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Portable automatic bioaerosol sampling system for rapid on-site detection of targeted airborne microorganisms

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Abstract

Bioaerosols could cause various severe human and animal diseases and their opportune and qualitative precise detection and control is becoming a significant scientific and technological topic for consideration. Over the last few decades bioaerosol detection has become an important bio-defense related issue. Many types of portable and stationary bioaerosol samplers have been developed and, in some cases, integrated into automated detection systems utilizing various microbiological techniques for analysis of collected microbes. This paper describes a personal sampler used in conjunction with a portable real-time PCR technique. It was found that a single fluorescent dye could be successfully used in multiplex format for qualitative detection of numerous targeted bioaerosols in one PCR tube making the suggested technology a reliable "first alert" device. This approach has been specifically developed and successfully verified for rapid detection of targeted microorganisms by portable PCR devices, which is especially important under field conditions, where the number of microorganisms of interest usually exceeds the number of available PCR reaction tubes. The approach allows detecting targeted microorganisms and triggering some corresponding sanitary and quarantine procedures to localize possible spread of dangerous infections. Following detailed analysis of the sample under controlled laboratory conditions could be used to exactly identify which particular microorganism out of a targeted group has been rapidly detected in the field. It was also found that the personal sampler has a collection efficiency higher than 90% even for small-sized viruses (>20 nm) and stable performance over extended operating periods. In addition, it was found that for microorganisms used in this project (bacteriophages MS2 and T4) elimination of nucleic acids isolation and purification steps during sample preparation does not lead to the system sensitivity reduction, which is extremely important for development of miniature bioaerosol monitoring instrumentation in the future.

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