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Indoor study on airborne fungi in swine house of Bangalore, India

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Abstract

In rural areas of India and other tropical as well as temperate countries a large number of people are occupationally involved with different types of animal sheds. In these sheds, a wide range of fungal growth substrates like moldy livestock foods, moldy hay, bedding of animals and their excreta are present, which could provide a huge airborne fungal spore load making these places unhygienic for the animal workers. The nature and seasonal variations of fungi have been investigated in the environments within partially and completely enclosed swine house during one-year period by fortnightly sampling from January 2011 to December 2011, using an Andersen two stage viable air sampler. The air samples were collected from indoor swine houses in Hessaraghatta village, Bangalore. A total of 69.11 CFU/m^3 airborne spore and 25 species representing 14 genera were recorded which included *Acremonium, Alternaria* sp, *A. alternata, Aspergillus* sp, *A. flavus, A. fumigatus, A. niger, Botrytis* sp, *Cladosporium* sp, *C. cladosporioides, C. herbarum, C.lunata, Curvularia* sp, *Fusarium* sp, *F.moniliforme, F.oxysporum, Mucor* sp, *Nigrospora* sp, *Pencillium* sp, *P. nigricans, Phoma, Rhizopus* sp, *Rhizopus oryzae, Scopulariopsis* sp, *Trichoderma* sp, and 1 unidentified genera. The aim of the present study was performed to evaluate the quality and magnitude of exposure to airborne fungi in indoor air and to compare the seasonal variation of fungal genera with regard to these environments.

Keywords: Andersen sampler, airborne spore, seasonal variation, swine house

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Introduction

Indian swine houses are generally places with high humidity where raw and decomposing swine dung, straw, livestock foods, and other materials provide suitable substrates for the growth of fungi. Airborne fungi are being proposed as a cause of adverse health effects, which is procreated continually in animal raising house is not only endangered to the feeders and domestic animals but also cause environment pollution. Fungal agents are responsible for a variety of respiratory diseases both in humans and animals. They may adversely affect human health through allergy, infection and toxicity. The main source of airborne fungi in indoor air is usually from outdoor air (Wu et al., 2000). The concentrations and types of airborne microfungi in the atmosphere are affected by many biological and environmental factors (Stepalska and Wolek, 2005). They vary greatly, by nature, with time, season, geographical, climatic and other physical factors (Abdel Hameed et al., 2007).

Many fungal spores are involved in respiratory allergies and may cause different kinds of infections (Caretta 1992; Waisel et al., 1997; Saini et al., 1998; Black et al., 2000). Seasonal variations in indoor environments especially in swine house frequented by a large number of

people who may be exposed to this type of aeroallergen (Infante et al., 1992; Meriggi et al., 1996). The data can help to identify to evaluate the quality and magnitude of exposure to indoor airborne fungi and to compare the seasonal variation of fungal species. The study will help to identify swine house systems, where most urgently mitigation techniques should be applied, in order to improve performance, welfare of animal and workers as well as to reduce emissions. Future swine house systems should be sustainable in relation to animal health and welfare, environment and occupational health aspects.

Materials and Methods

Sampling site and time

The swine house selected for this investigation was situated at Hessaragatta Village in Bangalore, India. Sampling was carried out in an enclosed swine house from the period from January 2011 to December 2011 on each month fortnightly sampling.

Collection of samples

Anderson two-stage viable sampler was placed in the center of the piggery house 1.5 meter above the ground level. Malt Extract Agar (MEA) was used as sampling medium. Air flow was 28.3 L/min during the sampling and the sampling time was limited to 5 mins (Andersen, 1958).

Treatment of samples

The exposed plates were placed in an incubator at 26 ^{0}C and incubated for 5 days, then the colony count was recorded and the colony count was recorded again in 7 days. 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. Identification of fungal colonies was based on morphological characteristics and microscopic observations with the help of Agarkar Research Institute, Pune (India).

Statistical analysis

The data collected were statistically analyzed by TTEST analysis of variance test in seasons and fungal value showing mean and significant differences were expressed were also analyzed (Table 1).

Table 1. Statistics showing mean value of fungal species and seasons mean and significant differences were expressed

Genera Name	Mean ± SD
Acremonium	0.04±0.09
Alternaria sp.	0.37±0.35
A.alternata	0.16±0.15
Aspergillus sp.	0.28±0.34
A.flavus	0.22±0.20
A.fumigatus	0.35±0.32
A.niger	0.10±0.06
Botrytis sp.	0.01±0.02
Cladosporium sp.	1.25±0.39
C.cladosporioides	0.24±0.37
C.herbarum	0.29±0.34
C.lunata	0.15±0.18
Curvularia sp.	0.09±0.11
Fusarium sp.	0.51±0.48
F.moniliforme	0.05±0.11
F.oxysporum	0.10±0.10
Mucor sp.	0.10±0.10
Nigrospora sp.	0.03±0.05
Pencillium sp.	0.72±0.49
P.nigricans	0.05±0.08
Phoma sp.	0.03±0.06
Rhizopus sp.	0.03±0.04
Rhizopus oryzae	0.03±0.05
Scopulariopsis sp.	0.01±0.03
Trichoderma sp.	0.13±0.19
Winter	4.99±12.81
Summer	3.29±8.72
Rainy	2.07±5.45

Table 2. Fungal species in CFU/m^3 through the year 2011 January to 2011 December

Genera and Species	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total	%
Acremonium	0	0	0.2471	0.1412	0.0706	0.0353	0	0	0	0	0	0	0.4942	0.71
Alternaria sp.	1.059	0.9178	0.7413	0.4236	0.2118	0.1412	0.1412	0.0706	0.0706	0.1765	0.353	0.1412	4.4478	6.43
A.alternata	0.4589	0.353	0.1412	0.1412	0.1765	0	0	0.1059	0.1412	0.0353	0.3177	0.1412	2.0121	2.91
Aspergillus sp.	0.9531	0.8119	0.6707	0.0706	0.1059	0.2824	0.0353	0.0353	0.0353	0	0.2118	0.2118	3.4241	4.95
A.flavus	0.2471	0.5648	0.3177	0	0.1059	0	0	0.353	0.5648	0.2118	0.1412	0.1412	2.6475	3.83
A.fumigatus	0.2471	0.6707	0.9178	0.6354	0.706	0	0	0.1059	0.2471	0.353	0.2118	0.1412	4.236	6.12
A.niger	0.0706	0.0353	0.1412	0.1059	0.1059	0.0353	0.1412	0.0353	0.1765	0.1059	0.1412	0.1059	1.2002	1.73
Botrytis sp.	0	0	0	0	0	0.0706	0	0	0	0	0.0353	0.0353	0.1412	0.20
Cladosporium sp.	1.765	1.6238	1.2002	1.0237	1.2708	1.2355	0.706	1.059	0.7413	1.1296	1.4473	1.8356	15.0378	21.75
C.cladosporioides	0.353	0.0706	0	0	0.1765	0.0706	0.0706	0.1059	0.0706	0.0353	1.2002	0.8119	2.9652	4.29
C.herbarum	0.353	0.1412	0	0.0706	0.1412	0.0353	0.1412	0.2471	0.1765	0.3177	0.7766	1.1649	3.5653	5.15
C.lunata	0.3883	0.0706	0	0.1765	0.0706	0	0	0.1412	0.1059	0.1059	0.2118	0.5648	1.8356	2.65
Curvularia sp.	0	0	0.1059	0.3883	0.0353	0.0706	0.1412	0.1059	0.2471	0.0706	0	0	1.1649	1.68
Fusarium sp.	0.9884	1.4473	0.9884	0.6001	0.2471	0.0706	0.2118	0.0706	0.1765	0.2118	0.1765	0.9884	6.1775	8.93
F.moniliforme	0	0	0	0	0	0	0.1059	0.353	0.1059	0.1412	0	0	0.706	1.02
F.oxysporum	0.0706	0.2118	0	0.0706	0.2118	0.3177	0.1059	0	0.0706	0.1059	0.0706	0.0353	1.2708	1.83
Mucor sp.	0.2471	0.0706	0.2118	0	0.1059	0	0.0353	0.1059	0.2118	0.0353	0.0353	0.1412	1.2002	1.73
Nigrospora sp.	0	0	0.0706	0.1059	0.1059	0.0353	0.0353	0	0	0.0706	0	0	0.4236	0.61
Pencillium sp.	0.7413	1.1296	0.9531	1.2002	0.706	0.8472	0.1412	0.2471	0	0.1765	1.2002	1.412	8.7544	12.66
P.nigricans	0	0	0.0706	0	0.0706	0	0.0353	0	0.0706	0.0706	0.0706	0.2824	0.6707	0.97
Phoma sp.	0.1765	0.1059	0	0	0	0	0.0706	0.0706	0.0353	0	0	0	0.4589	0.66
Rhizopus sp.	0	0	0.0706	0.0706	0	0.0706	0.0353	0.0706	0	0.0353	0	0.0353	0.3883	0.56
Rhizopus oryzae	0	0	0	0.0353	0.0353	0.0706	0.1059	0.1059	0.0706	0.0353	0	0	0.4589	0.66
Scopulariopsis sp.	0	0	0.0353	0.0353	0.0353	0	0.0353	0.0353	0	0.0353	0	0	0.2118	0.3
Trichoderma sp.	0.4942	0	0	0.1412	0.0353	0.1059	0.0353	0.0706	0.1412	0.2118	0.1059	0.3177	1.6591	2.4
Unidentified	0.3177	0.1765	1.1296	0.1412	0.2471	0.2118	0.2471	0.2118	0.1765	0.3883	0.2118	0.1059	3.5653	5.15
Total	8.9309	8.4014	8.0131	5.5774	4.9773	3.7065	2.5769	3.7065	3.6359	4.0595	6.9188	8.6132	69.1174	100

Results and Discussion

Fungal spore of swine house showed the higher variation in the sampling period. In India, the indoor fungal concentrations are high in different occupational indoor environments (Sawane and Saoji, 2004). The fungal spores are ubiquitous worldwide and their numbers and species are known to vary with the season of the year to weather changes (Ren et al., 2001; Bartlett et al., 2004; Stepalska and Wolek, 2005; Kasprzyk and Worek, 2006; El-Morsy, 2006). A total of 25 species representing 14 genera were identified for the entire period of observation. The predominant genera recorded were *Cladosporium* (21.75%), *Pencillium* (12.66%), *Fusarium* (8.93%), *Alternaria* (6.43%) and *A.fumigatus* (6.12%) colony count respectively and are as represented in Table 2. The above studies revealed the predominant CFU's during the month of January followed by December, February, March and November respectively. This could because of improper management of the indoor environment generated by such things as animal faeces, litter, feed, feather dandruff and poor ventilation. In addition to this, the predominant indoor airborne fungi reported in this study were consistent with previous indoor air studies (Aydogdu et al., 2005, Sarica et al., 2002, Yazicioglu et al., 2004). Asan et al. (2002) found *Cladosporium, Penicillium, Fusarium, Alternaria* and *Aspergillus* as the predominant genera in their study. Different fungal species may have different pathogenicities and meanwhile body resistance is also the key against fungal infection therefore, it needs in-depth investigation of aerosol fungal pathogenicity and body immunity to determine harms of fungal aerosols to human beings and animals. The swine house indoor fungi also revealed significant seasonal behavior is showed in Table 3. The highest levels of spore concentrations in the winter season (November-February), medium in summer season (March-June) and lowest in rainy season (July-October). The reports revealed the complete absence of *F.moniliforme* and *Phoma* during summer, *botrytis* in rainy season and *Acremonium, Curvularia, F.moniliforme, Nigrospora,*

P.nigricans, *Rhizopus* and *R.oryzae* during the winter season (November-February).

Table 3. Fungal species in CFU/m^3 throughout the three seasons and year Jan'2011 to Dec'2011

Groups	Summer (March-June)	Rainy (July-October)	Winter (November-Feburary)
Acremonium	0.9884	0	0
Alternaria sp.	3.0358	0.9178	4.942
A.alternata	0.9178	0.5648	2.5416
Aspergillus sp.	2.2592	0.2118	4.3772
A.flavus	0.8472	2.2592	2.1886
A.fumigatus	4.5184	1.412	2.5416
A.niger	0.7766	0.9178	0.706
Botrytis sp.	0.1412	0	0.1412
Cladosporium sp.	9.4604	7.2718	13.3434
C.cladosporioides	0.4942	0.5648	4.8714
C.herbarum	0.4942	1.765	4.8714
C.lunata	0.4942	0.706	2.471
Curvularia sp.	1.2002	1.1296	0
Fusarium sp.	3.8124	1.3414	7.2012
F.moniliforme	0	1.412	0
F.oxysporum	1.2002	0.5648	0.7766
Mucor sp.	0.6354	0.7766	0.9884
Nigrospora sp.	0.6354	0.2118	0
Pencillium sp.	7.413	1.1296	8.9662
P.nigricans	0.2824	0.353	0.706
Phoma sp.	0	0.353	0.5648
Rhizopus sp.	0.4236	0.2824	0.0706
Rhizopus oryzae	0.2824	0.6354	0
Scopulariopsis sp.	0.2118	0.2118	0
Trichoderma sp.	0.5648	0.9178	1.8356
Unidentified	3.4594	2.0474	1.6238
Total	44.5486	27.9576	65.7286

Aspergillus fumigatus may cause allergic alveolitis, asthma, pulmonary *aspergillosis* and *mycotoxicosis* (Dutkiewicz, 1994). *Aspergillus niger* and *Aspergillus flavus* may also infect the respiratory systems of human beings and animals (Edward et al., 1993). The reports of the above studies revealed the recognition of *A. fumigatus*, *A.niger* and *A.flavus* as hazardous moulds in the working environments. *Alternaria* may cause skin *alternariosis* and also allergic pneumonia, asthma and possibly esophageal cancer, *Penicillium* may cause *penicilliosis*, often secondary to leukemia and lymphoma, leading to cerebral or pulmonary lesions and *Fusarium* is a common contaminant of cereals, feedstuff under certain environmental conditions, it may produce toxins, leading to poisoning of human beings and animals (Zengmin et al., 2009).

The health risk of indoor air pollutants is a critical public health concern and studies reported indoor dampness and health outcomes, including respiratory symptoms, headache, and upper respiratory airway infections (Verhoeff and Burge, 1997). The World Health Organization working group has concluded that the individual species of microbes and other biological agents responsible for health effects cannot be identified because people are often exposed to multiple agents simultaneously (WHO, 2009).

The swine house investigated in this study contained very high level of airborne fungi. The need to specifically evaluate the composition of the fungal community and its potential health effects on exposed workers seem to be crucial (Anne Oppliger et al, 2005). Monitoring of airborne micro fungi of seasonal variations of their may provide a basis for future epidemiologic investigations of the role of fungal exposure as a risk factor for disease (Halide Aydogdu and Ahmet Asan, 2008). In swine house, the investigations on indoor airborne fungi affecting workers health are important for prevention of fungal diseases and symptoms. Better understanding of indoor airborne fungal concentration and seasonal variation in swine house would help us to regulate and control

fungal diseases for more clinical and epidemiological investigations must be undertaken.

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