Continuous bioaerosol sampling using inertial microfluidics

Jeongan Choi and Jae Hee Jung

Center for Environment, Health and Welfare Research, Korea Institute of Science and Technology (KIST), Seongbuk-gu, Seoul 02792, Republic of Korea
Keywords: Real-time Sampling, Bioaerosol, Particle Inertia, Microchannel
Presenting author email: jaehee@kist.re.kr

As indoor air quality (IAQ) management has become an important issue in modern society, there is a great deal of research interest in the presence of bioaerosols, which are airborne particulate matter of biological origin, in relation to their adverse health effects (Goyer, 2001; Nazaroff, 2014). As bioaerosols can travel freely with air flow and can spread over a wide area over a short period, exposure to high concentrations of these toxic bioaerosols can have harmful effects in humans. Therefore, for active disease control and to minimize bioaerosol exposure risk, there is a requirement for effective bioaerosol monitoring systems, including continuous bioaerosol sampling and rapid analysis (Jung and Lee, 2013; Fraser et al., 2009; Agranovski et al., 2004).

Here, we present a novel bioaerosol sampling technique based on inertial microfluidics with two-phase continuous flow. This two-phase fluid, sampling air and collecting liquid, stably forms a stratified flow in the simple curved-microfluidic channel composed of one curve with an angle of 180°, two inlets, and two outlets in a single microchip. The collecting liquid covers the outer wall of the channel during bioaerosol sampling. For collection, the particles are transferred from air to the liquid phase by centrifugal and drag forces by passing fluids through the curved region.

This microfluidic-based aerosol-into-liquid sampling system, called the MicroSampler, is driven by particle inertial differences. The operating performance of MicroSampler was evaluated using standard polystyrene-latex (PSL) particles and a real-time particle analyzer. For application to the bacterial bioaerosol sampling (*Staphylococcus epidermidis*), the various characteristics of the MicroSampler system with regard to physical collection capability and microbial recovery (i.e., culturability) were investigated in comparison with conventional bioaerosol samplers, such as gelatin filters and BioSampler.

The cut-off diameter of particle collection was selected controlling the air flow velocity (microfluidic air flow of 0.6 L/min showed a particle collection efficiency of ~98% at a particle diameter of 1 μm), and continuous enriched particle sampling was possible for real-time post-processing application. With regard to biological collection efficiency, the MicroSampler showed superior microbial recovery (*S. epidermidis*) compared to the conventional BioSampler technique. The MicroSampler makes it possible to perform size-selective particle sampling with high collection efficiency and rapid recognition with a low air sample volume.

Our results indicated that the developed system represents a significant step forward as an inexpensive, simple, portable and continuous inertial bioaerosol collector for real-time bioaerosol detection.

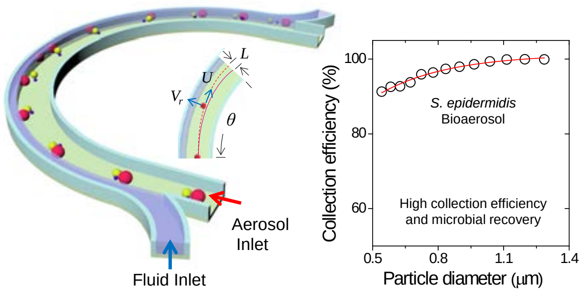

Figure 1. Schematics of continuous aerosol sampling based on inertial microfluidics and its particle collection performance (%) (*S. epidermidis*)

This research was supported by the KIST Institutional Program.

Gralton, E., Tovey, M. Mclaws and Rawlinson, W. D. (2011) *J. Infection*, **62**, 1-13.

Goyer, N. *Bioaerosols in the Workplace: Evaluation, Control and Prevention Guide: Technical Guide*, Montreal: IRSST, (2001).

Nazaroff, W. (2014) *Indoor Air*, **26**, 61-78.

Jung, J. H. and Lee, J. E. (2013) *J. Aerosol Sci.*, **65**, 101-110.

Fraser, C. et al. (2009) *Science*, **324**, 1557-1561.

Agranovski, I. E. et al. (2004) *Atmos. Environ.*, **38**, 3879-3884.