Micro(bio-)calorimetry - Instrument and Method Development for Microbiological Drinking Water Analysis

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Abstract:

Drinking water is one of the most valuable resources on our planet and forms the fundament for a healthy life. Lack of hygiene and poor maintenance threaten the cleanliness and quality of drinking water, especially from a microbiological point of view. Pathogenic microorganisms like coliform bacteria, Legionella species and faecal germs pose an immediate threat to our health. For more than 100 years, microbiological drinking water analysis has been based on the simple but time-consuming enumeration of colony-forming units on agar plates. A defined sample volume is applied directly to a solid culture medium (0.5 to 1 mL), or a pre-enrichment step is performed using membrane filtration (50 to 100 mL) and the culture is then incubated. The analytical procedure is precisely prescribed by various ISO standards and requires between 2 (*P. aeruginosa*) and 10 days (*L. pneumophila*), depending on the pathogen.

Although there are already many applications of calorimetric detection of pathogens, these are often limited to bacteriological studies of body fluids [1,2]. Interestingly, applications for microcalorimetry in the context of detecting microbial contaminations in drinking water are rare [3]. In addition, the microcalorimeters currently available are not specifically designed for microbiological analyses or are limited to the use of conventional cultivation techniques, which are defined in the ISO standards.

In order to overcome the current instrument limitations and application gaps in calorimetric analysis of drinking water samples, this work is based on three main research issues: (i) the systematic investigation of conventional cultivation techniques in the context of calorimetric detection of microorganisms, (ii) the evaluation of selective culture media for calorimetric detection of *Legionella pneumophila*, and (iii) the development and testing of an early-engineer micro(bio-)calorimeter, specifically designed for microbiological analysis.

Our results demonstrate that (i) conventional cultivation techniques are transferable to calorimetric detection [4], although commercial microcalorimeters have some limitations, (ii) target bacteria-oriented calorimetric detection via selective media can be a promising approach in drinking water analysis, and (iii) the novel micro(bio-)calorimeter has been successfully tested on reference strains and cooling tower samples.

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