Oxidative Potential as a Health Risk Estimation of Ambient $PM_{2.5}$ in Chiang Mai City, Northern Thailand: A Study in 2021

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Abstracts

This study aims to ascertain the oxidative potential (OP) of $PM_{2.5}$ in Chiang Mai (CM) City, Northern Thailand, which suffers from severe air pollution involving health risk. The dithiothreitol assay (DTT) was used to analyze the OP of 53 samples of $PM_{2.5}$ filters collected between January and April 2021 using a medium-volume air sampler with a flow rate of 100 L/minute for 24 hours every other day. We analyzed components of $PM_{2.5}$ including carbonaceous content [i.e., organic carbon (OC), elemental carbon (EC), water soluble organic carbon (WSOC)], eight water-soluble inorganic ions (WSIIs), and twenty-one metal components.

The study found that OP^{DTTv} (volume-normalized DTT activity) in $PM_{2.5}$ had an average of 0.13 ± 0.01 nmol/min/m^3 and OP^{DTTm} (mass-normalized DTT activity) of 2.44 ± 0.24 pmol/min/μg. OP^{DTTv} was moderately correlated with carbonaceous components (r = 0.44 - 0.50, P <0.01), WSIIs components (r = 0.41 - 0.55, P <0.01), and metal components (r = 0.40 - 0.48, P <0.01). There is no significant positive correlation between such $PM_{2.5}$ components and the OP^{DTTm} found in this study. Interestingly, moderate positive correlations were observed between OP^{DTTv} and potassium (K, K^+) and WSOC, indicating that these sources were primarily derived from biomass combustion tracers and secondary organic aerosols, respectively. Moderate positive correlations were also observed between OP^{DTTv} and secondary ions (NO_3^-, NH_4^+). The redox-active nature of NO_3^- produced by gases and free radicals led to OP^{DTTv} associations with secondary ions. Furthermore, associations were found between OP^{DTTv} and transition metals such as copper (Cu) and iron (Fe), which contribute to generating oxidative stress.

Our study showed that the OP of $PM_{2.5}$ is dominated by carbonaceous components from burning biomass, secondary organic aerosols, and transition metals. Further OP studies of other chemical components in $PM_{2.5}$ should also be explored to estimate more potential health risks.

Keywords: Oxidative potential; $PM_{2.5}$ components; Health risk; Chiang Mai City