$PM_{2.5}$-Bound Dioxins and Furans in Urban Air: Congener Profiles, Sources and Health Risks

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Abstract

Polychlorinated dibenzo-*p*-dioxins (dioxins) and polychlorinated dibenzofurans (furans) are persistent organic pollutants that are toxic and prone to bind with fine particulate matter ($PM_{2.5}$), posing potential health risks by inhalation. This study aimed to quantify the levels of dioxins/furans in $PM_{2.5}$ from the urban air of Kuala Lumpur, investigate the potential sources contributing to atmospheric dioxins/furans and assess the health risks associated with inhalation exposure. $PM_{2.5}$ samples were collected on quartz microfibre using a high-volume sampler. The analysis of dioxins/furans was performed using gas chromatograph-high-resolution mass spectrometry equipment. The potential sources were apportioned using a positive matrix factorisation (PMF) model. Carcinogenic and non-carcinogenic health risk assessments for children and adults were estimated using the United States Environmental Protection Agency (USEPA) approach. The average $PM_{2.5}$ concentration was 18.4 ± 8.9 μg m^{-3} with approximately 62% of daily $PM_{2.5}$ samples exceeding the World Health Organization 2018 guideline. The average dioxins/furans concentration in $PM_{2.5}$ was 6332 ± 3558 fg m^{-3}, corresponding to the toxic equivalent (TEQ) concentration of 223 ± 161 fg WHO-TEQ m^{-3}. $PM_{2.5}$ displayed a significantly good correlation with total dioxins and furans ($r = 0.702$, $p < 0.01$). The higher chlorinated congener groups (hepta- and octa-) dominated up to 80% of the overall dioxins and furans. The PMF model suggests that traffic-related emissions (38%) are the primary sources of dioxins/furans in $PM_{2.5}$, followed by clinical waste incinerator (25%), industrial emissions (21%) and local combustion (16%). Cancer risks estimated a likelihood of 2.3 cases per million adults and 0.7 cases per million children developing cancer resulting from inhalation exposure to $PM_{2.5}$-bound dioxins/furans in their lifetime. Non-carcinogenic effects are negligible in all cases. This study discovered that the dioxins/furans in $PM_{2.5}$ were dominated by less toxic congener groups (hepta- and octa-), posing tolerable health risks to the urban population of Kuala Lumpur.

Early Career Scientist

NO, I am not an early career scientist.

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