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Urban Particulate Matter-Induced Oxidative Damage Upon DNA, Protein, and Human Lung Epithelial Cell (A549): PM2.5 is More Damaging to the Biomolecules than PM10 Because of More Mobilized Transition Metals

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The mobilizable amount of transition metals is a fraction of the total amount of the metal from urban particulate matter. Although the fraction is small, some metals (Fe, Cu) are the major participants in a reaction that generates reactive oxygen species (ROS), which can damage various biomolecules. Damaging effects of the metals can be measured by the single strand breakage (SSB) of X174 RFI DNA or the carbonyl formation of protein. In another study, we have shown that more metals are mobilized by PM2.5 than by PM10 in general. DNA SSB of >20% for PM2.5 and >15% for PM10 was observed in the presence of chelator (EDTA or citrate)/reductant (ascorbate), compared to the control (<3%) only with the chelator. The carbonyl formation by both PMs was very similar in the presence of the chelator, regardless of the kind of proteins. Compared to the control in the absence of chelator/reductant, 3.3 times and 4.9 times more carbonyl formation for PM2.5 and PM10, respectively, was obtained with BSA in the presence of chelator/reductant, showing that PM10 induced 33% more damage than PM2.5. However, 4.8 times and 1.9 times more carbonyl formation for PM2.5 and PM10, respectively, was observed with lysozyme in the presence of chelator/reductant, showing that PM2.5 induced 250% more damage than PM10. Although different proteins showed different sensitivities toward ROS, all these results indicate that the degrees of the oxidation of or damage to the biomolecules by the mobilized metals were higher with PM2.5 than with PM10. Therefore, it is expected that more metals mobilized from PM2.5 than from PM10, more damage to the biomolecules by PM2.5 than by PM10. We suggest that when the toxicity of the dust particle is considered, the particle size as well as the mobilizable fraction of the metal should be considered in place of the total amounts.