Effect of Collection Methods on Combustion Particle Physicochemical Properties and their Biological Response in Human Macrophage and Lung Epithelial-Like Cells

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Abstract

The relationship between combustion particle physicochemical properties and biological/toxicological responses are not well understood. This study focuses on one potentially complicating factor: particle collection methods. It addresses the impact of particle collection methods on laboratory-generated combustion particles produced with a jet-fuel surrogate under well-controlled combustion conditions. The three collection methods include: direct bubbling in the DI water, collection on a 200-nm PTFE filter followed by resuspension in DI water, and collection on a cold plate followed by scraping and resuspension in DI water. These three approaches yield products of combustion with important differences in particle size, particle size distribution, surface area, the presence of extractable materials in the aqueous fraction, oxidative potential, and induction of inflammatory responses in model lung cells. Among all the collection methods, only the directly bubbled sample retained the bimodal distribution of gas-phase in the suspended-phase. The directly bubbled sample had the smallest mean rms radius in the suspended phase (48.71 nm), followed by filtered (57.4 nm) and scraped (84.97 nm), as measured by multi-angle light scattering in-lined with asymmetrical flow field-flow fractionation. These size differences were confirmed by dynamic light scattering. The bubbled sample contained ~50 % of its total mass as dissolved organics, and GC-MS results for this sample showed the presence of lower molecular weight compounds that were not found in the other two samples. Also, the bubbled sample contained more polycyclic aromatic hydrocarbons compared to the other two samples. These differences in physicochemical properties affected the biological responses in THP-1 cells, which were selected to represent pulmonary macrophage-like cells. The bubbled sample induced greater oxidative potential and reactive oxygen species, which is likely related to the total amount of organic species. The scraped sample induced a higher inflammatory response (TNFα), which may be related to the surface area of this sample. These findings have important implications in understanding of the adverse impact of air pollution on human health and for research efforts to better understand the key mechanisms involved.