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Assessment of Seasonal Mutagenicity in PM1 Organic Extracts from Agra's Urban Atmosphere by Ames Test

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Abstract

This study aimed to evaluate the mutagenic potential of PM_1 organic extracts using the Ames test both with and without metabolic activation by employing *Salmonella typhimurium* strains TA98 (to detect frameshift mutations) and TA100 (to detect base-pair substitutions) and quantify polycyclic aromatic hydrocarbons (PAHs) using Gas Chromatography-Mass Spectrometry (GC-MS). Weekly samples were collected over a one-year period (2021-2022) from urban locations in Agra, utilizing an Envirotech APM577 sampler. The annual mean concentration of PM_1 was found to be 82.9 ± 33.4 µg/m³, while the mean concentration of the sixteen priority PAHs (∑16PAHs) was 374.5 ± 17.2 ng/m³. Low-molecular-weight (LMW) PAHs, constituted 22 ± 2 % of the total PAHs associated with PM_1, whereas high-molecular-weight (HMW) PAHs comprised the remaining 80 ±12 %. The concentration of carcinogenic PAHs (∑PAH carcinogens) was recorded at 251.6 ± 10.2 ng/m³. It was further observed that TA98 showed a six-fold increase in mutagenic response in winter compared to post-monsoon, while TA100 showed a 1.5-fold increase. This suggests a dominance of direct-acting compounds in winter. Conversely, the addition of S9 resulted in a three-fold increase in the mutagenic response in TA98 and a 2.5-fold increase in TA100 in post-monsoon, indicating a prevalence of indirect mutagens during this period. The mutagenic response was particularly pronounced in the TA100 strain, which is more sensitive to base pair mutations. Notably, the addition of the S9 mix did not significantly affect mutagenic activity in the TA100 strain, suggesting that direct mutagenesis is likely driven by nitrogenated and oxygenated compounds. However, in the TA98 strain, the mutagenic response increased with the addition of the S9 mix in samples collected during the summer and post-monsoon seasons. In contrast, winter samples showed a higher mutagenic response without the S9 mix, highlighting the complex interaction between air pollutants and their mutagenic potential across different seasons.

Correlation analysis revealed significant positive correlations between PAHs and mutagenic ratio for both total PAHs and individual PAH compounds, such as Benzo (a)Pyrene (B[a]P) r = 0.7, Benzo (b) Fluoranthene (B[b]F) r = 0.5, and Acenaphthene (Ace) r = 0.7. These results underscore the significant role of PAHs in driving mutagenicity in urban air and emphasize the health risks associated with air pollution. The pronounced mutagenic effects observed, particularly during the winter and post-monsoon seasons, suggest that these PM_1-bound compounds pose a substantial risk to public health in urban environments.

Keywords: PM_1, PAHs, Frameshift mutation, Base pair mutation, Metabolic activation