Case Study: Solar Disinfection in India

On a global basis, around two million deaths every year are attributed to water-borne diseases, especially to childhood diarrhoea and dysentery. In India, almost three-quarters of a billion people live in rural areas without access to safe drinking water, where water-borne infections are a major cause of illness. Water treatment methods used at the household level in such rural communities include boiling, small-scale filtration, and chemical disinfection, but factors such as high cost and the unavailability of fuel or chemical disinfectants can limit their effectiveness. Solar disinfection is an alternative, sustainable low-cost approach for water treatment in locations where sunlight is plentiful: it involves exposing water kept in transparent bottles to sunlight for several hours. The UV and shortwave visible components of the sunlight inactivate the bacteria as a result of photo-oxidation of key biomolecules such as membrane proteins and lipids, making it safe to drink. Discarded clear plastic soft drinks bottles can be used, thereby making the most of something that would otherwise be a waste item.

The practical applications of sunlight as a household-level water treatment process are currently under study in a collaborative project between researchers at Cochin University of Science & Technology, Kerala, India and Northumbria University, Newcastle upon Tyne, UK. The project is funded by the Wellcome Trust and involves measuring the effectiveness of sunlight for the inactivation of faecal indicator microbes such as Escherichia coli (E. coli) and similar bacteria under a range of different weather conditions across an annual cycle. The laboratory-based studies at Cochin are complemented by field evaluation of solar water treatment within rural villages in three different locations in India: the tropical region of Allepey, Kerala where monsoon rains provide plenty of water; the desert area around Jodhpur, Rajasthan where water is in short supply and where surface water in ponds is used for drinking; and the flood-prone region around Gorakhpur, Uttar Pradesh, where the water table is close to the surface and is readily contaminated.

In Cochin, Shibu Mani and Ranjit Kanjur are two researchers working with Professor Isaac Bright Singh, making regular measurements of UVA, UVB and total irradiance using Skye probes and a Spectrosense logging meter. These are then used to compare the average rate of bacterial inactivation with the overall intensity of the sunlight during illumination of the bottles, in order to establish the operational limits of the process. So far, the results indicate that the bacteria are rapidly inactivated in full-strength sunlight, with a single day of sunlight sufficient to inactivate bacteria in deliberately contaminated and in natural water samples under all but fully overcast conditions (average illumination below 300 W m^{-2}). At a practical level, if the sun is sufficiently strong to give clearly-defined shadows, then it should give consistently effective results. Inactivation can also be further enhanced by using a reflective backing, made of stainless steel to return the sunlight back through the water within the bottle.

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