Sensitive low-cost CCD-based detector for determination of UV-LED water microbial disinfection

Reuven Rasooly*, Ziv Magoz, Ji Luo, Paula Do, Bradley J. Hernlem

Western Regional Research Center, Foodborne Toxin Detection & Prevention Research Unit, Agricultural Research Service, United States Department of Agriculture, Albany, CA 94710, USA, Tel. +1-510-559-6478; email: reuven.rasooly@ars.usda.gov (R. Rasooly)

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ABSTRACT

Ultraviolet (UV) is widely used for bacterial disinfection of water, mainly derived from low-pressure mercury UV (LP-UV) lamps. The newly developed UV light-emitting diodes (UV-LEDs) have been of great interest as an alternative to LP-UV. Because of the lack of uniformity in research materials and methods and because no standard methods are available for UV-LEDs, it becomes difficult to make comparisons of alternative microbial disinfection. To overcome some of these limitations we present here a simple low cost new charge coupled device (CCD)-based sensitive method for determination of UV-LED microbial disinfection of water. The system was tested for UV-LED disinfection using a novel internal reflection UV-LED flow-through reactor. Samples of 200 mL water were spiked with 1,000,000 CFU (colony forming unit) pGlo fluorescent Escherichia coli and treated for 4 min with different UV-LED fluence (UV dose). To improve detection at low cell number we used filtration of a relatively large sample volume, the membrane filters were placed on agar plates containing arabinose that regulates the expression of the green fluorescent protein in the live bacterium and their viability was quantified by measuring their fluorescence with a CCD camera enabling detection of very low number of cells (0.62 cells/mL). The number of viable cells decreased with the increased level of UV illumination. At level of 100% illumination the disinfection was ~99.99% and the CCD-based detection was in agreement with a commercial detector system. These results demonstrate the potential of the CCD-based method combined with fluorescence E. coli to standardize UV-LED water microbial disinfection. Also, it compares the effectiveness of technologies for flow rate and UV radiation level for water disinfection.

Keywords: UV-LED; Disinfection; CCD; GFP; CFU

* Corresponding author.