Flow-based chemiluminescence microarrays as tool for rapid detection of pathogens and toxins

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Introduction

Small quantities of hazardous contaminants like pathogens and toxins have to be identified as fast as possible to prevent outbreaks associated with water, food and air. Therefore, rapid concentration and detection technologies are emergently needed to replace cultivation methods in future. Microarray-based detection methods are needed to detect the entity of possible pathogens and toxins in parallel.

Methods and Results

A hygiene online monitoring (HOLM) system was established for the analysis of pathogenic viruses and bacteria in raw water and drinking water. Ultrafiltration, monolithic adsorption filtration, centrifugal ultrafiltration was combined to reduce sample volumes from 1 m^3 to 1 mL in 2 h. After nucleic acid extraction, DNA of bacteria and viruses was amplified on DNA microarrays by means of heterogeneous asymmetric recombinase polymerase amplification (haRPA) reaction. The detection was processed automatically on the flow-based chemiluminescence microarray analysis platform MCR 3.[1] We have shown that bacteriophages spiked in a drinking water pipeline (flow rate 14 m^3/h) could be found after 40 m by our developed HOLM system.

Another example is the detection of *Legionella pneumophila*. Legionellosis outbreaks have occurred consistently during the last years worldwide. Aerosolized *L. pneumophila* from evaporative cooling towers were found frequently as source. *Legionella pneumophila* are concentrated in acidified process water with high efficiency by combining monolithic adsorption filtration and centrifugal ultrafiltration.[2] Concentrated samples are quantified by flow-based chemiluminescence sandwich microarray immunoassays (CL-SMIA). Viable *Legionella* spp. can be quantified by combination of promidium monoazide treatment and haRPA analysis.[3] The measurement of *Legionella* spp. by PMA-haRPA is important for rapid risk assessment qualifying the hygiene status of evaporative cooling towers which are treated with biocides.

The detection of Staphylococcus enterotoxins B (SEB) in milk is important for food safety. Superparamagnetic iron oxide-shell silica-core nanocomposites were synthesized as a new material for immunomagnetic separation (IMS).[4] IMS is combined with CL-SMIA to quantify SEB in 100-mL milk samples. The detection limit could be reduced from 0.13 µg/L (CL-SMIA) to 0.39 ng/L (IMS-CL-SMIA).

Conclusion

Flow-based chemiluminescence microarrays are a powerful analytical tool for rapid and multiplexed quantification of pathogens and toxins in water and food samples. Combination of concentration methods and microarray-based analysis is important to quantify bioorganic traces in large volume sample volumes like water or milk.

Bibiography

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