Fine Particulate Matter Bound Polycyclic Aromatic Hydrocarbon Species in Ambient Atmosphere of Delhi: Concentration, Sources, and Associated Health Risk Assessment

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The present study was carried out to determine the concentration of fine particulate ($PM_{2.5}$) bound polycyclic aromatic hydrocarbons (PAHs) in the ambient atmosphere of Delhi, their sources, and associated health risk to the general population living in the area. $PM_{2.5}$ samples were collected for a time period of 4 months between November 2017 and February 2018 with a sampling frequency of one sample per week. The mean $PM_{2.5}$ and associated 16 USEPA priority PAHs (Σ_{16}PAHs) concentration was 263.9±187.0 μg/m^3 and 117.1±83.3 ng/m^3 respectively and they shown a good correlation (r = 0.59) during the study. The mean concentration of 5-ring PAHs was found highest during the study period followed by 3-ring, 6-ring, 4-ring, and 2-ring species (Scheme 1). Particulate bound high molecular weight species (4-ring, 5-ring, and 6-ring) were dominant over low molecular weight species (2-ring and 3-ring) and their mean concentration was 77.4±73.2 ng/m^3 and 38.6±16.0 ng/m^3 respectively.

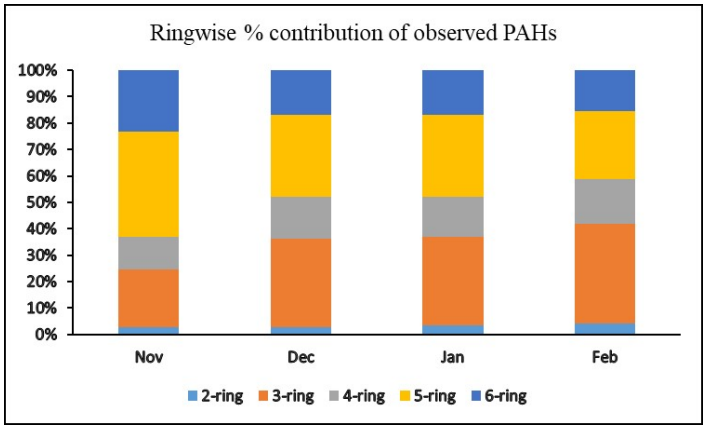

Figure: Ringwise % contribution of observed PAHs at the sampling site.

Seven PAHs, namely B[a]A, Chry, B[b]F, B[k]F, B[a]P, DB[ah]A, and I[cd]P classified as carcinogenic (Group 1), and probable and possible carcinogen (Group 2A and 2B) by USEPA contributes about 42.6% to Σ_{16}PAHs. The concentration of B[a]P, the most carcinogenic species among the known PAHs was 8.2±9.5 ng/m^3, which is more than 8 times the annual B[a]P National Ambient Air Quality Standard in India (1 ng/m^3). The total carcinogenicity due to the observed concentration of 16 PAHs was calculated as B[a]P equivalent (B[a]P_{eq}) using toxic equivalency factor values given by Nisbet and Lagoy[1], and that was 29.3 ng/m^3. Incremental lifetime cancer risk calculated using mean B[a]P_{eq} values as a surrogate for the total toxicity due to Σ_{16}PAHs and it was found that if the observed concentration of B[a]P_{eq} is inhaled by the Delhi population for a lifetime, then for a unit cancer risk of 8.7E−05, ~36 cancer cases per million population may occur. The source apportionment tools viz. molecular diagnostic ratio and principal component analysis have identified vehicular emission, fossil fuel, wood, and biomass burning as the leading sources of PAHs in Delhi. Backward wind trajectories constructed with the help of HYSPLIT transport and dispersion model suggest incursion of regional and transboundary pollutants in Delhi.

[1] Nisbet, I. C., & Lagoy, P. K. (1992). Toxic equivalency factors (TEFs) for polycyclic aromatic hydrocarbons (PAHs). *Regulatory toxicology and pharmacology*, *16*(3), 290-300.