Environment Conservation Journal 11(1&2) 37-40, 2010
(ISSN 0972-3099)

Assessment of fungi and suspended particulate matter in the indoor air of households of Jammu city (J&K)

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Received: 15-02-2010 **Accepted: 12-04-2010**

Abstract

The present study was conducted to assess status of suspended particulate matter (SPM) and fungi in the indoor air of households located at different sites in Jammu city. The study area was divided into seven sites. At each site, two households were selected randomly and in each household sampling of SPM (µg/m^3) and Fungi (CFU/m^3) were done twice at three sub sites *i.e.* bedroom, kitchen and drawing room. *Alternaria alternata, Mucor* sp., *Alternaria* sp., *Aspergilus niger, A. fumigatus, A. clavatus, A. versicolor, A. glaucus, Fusarium oxysporum, Geotrichum* sp. were observed to be the most common fungi in the study area. SPM was found to be maximum (1006µg/m^3) in households near water body and minimum (659µg/m^3) in the households near hospital. The minimum value of fungal count (20076 CFU/m^3) was exhibited by households near National Highway I-A whereas maximum value of fungal count (2 7 2 2 6 CFU/m^3) was exhibited by the Households located in commercial area. A significant positive correlation (r) was also found between SPM and fungi (+0.06 to +0.62) as well as fungi and relative humidity (+0.10 to +0.60) in the study area.

Keywords: *Air pollution, Biological contamination, Fungi, Indoor air, Suspended particulate matter*

Introduction

Air pollutants pollute both indoor and outdoor environment. Indoor air pollution can be traced to prehistoric times when man first moved to temperate climate and used fire for cooking and warming. Our buildings have undergone radical changes over past few decades thereby resulting in less opportunity to exchange indoor air with outdoor air. This has led to concentration of air pollutants like dust, CO_2, bacteria etc within the building (Purohit and Ranjan, 2005). In urban areas, exposure to indoor air pollution has increased due to variety of reasons, including the construction of more tightly sealed buildings, reduced ventilation, the use of synthetic materials for building and furnishing and the use of chemical products, pesticides and household care products. Indoor air pollution can begin within a building or drawn from outdoors.

The impact of bio pollutants on the environment is man's basic problem. The causal agents of illness and stress can be of chemical, physical or biological origin and have a sizeable impact on productivity. Biological contamination of environment has received great attention in recent years as a possible cause of illness at home and at work place (Nair *et al*., 1996). Many people spend more than 90% of their times indoors in tightly sealed, poorly ventilated work places, commercial and public buildings (Reijula, 1996). Insufficient ventilation, excess temperature, chemicals, dust and microorganisms are the main indoor air problems (Husman, 1996). Microorganisms are always present in outdoor air but their number and types changes with time of day, weather, season, geographical location and with the local spore sources. Microorganisms and airborne spores in dwellings may enter from outdoors or from moulds growing on walls and windows or on food scraps and other organic material in house dust or retained in crevices or from humidifiers of air conditioning systems (Nair *et al.*, 1996).

Fungal spores constitute a major component of airspora. The presence of fungal propagules in air can cause health hazard in all segments of population. In present study attempt has been

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made to assess the status of fungi, SPM, relative humidity and their correlations in the indoor air of households of Jammu city.

Materials and Method

The study area was divided into seven sites:

Site I : Households located near G.B. Pant Hospital, Nai Basti
SiteII :Households in Commercial area, Jain Bazar
Site III :Households near National Highway I-A
Site IV : Households at Crossing, Satwari
Site V : Households in residential area but near Water Body, Jullaka Mohalla
Site VI : Households in residential area but away from big open drain, Sainik Colony
Site VII :Households in residential area but near big open drain, Bakshi Nagar.

At each site two households were selected randomly and in each household sampling of SPM and Fungi was done twice (i.e. once during July–Sept.2008 and once during Oct.–Dec.2008) at three sub sites i.e. Bedroom, Kitchen and Drawing room. Average value of each parameter with standard deviation for an average household at each site was compiled from data of twelve readings in a period of six months. Correlation coefficients (r) of SPM and Fungi and Fungi and Relative Humidity were calculated using Pearson product moment method.

Air Sampling for SPM was done by using Handy Air Sampler Envirotech APM 821 for two hours at a height of 5 ft above the ground. SPM was determined by formula:-

$$\text{SPM } (\mu g/m^3) = \frac{(W_2 - W_1) \times 10^3}{T \times \frac{R_1 + R_2}{2}}$$

Where,

W_1 &W_2 = initial and final weight of filter paper
R_1& R_2 = initial and final flow rate in cubic metre
T = sampling time in minutes

Air sampling for fungi was done using Handy Air Sampler Envirotech-APM 821 for 10 min at a height of 5 ft above the ground using sterile impingers containing 8 ml of distilled water. Four Petri plates i.e. one with Nutrient Agar (peptic digest of animal tissue, beef extract, yeast extract, sodium chloride, agar, pH 7.4±0.2), second with Potato Dextrose Agar (potato infusions, dextrose, agar, pH 5.6±0.2), third with Rose Bengal Agar Base (papaic digest of soyabean meal, dextrose, monopotassium phosphate, magnesium sulphate, rose bengal agar, pH 7.2±0.2) and fourth with Czapek Dox Agar (sucrose, sodium nitrate, dipotassium phosphate, magnesium sulphate, potassium chloride, ferrous sulphate, agar, pH 7.3±0.2) were inoculated with 2ml. of impinged water from each impinger in Laminar flow and incubated at 25-30^{0}C for 7 days in BOD incubator.

The quantification of fungal count was done by using the formula:-

No. of microbes per volume (l) of air (CFU/m^3)

$$= \frac{\text{No. of microbes collected by impinger}}{\text{Volume of air}}$$

No. of microbes collected by impinger
= Sum total no. of colonies in all the four plates

Volume of air = Sampling time X Flow rate of air in cubic metre

Sampling of fungi was also done directly by exposing Petri plates with above said media to ensure that all the existing fungi have been impinged. Fungal study from each colony was carried out using Aniline blue and Lacto phenol stain. Relative humidity was calculated using Psychrometer having wet bulb and dry bulb thermometers. The value of RH (%) was calculated from the temperature in dry bulb thermometer and depression in temperature in wet bulb thermometer using standard table of relative humidity. A control set for each culture media was prepared and the colonies found growing on the culture medias were subtracted from the respective exposed culture medias.

Results and Discussion

The analysis of data revealed that households near Hospital (Site I) exhibited minimum indoor SPM of 659±253µg/m^3 whereas households near Water body (Site V) exhibited maximum indoor SPM of 1006±225 µg/m^3. The bedroom located in Site III (Households near National Highway I-A) exhibited minimum average fungal count of 6405 CFU/m^3 whereas bedroom located in Commercial

Table I: -Indoor SPM and Fungi in households at different sites of Jammu city

Households	SPM (µg/m^3)	Relative humidity (%)	Average Number of fungi (CFU/m^3) in			
			Average Bedroom	Average Kitchen	Average Drawing room	Average Household
SITE I	659±253 (293-1055)	76±7.0 (60-83)	6969±1575 (5742-9241)	6831±2316 (4655-9870)	7201±1916 (5332-9857)	21002 ±5628 (16092-28967)
SITE II	900±327 (446-1561)	73±6.0 (64-82)	8336±1548 (6037-9368)	9855±1413 (8004-11443)	9035±1154 (7999-10666)	27226 ±915 (26012-28038)
SITE III	708±239 (292-1055)	74±8.0 (60-83)	6405±2019 (4471-9241)	6769±2345 (4655-9870)	6902±2192 (5147-9857)	20076 ±6368 (14911-28967)
SITE IV	859±161 (586 -1055)	74±8.0 (64-83)	8321±1487 (6105-9241)	8624±2647 (4655 -10033)	8033±1954 (5332-9857)	24979 ±5977 (16092-28967)
SITE V	1006±225 (624 -1393)	76 ±7.0 (69-91)	8099±3402 (4746-11758)	8262±3716 (5012-13583)	7957±2460 (5684-11300)	24318 ±9230 (16394-36641)
SITE VI	799±303 (224 -1393)	71±7.0 (60-84)	7859±3746 (3718-11758)	7878±4049 (4271-13583)	7249±3331 (3440-11300)	22987 ±10899 (11428-36641)
SITE VII	700±404 (293 -1561)	75±4.0 (68-82)	6984±1649 (5742-9368)	8062±2498 (5463-11443)	8203±1846 (6529-10666)	23249 ±4541 (18292-28038)
Average Household in study	804±296 (224-1561)	74±7.0 (60-91)	7568±2218 (3718-11758	8040±2695 (4271-13583	7797±2068 (3440-11300)	23405 ±6498 (11428-36641)

area *i.e.* Site II exhibited maximum value of average fungal count of 8336 CFU/m^3. The kitchen located in Site III Households near National Highway I-A) exhibited minimum average fungal count of 6769 CFU/m^3 whereas kitchen located in commercial area i.e. Site II exhibited maximum value of 9855 CFU/m^3. The drawing room located in Site III (households near National Highway) exhibited minimum average fungal count of 6902 CFU/m^3 whereas drawing room located in Commercial area *i.e.* Site II exhibited maximum value of 9035 CFU/m^3(Table I). The average count of fungi in the indoor air exhibited minimum value of 20076 CFU/m^3 at Site III *i.e.* households near National Highway I-A and maximum value of 27226 CFU/m^3 at Site II *i.e.* households located in commercial area. Overall analysis at different sites of study area revealed that households in the study area exhibited average indoor SPM of 804±296 µg/m^{3}with range of 224 -1561µg/m^3. Analysis of data further revealed that fungi exhibited average fungal count of 23405 ± 6 4 9 8 CFU/m^3 with 87% ascomycota, 10% zygomycota and 3% sterile hypha. The critical analysis of data revealed that maximum fungal count was exhibited by the kitchen, followed by drawing room and bedroom of the study area. (Table I).Overall analysis of data revealed that households near Hospital exhibited minimum indoor SPM which might be due to maintenance of best sanitation conditions whereas Households near water body exhibited maximum indoor SPM due to dumping of silting material on banks of water body and households at Site III i.e. households near National Highway I-A exhibited minimum value of fungal count this might be due to concentration of SO_2 and NOx. Subba Rao *et al.* (1988) and Subramanyam (1991) while studying microbial air quality of Madras city also reported that increase in concentration of SO_2 and NOx decreased microbial content of air whereas maximum value of fungal count was exhibited at Site II *i.e.* Households located in Commercial area this was due to narrow lanes with no exposure to direct sunlight and humid conditions.

A significant correlation was found between SPM and fungi (+0.06 to +0.62) and fungi and relative humidity (+0.10 to +0.60) at all sites of study area

(Table II). Subramanyam *et al*. (1999) also observed positive correlation between fungi and SPM while studying airborne fungi in urban environment.

Table II: Correlation coefficient(r) of SPM and Fungi and Fungi and Relative Humidity in households at different sites of Jammu city

SPM in households at different Sites	SPM and Fungi	Fungi and Relative Humidity
SPM at Site I	+0.09	+0.60
SPM at Site II	+0.11	+0.41
SPM at Site III	+0.20	+0.55
SPM at Site IV	+0.06	+0.14
SPM at Site V	+0.06	+0.10
SPM at Site VI	+0.62	+0.56
SPM at Site VII	+0.38	+0.50

A total of 22 fungal types were found. They are *Aspergillus niger*, *Aspergillus versicolor*, *Aspergillus clavatus*, *Aspergillus glaucus Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus* sp., *Trichoderma* sp., *Alternaria* sp., *Alternaria alternata*, *Mucor* sp., *Rhizopus* sp., *Cladosporium* sp., *Geotrichum* sp., *Fusarium oxysporum*, *Fusarium solani*, *Curvularia lunata*, *Bipolaris spicifera*, *Bipolaris* sp., *Penicillium* sp., *Aeurobasidium* sp., *Yeast and Sterile hypha.*

*The o*verall highest prevalence of fungal types was represented by *Aspergillus* followed *by Alternaria* and *Fusarium*. It was in agreement with the findings of Begum and Ahmed (2006) and Begum *et al.* (2001) who found *Aspergillus* to be most dominant in the air.

The present study also revealed that fungal count in indoor air is affected more by indoor sources of pollutants than outdoor sources of pollutants. There was statistically significant correlation between the total number of fungi and the concentration of suspended particulate matter. It is clear that everyday activities may result in significant changes in numbers and types of such air borne moulds (Lehtonen *et al.*, 1993)

Outdoor air used to penetrate into buildings easily through windows and doors (Dingle, 1957) to become a potential source of indoor fungi (Husman, 1996) but at the same time indoor environment, building materials, humidity and insufficient ventilation were suitable habitats for growth of outdoor organisms (Reijula, 1996).

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