Improving the Efficiencies of Andersen Impactors Using Mineral-Oil-Spread Agar Plate

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As a bioaerosol sampling standard, Andersen type impactor is widely used since its invention in 1950s, including the investigation of the anthrax attacks in the United States in 2001. However, its related problems such as impaction and desiccation stress as well as particle bounce have not been solved. Here, we improved its biological collection efficiencies by plating a mineral oil layer (100 μL) onto the agar plate. An Andersen six-stage sampler and a BioStage impactor were tested with mineral-oil-spread agar plates in collecting indoor and outdoor bacterial and fungal aerosols. The effects of sampling times (5, 10 and 20 min) were also studied using the BioStage impactor when sampling environmental bioaerosols as well as aerosolized Bacillus subtilis (G+) and Escherichia coli (G-). In addition, particle bounce reduction by mineral-oil-plate was also investigated using an optical particle counter (OPC). Experimental results revealed that use of mineral-oil-spread agar plate can substantially enhance culturable bioaerosol recoveries by Andersen type impactors (p-values<0.05). The recovery enhancement was shown to depend on bioaerosol size, type, sampling time and environment. In general, more enhancements (extra 20%) were observed for last stage of the Andersen six-stage samplers compared to the BioStage impactor for 10 min sampling. When sampling aerosolized B. subtilis, E. coli and environmental aerosols, the enhancement was shown to increase with increasing sampling time, ranging from 50% increase at 5 min to ~100% at 20 min. OPC results indicated that use of mineral oil can effectively reduce the particle bounce with an average of 66% for 10 min sampling. Our work suggests that enhancements for fungal aerosols were primarily attributed to the reduced impaction stress, while for bacterial aerosols reduced impaction, desiccation and particle bounce played major roles. The developed technology can readily enhance the agar-based techniques including those high volume portable samplers for bioaerosol monitoring.

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