$PM_{2.5}$-bound Metals and PAHs Collected from in Different Environments and Their Toxic Effects on *Caenorhabditis elegans*

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Abstract

$PM_{2.5}$ has been shown to disrupt developmental, neurological, and reproductive functions in in vivo models, including *Caenorhabditis elegans* (*C. elegans*). In this study, $PM_{2.5}$-bound metals and polycyclic aromatic hydrocarbons (PAHs) were analyzed in traffic-related air pollution (TRAP), urban, and industrial areas to determine whether these components contributed to the observed adverse effects in *C. elegans*. $PM_{2.5}$ collected from all three areas induced significant developmental (body growth), reproductive (brood size), neurological (head thrashing and body bending), and oxidative stress (gene expression) effects at concentrations between 1.0 and 100 mg L^{-1}. Notably, even at a low concentration of 0.1 mg L^{-1}, $PM_{2.5}$ from industrial areas caused significant impairments in locomotion and reproduction and triggered elevated reactive oxygen species (ROS) production compared to the urban and TRAP areas. Although the concentrations of $PM_{2.5}$-bound PAHs and PAH-BaPeq did not differ significantly among the three regions, the levels of toxic elements—particularly lead (Pb) and copper (Cu)—were significantly higher in industrial $PM_{2.5}$. These findings suggest that the enhanced toxicity observed in the industrial $PM_{2.5}$ samples, especially regarding reproduction, locomotion, and SOD-related ROS production at low doses, may be primarily attributable to the elevated concentrations of $PM_{2.5}$-bound heavy metals rather than PAHs. Thus, lead and copper appear to play a major role in mediating the toxic effects of $PM_{2.5}$ in *C. elegans*, particularly in the industrial area samples.

Keywords: *Caenorhabditis elegans*; $PM_{2.5}$;Polycyclic aromatic hydrocarbons (PAHs); Heavy metals.