Can solar driven processes effectively control antibiotic resistance and cytotoxicity during drinking water treatment?

Antibiotics, antibiotic resistant bacteria and antibiotic resistant genes have been detected in various aquatic environments because of the disposal of both treated and untreated wastewater. Their occurrence in water is a threat for human and animal health worldwide because they can promote antibiotic resistance (AR) spread, thus reducing the therapeutic potential of antibiotics against human and animal pathogens. The lack of groundwater sources in several geographical area worldwide make surface water the best alternative option for producing drinking water. But, because of the higher risk of contamination compared to groundwater, surface water should be properly treated and/or disinfected before potable use.

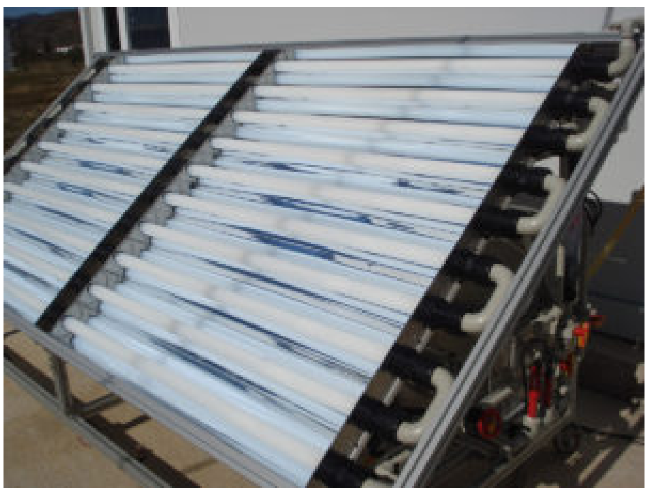

Fig. 1. Solar reactor for water treatment

Water disinfection may be a possible solution to minimize AR spread but conventional processes, such as chlorination, result in the formation of dangerous disinfection by-products (DBPs). As matter of fact, chlorine reacts with organic matter and other precursors to form regulated and emerging carcinogenic DBPs (e.g., trihalomethanes). Epidemiological studies have shown that consumption or exposure to DBPs concentrations above the maximum containment level in water can be associated with problems of liver, kidney, the central nervous system and increased risks of bladder, and colorectal cancers.

In order to find effective disinfection processes, alternative to chlorination, in this study oxidants/catalysts were coupled with UV radiation (H_2O_2/UV, TiO_2/UV and N-TiO_2/UV) (also known as Advanced Oxidation Processes (AOPs)), to be compared with chlorination in the inactivation of an AR *Escherichia coli* (*E. coli*) strain in surface water. In AOPs, UV artificial light can be replaced with sunlight thus saving energy costs and making solar driven AOPs a feasible and attractive option to produce drinking water in small communities (Fig. 1).

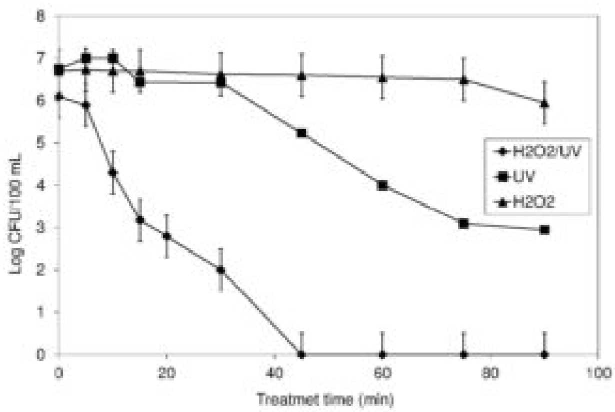

Fig. 2. Inactivation of AR *E. coli* strain by H_2O_2/UV, UV and H_2O_2

In this work sunlight was simulated by a special UV lamp to address experimental need. Under the investigated conditions, chlorination (1.0 mg L^{-1}) was the faster process (2.5 min) to achieve total inactivation of the initial bacterial density. Among AOPs, H_2O_2/UV resulted in the best inactivation rate: total inactivation was achieved in 45 min treatment (Fig. 2). Moreover, in spite chlorination of surface water results in the formation of toxic by-products (among which chloroform), cytotoxicity tests did not show significant differences between the two investigated processes. Accordingly, further studies need to show that these new disinfection processes are a reliable alternative to chlorination.

Luigi Rizzo
University of Salerno, Department of Civil Engineering, 84084 Fisciano (SA), Italy

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