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INDOOR/OUTDOOR LEVELS OF GASEOUS POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN A SEMI ARID REGION OF INDIA

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Introduction

A large number of chemical compounds that damage the ambient as well as indoor air quality are formed mostly from combustion sources like gasoline and petrol/diesel fueled automobiles, waste incineration, residential heating systems that combust fuels such as coal, wood, gas and oil, various industrial processes and volatilization from polluted grounds. Among the compounds formed are Polycyclic Aromatic Compounds including Polycyclic Aromatic Hydrocarbons (PAHs) **(Yang et al., 2002)**. PAHs are compounds made up of carbon, hydrogen and at least two fused benzene rings in a linear, angular or cluster arrangement. Atmospheric PAHs are partitioned between the particulate matter and gas phases, depending on the PAH molecular weight. Low molecular weight PAHs have higher concentrations in the vapor phase while high molecular weight PAHs are often associated with particles **(Bi et al., 2003)**. There is much information on the multi ringed heavier PAHs but have left the lighter vapour phase PAH components rather neglected. Although these lighter compounds have weaker carcinogenic/mutagenic properties, they are the most abundant in the urban atmosphere and react with other pollutants to form more toxic derivatives **(Park et al., 2002)**. In many circumstances the environmental occurrence of PAHs has been associated with adverse effects on public health. Depending on atmospheric conditions and chemical reactivity, these compounds may be carried over long distances and pollute even the remotest areas **(Fernandez et al., 2000)**. With the increase in fossil fuel combustion, resulting from the industrial expansion, traffic and population growth, over last few decades, the atmospheric concentrations of PAH in Asian countries are expected to be high **(Ravindra et al, 2001)**. It is believed that there is no "*Threshold*" or "*Safe*" level for the mutagenic compounds, hence exposure to these PAHs at any level provide the risk of toxic effects **(Masih et al, 2005)**. Thus, the aim of this study was to determine gaseous contamination by PAHs and to identify sources based on variations in PAHs profiles between the sites as well as to assess the carcinogenic potencies related to PAHs.

Experimental

Sampling sites

Agra, the city of Taj Mahal (27°10'N 78°02'E) is located in the north central part of India about 200 kms South of Delhi in the Indian state of Uttar Pradesh. A part of the great northern Indian plains, Agra city is considered as a semi-arid zone as two third of its boundaries are surrounded by the Thar desert of Rajasthan. Three highways are crossing the city. In winter the temperature ranges from 5.5°C to 30.5°C. The down ward wind is west-north-west *i.e*. WNW 9.4% and north-north-west *i.e*. NNW 11.8% in winters **(CPCB, 2006)**.

Air sampling and analytical procedures

Air samples were taken twice a week with small pumps (Envirotech Handy Sampler APM 821, Okhla, New Delhi, India) during winter season (Nov. 2005-Feb. 2006). Therefore total thirty two samples were collected from urban, rural and roadside sites. The pump was set at 2 L/min. and run continuously for 20 hrs aspirating air through XAD-2 resin (150 mg) retaining PAHs in the gaseous phase. Sample flow was measured before and after sampling using calibrated rotameters with an accuracy of ±1%. The XAD-2 resin tubes with Teflon were pre-filter, extracted with dichloromethane for 48 hrs, vacuum-dried in desiccators. After sampling the XAD-2 resin tubes with Teflon were extracted with methylene chloride (DCM) and the extracts analyzed by GC/MS. Prior to GC/MS analysis, a 1 mL aliquot of the extract was spiked with internal standards **(REAC, 2002)**.

Results and discussion

The average concentrations of individual indoor/outdoor PAHs found in air at the various sites are shown in Figure 1(a & b). The total indoor/outdoor PAH (TPAH) concentrations were 10.27/4.47, 8.33/5.30, and 7.56/2.54 ng m^{-3} at urban, roadside, and rural sites respectively. The mean concentration of TPAH was 9.06 ng m^{-3} at indoor and 4.14 ng m^{-3} at outdoor for all sites together and the range was from 0.15ng m^{-3} to 4.88 ng m^{-3} and 0.10 ng m^{-3} to 1.80 ng m^{-3} of indoor and outdoor respectively. The urban site had the highest total indoor PAH concentration followed by roadside and rural site whereas the total outdoor PAH was highest at roadside followed by urban and rural site. High indoor PAH concentrations at urban site may result from the households indoor activities (cooking, incense burning, cigarette smoking) as this site is very dense and the houses are built in an unplanned manner. The other reason can be mixing of PAHs with the ambient atmosphere hence diluting the concentrations, which is not the case with indoor samples. However High outdoor PAH concentrations at roadside in comparison to other two outdoor sites**,** are attributable to the proximity of the busy road, which has very intense automobile traffic about 10^5 vehicles per day **(CPCB, 2006).** These results also indicate that PAH concentrations are strongly linked to the land use of the site. Overall naphthalene was the predominant compound and the trends of the concentrations of the major PAH found in present study were naphthalene > 2-methylnaphthalene > 1-methylnaphthalene, both at indoor and outdoor at all the sites. The correlation coefficient between Indoor and Outdoor concentrations of PAHs at different sites is given in Figure 2, which shows a positive correlation at all the sites i.e. urban (0.835075), roadside (0.769531) and rural site (0.266446). This illustrates that the indoor/outdoor correlations of PAHs is significant at urban and roadside, but it is insignificant at rural site.

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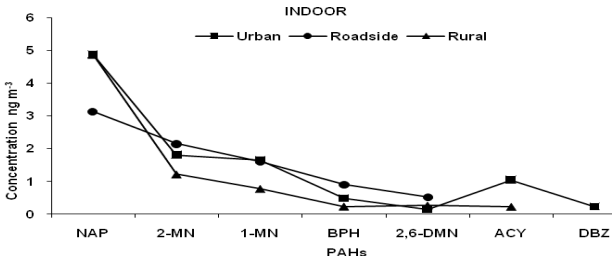
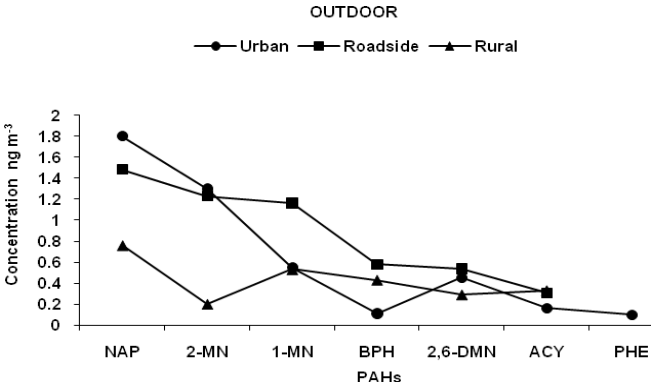


1(a)



1(b)

Figure 1(a & b): Average individual concentrations of PAHs (Indoor & Outdoor) at different sites

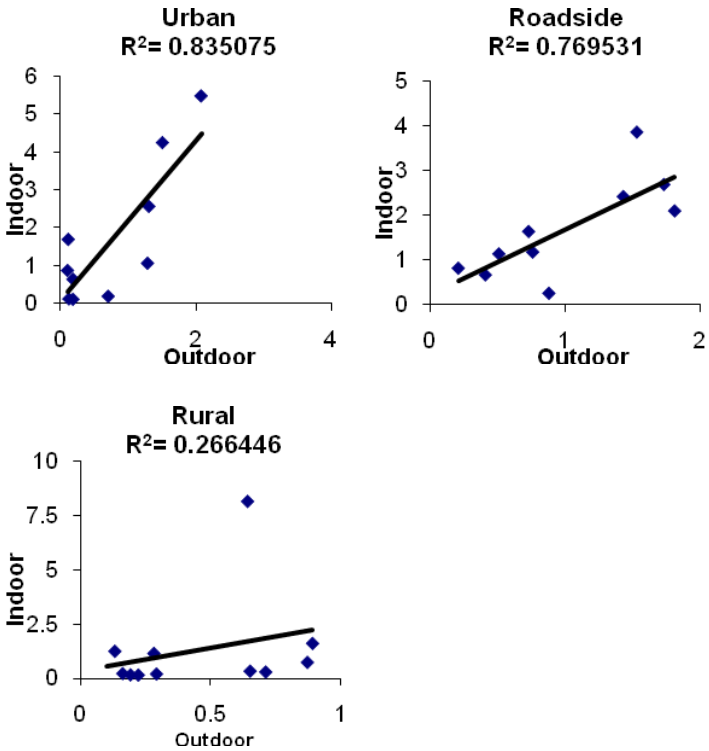


Figure 2: PAHs Indoor/Outdoor correlations at different microenvironments