Effect of sampling time on the overall performance of portable microbial impactors

G. Mainelis and M. Tabayoyong
Department of Environmental Sciences, Rutgers - The State University of New Jersey, 14 College Farm Road, New Brunswick, New Jersey 08901-8551, USA

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Exposure to airborne bacteria and fungi has been linked to various negative health effects. Portable microbial samplers are being increasingly used for monitoring presence of viable bioaerosols; however, data about their performance characteristics are only starting to appear. This study is a continuation of our efforts to analyze and determine various performance characteristics of several portable microbial impactors: SMA MicroPortable, BioCulture, Microflow, Microbiological Air Sampler (MAS-100), Millipore Air Tester, SAS Super 180, and RCS High Flow when collecting bacteria and fungi both indoors and outdoors. All these samplers collect biological particles on agar media and their built-in sampling flow rates range from 30 to 180 L/min. According to our previous studies, the impactors’ cut-off size, or \( d_{50} \), range from 1.2 to 7.0 \( \mu \)m (Yao and Mainelis, 2006). In this part of the study, we analyzed whether the sampling time affects the overall performance of the portable impactors.

The experiments were performed with seven portable impactors and a BioStage impactor (Andersen N-6 equivalent), which served as a reference sampler. The bacterial and fungal samples were collected indoors and outdoors with portable impactors operating simultaneously and collecting samples for different sampling periods: \( t_s = 2, 5, 10, \) and \( 30 \) minutes. During all four different sampling periods, the reference BioStage collected samples for \( t_s = 2 \) minutes only. Overall, nine replicates for both bacteria and fungi were collected for each sampling time and environment. The collected samples were incubated at room temperature and the formed Colony Forming Units (CFUs) were counted after 24, 48 and 72 hours. Tryptic soy agar (TSA) was used for collection of bacteria, while Malt Extract Agar (MEA) was used to collect fungi. To determine the effect of sampling time, the Concentration Ratio, \( CR(t_s, i) \), was determined as

\[
CR(t_s, i) = \frac{C(t_s, i)}{C_r(t_s = 2 \text{ min})}
\]

where \( C(t_s, i) \) is a concentration determined by a test sampler \( i \) during sampling time \( t_s \), and the \( C_r \) is a concentration measured by a reference sampler. This procedure was applied for both bacteria and fungi and for both sampling environments.

The indoor bacterial and fungal concentrations measured by the reference BioStage impactor was generally below 100 CFU/m\(^3\). The average CR for the portable impactors at \( t_s = 2 \) min when sampling bacteria was 0.3 and decreased to 0.15 for \( t_s = 30 \) min. The values for fungi were 0.44 and 0.27, respectively. Both the effect of sampling time \( t_s \) and the impactor model were statistically significant (\( p<0.0005 \)).

The preliminary outdoor sampling experiments indicated that for most of the samplers, sampling times above 5 min caused CFU overload, therefore the procedure was modified in the following way: all samplers were operated for 2 min outdoors and then were brought into a clean environment where they sampled clean air only (no particles present) for \( t_s – 2 \) min. This experiment was designed to investigate a potential desiccation effect, once the microorganisms are already deposited on agar.

According to the reference sampler, the outdoor bacterial concentrations ranged from 200 to 2,000 CFU/m\(^3\), while fungal concentrations ranged from 600 to 8,000 CFU/m\(^3\). The average CR for the portable impactors at \( t_s = 2 \) min when sampling bacteria was 0.43 and decreased to 0.03 for \( t_s = 30 \) min. The values for fungi were 0.27 and 0.02, respectively. Both the effect of sampling time \( t_s \) and the impactor model were statistically significant (\( p<0.0005 \)).

This research shows that sampling time may play a significant and substantial role in both indoor and outdoor environments when determining bioaerosol concentration. Due to desiccation of already collected microorganisms by the air passing through the samplers, their recovery could be reduced by a factor as high as 10.

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