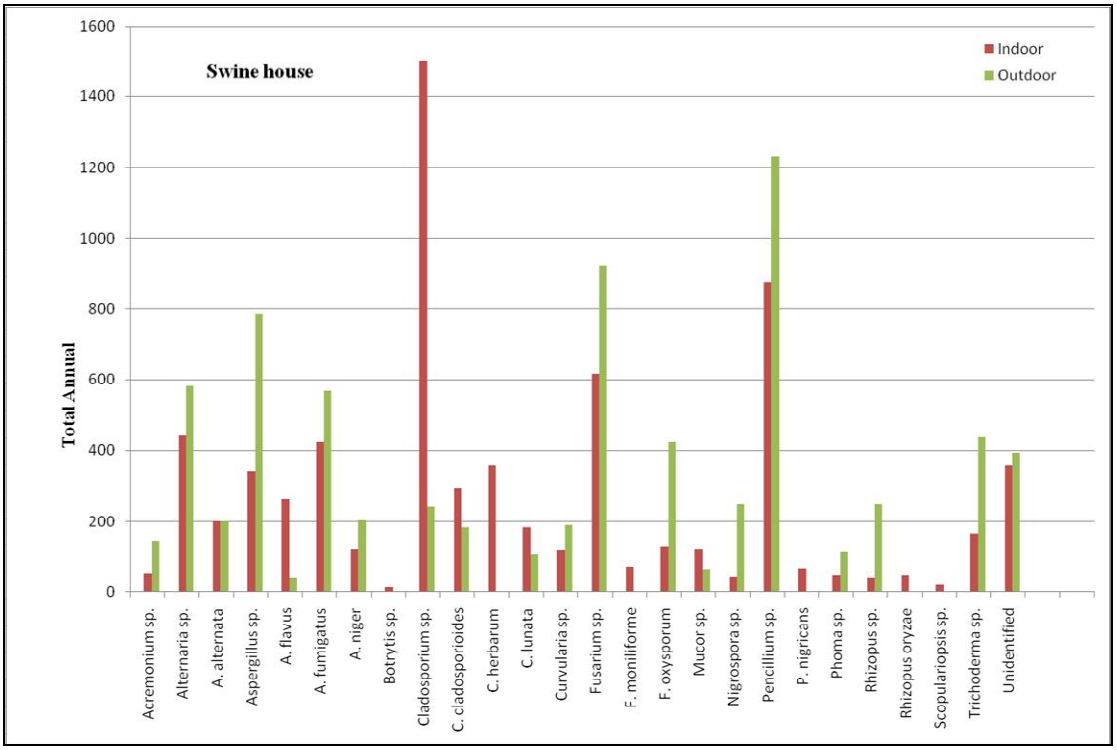

Fig. 4. Annual occurrence of fungal spores (CFU/m^3) recorded from January 2011 to December 2011 in the indoor and outdoor air of the swine house

4. DISCUSSION

The study carried out on the indoor and outdoor airborne fungal spores of animal rearing houses *viz.,* rabbit house, cow shed, poultry farm and swine house at Hessaraghatta village, Bangalore was analysed. There are several reports on the airborne fungal spores from both indoor and outdoor environment of animal houses conducted in rabbit house [7,8], cow shed [9,10], poultry farm [11,12] and swine house [13,14]. Fungal spores had been considered to be correlated with air pollution and also they had been proposed to be a cause of adverse health effects on humans, animals and plants [15]. There are numerous reports of contamination of indoor air with fungal spore levels well in excess [16,17].

Adhikari [9] collect the total airborne fungal spores was 233-2985 CFU/m^3 and concentration of viable colony-forming units ranged between 165 CFU/m^3 and 2225 CFU/m^3. Ajoudanifar [10] assessed the concentration of airborne fungi in cattle and poultry houses ranged from 10 CFU/m^3 to 1700 CFU/m^3 in indoor and 10 CFU/m^3 to 2170 CFU/m^3 in outdoor environments. Doris [11] investigated the concentration was 1.7×104 CFU/m^3 at the workplace of a poultry slaughterhouse.

In India, indoor fungal concentrations are high in different occupational indoor environments as reported by Jain [18] and Sawane and Saoji [19]. This is of much alarming scenario as *Penicillium* cause penicilliosis, leading cerebral or pulmonary lesions [8]. *Aspergillus* is a major pathogen and cause allergic alveolitis, asthma, pulmonary aspergillosis and mycotoxicosis [20]. *Alternaria* causes skin alternariosis, allergic pneumonia, asthma and also esophageal cancer. *Fusarium* is a common contaminant of cereals and feedstuff and under certain environmental conditions; producing toxins, poisoning human beings and animals. *Aspergillus niger* and *Aspergillus flavus* also infect the respiratory systems of living organisms [21].

Factors such as building dampness, hygiene conditions indoors and in the surrounding environment favour the growth and proliferation of fungi including the pathogenic species [22]. There is clinical evidence that exposure to mould and other dampness-related microbial agent

increases the risk of rare conditions such as hypersensitivity, pneumonitis, allergic alveolitis, chronic rhinosinusitis and allergic fungal sinusitis [23]. This could be because of improper management of the indoor environment and poor ventilation. In the naturally continuous mixing of indoor and outdoor air, the concentration of fungi can be two to five times higher than the outdoor level [24]. However, the spore concentration has been observed to be much lower in outdoor environment. Because many people spend as much as 90% of their time indoors, the health risk of indoor air pollutants is of critical public health concern.

Studies have shown association between reported indoor dampness and health outcomes, including respiratory symptoms, headache and upper respiratory airway infections [25]. According to other authors [26], general outdoor environments usually have higher levels of airborne fungi than indoor places. In our study, airborne fungi had higher concentrations than outdoor. The present survey of both qualitative and quantitative information obtained from this study could be useful for Aerobiologists, Veterinarians and Clinicians to forecast fungal spore load to the atmosphere and for therapeutic studies including allergy diagnosis.

5. CONCLUSION

It is clear that high contamination of fungal spores with multiple allergenic in indoor and outdoor air at animal rearing houses poses a serious problem from the point of view on workers health protection. This data helped us to prepare the fungal calendar on this region also to develop the standards of indoor air quality. Obviously, the presence of a good ventilation system inside buildings eliminates to some extent the influence of indoor sources and gives scope for further such studies.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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