Next generation instrumentation to study infectious species on an aerosol

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The need for a detailed understanding of the factors that determine the lifetime of aerosolized microorganisms is crucial to predict and mitigate the outbreak of disease. Although critical, the study of bioaerosol while suspended in air is challenging for a number of reasons: (1) the stable, reliable and gentle generation of a bioaerosol is key to producing consistent results, (2) the bioaerosol must be suspended for prolonged periods of time in a stable and tailorable environment, and (3) the bioaerosol must be readily removed from the gas phase and deposited onto a substrate for further analysis (e.g. test viability).

The technology to be presented addresses each of these critical issues in bioaerosol longevity analysis. The technology utilizes piezoelectric droplet on demand dispensers to gently produce droplets of known and designed composition. These droplets are injected into an electrodynamic trap where they remain suspended at the null point of the trap for any desired period of time (Figure 1).

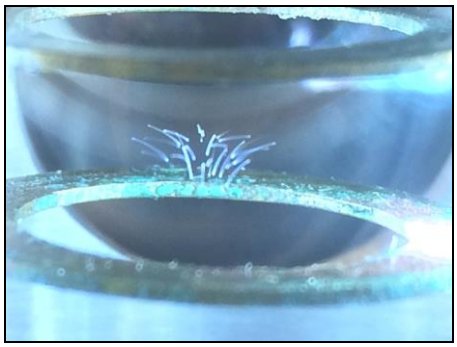

Figure 1. A population of >15 individual droplets, each containing ~20 CFU of *e. coli*.

The population of droplets (whose absolute number can be readily counted) are then removed from the trap and directly deposited onto a substrate, whose composition can be anything, including agar, dry petri dish or liquid broth. The absolute number of colony forming units (CFUs) per population of droplets is then quantified offline.

There are numerous advantages to this technology over conventional techniques. First, the employment of a droplet on demand dispenser to produce the droplets ensures that no damage is caused to the bacteria during the aerosolization process, a common problem found via conventional nebulization methods (Zhen *et al.*, 2013; Zhen *et al.* 2014). Additionally, the size distribution of the droplets produced by a droplet dispenser is highly reproducible, ensuring that the composition of the droplets (including CFU per droplet) remains constant.

The interior volume of the electrodynamic trap is 110 mL, with the air (whose composition is known and tailorable) that flows through the trap at a rate of upwards of 200 mL/min. This ensures that the composition of the gas phase that the droplets interact with is constant, and not affected by the droplets themselves.

By manipulating the substrate which the bioaerosol is deposited onto, the general health of the bacteria within the droplet can be probed; differences between longevity and infectivity of the species in the droplet may be inferred.

Some of the initial findings from this technology will be presented. For example, *e. coli* longevity as a function of time and environmental conditions was measured and compared to previously reported literature values (Figure 2).

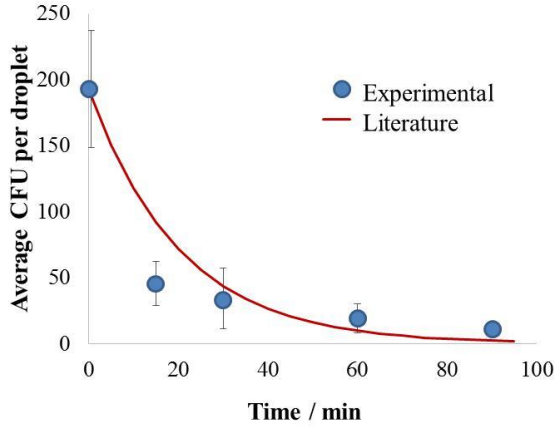

Figure 2. Decline in the CFU (*e. coli*) per droplet as a function of time, at a relative humidity of 50%. Experimental data is compared to values reported in the literature.

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