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Ultra-Violet (UV): A Good Bacterial Sterilizer?

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Abstract

Introduction: The aim of this study was to improve the DISTER-UV and to perform microbiological quality control at the biomedical laboratory of the West African Polytechnic University from January 2022 to November 2022. **Methodology:** During this eleven-month prospective study, we set up a quality control device (QCD). For microbiological quality control, we performed different cultures of bacteria with different bacteriological and morphological characteristics at T0 (no sterilization) and at T30 (after 30 minutes of sterilization under DISTER-UV). **Results:** After the realization, the DCQ attached to the DISTER-UV1 allows to display of the UV wavelength present in the light box. This device also displays and alerts when the UV intensity emitted by the lamps is below 250 nm. During microbiological quality control, the cultures carried out at T30 and incubated for 24 hours did not reveal any bacterial colonies. This shows the bactericidal character of DISTER-UV-2. **Conclusion:** The improvement and the microbiological quality control allowed us to switch from DISTER-UV1 (without sensor) to DISTER-UV-2 (with sensor or DCQ). The biological control allowed us to affirm that the DISTER-UV-2 is bactericidal.

Keywords

Sterilization, Ultraviolet Radiation, Bactericide, Quality Control, Bacteria

1. Introduction

Microorganisms are classified separately from plants and animals because of their tiny size. While some are essential to life, as in the human digestive system, others can cause serious diseases and humans must constantly control their growth. Traditional techniques for controlling microorganisms, such as pasteurisation, only result in a reduction in the total amount of microorganisms. Alternative methods involving wet or dry heating, filtration and the use of chemical agents

may also have some effect, but irradiation with UV radiation is considered by far the most effective method [1].

Ultraviolet (UV) radiation is a type of radiant energy in the wavelength range between 100 and 400 nm on the electromagnetic spectrum. UV radiation has shorter wavelengths and higher energy than visible radiation (light). The shorter the wavelength, the more energetic and dangerous it is and the deeper it can penetrate living organisms. UV radiation is divided into three types: UV-A, UV-B and UV-C [2]. The latter is used to kill pathogens such as bacteria, viruses or fungi on surfaces, in air streams or in liquids.

Indeed, in the context of COVID-19, the need to sterilize hospital materials became increasingly important. As UV-C is an accessible medium, we wanted to know if it can really neutralise bacteria.

In order to do this, we use an ultraviolet sterilization device, the light box model, and an intelligent sterilization device called DISTER-UV-2.

2. Methodology

Our study was initiated by the biomedical laboratory of the West African Polytechnic University (UPOA) under the supervision of the Director of Studies of the said University. In a context of increasing frequency of healthcare associated infections, we developed an ultraviolet radiation sterilization device for the elimination of bacteria liable to contaminate medical equipment. This study was conducted over a period of 3 years, the radiation dose emitted by the DISTER-UV lamps was 15000 mJ/cm^2.

2.1. Design of a UV-C Sterilization Device

The UV-C sterilization device designed at the biomedical laboratory of the West African Polytechnic University (UPOA) was named the light box model intelligent device for sterilization by ultraviolet radiation (DISTER-UV). This UVGI device was designed and built in 24 months and can sterilize medical devices such as syringe pumps, scissors, probes, goggles, etc. (**Figure 1**).

Figure 1. Model of the DISTER-UV light box.

2.2. Bacteriology Procedure

In order to test the effectiveness of the DISTER-UV light box on the elimination of bacteria, we used pure bacterial strains to test the capacity of the DISTER to eliminate them. The choice of these bacteria for the inocula was made on the basis of well-defined criteria, namely metabolism (aerobic, aerobic-anaerobic faculty) and morphology (Gram stain and cocci or bacillus) but also the frequency of bacteria in the hospital environment. The latter were: *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*.

2.3. Disinfection Protocol

2.3.1. Sterilization of Working Materials

We used bottles as materials to be sterilized. The aim of this sterilization procedure (rinsing and cleaning with 90˚ alcohol) was to eliminate any risk of external contamination. In other words, to eliminate all bacteria that could be found on the surface of the bottles.

2.3.2. Distribution of Bacterial Inocula

The bacteria used for the sterilization tests were differently distributed in sterile Nunc tubes containing 0.5 mL of physiological water to obtain an inoculum of 10^8 CFU.

2.3.3. Sterilization Test of the Bottles by the DISTER-UV

This test consisted in verifying the capacity of the DISTER-UV to eliminate bacteria (*Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*). To test this aspect, our methodology consisted of:

- Contaminating or staining a well-defined area (framed in the wheel) at the level of the already sterilized bottles with prepared bacterial inocula.
- Put under DISTER-UV for 30 min (reference values) (**Figure 2**, **Figure 3**).

Figure 2. Bottle with contaminated area to be sterilized.

2.3.4. Bacterial Cultures

We performed control cultures on ordinary Müller-Hinton agar for each bacterial strain (cultures at T0: no sterilization). Then we took a sample using sterile swabs from the soiled part of the bottles, which were put under UV light for 30 minutes. Then inoculate the samples in nutrient culture media (GSC) (cultures at T30: after sterilization) for incubation for 24 hours.

3. Results

3.1. Control Cultures

Our work carried out at the UPOA Biomedical Laboratory in partnership with the bacteriology laboratory of the Idrissa Pouye General Hospital (HOGIP) allowed us to verify that our bacterial strains were alive (culture at T0) by plating them on ordinary MH agar. And after 24 hours of incubation, we observed good growth in MH of all the strains used (**Figure 4**, **Figure 5**).

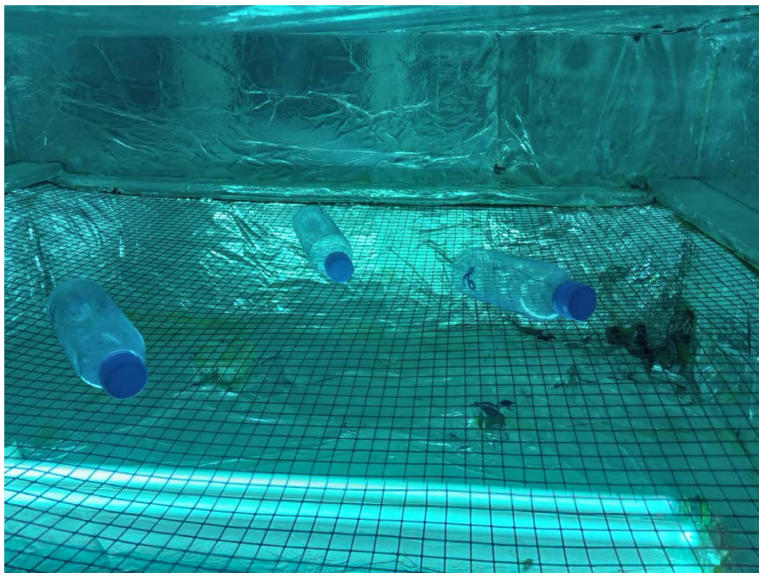

Figure 3. Bottles under DISRER-UV during the sterilization process.

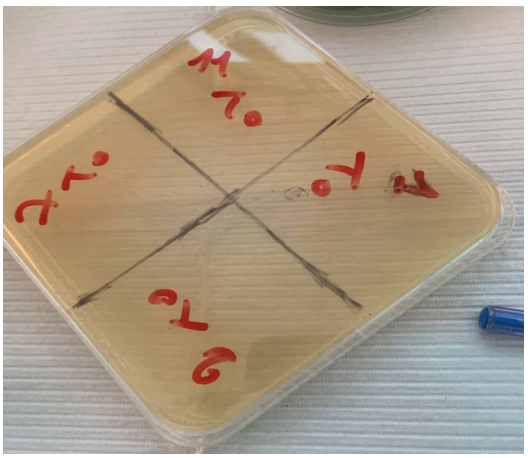

Figure 4. Pre-incubation control culture.

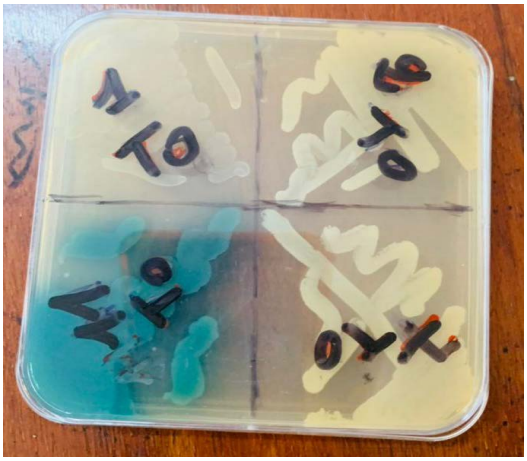

Figure 5. Control culture after 24 hours of incubation.

Table 1. Microbiological quality control of the DISTER-UV-2 lightbox.

Bacterias stains	Initial CFU	CFU after 24 hours of incubation time
E. coli	10^8	$<10^4$
K. pneumoniae	10^8	$<10^4$
P. aeruginosa	10^8	$<10^4$
S. aureus	10^8	$<10^4$

3.2. Sterility Test Cultures

It corresponds to the culture of samples taken from the soiled parts of the bottles which have already been put under DISTER-UV for 30 minutes. The absence of growth observed in all the cultures shows elimination of the bacteria (Table 1).

4. Discussion

The bacteria selected on the basis of criteria (morphological, metabolic) were alive as shown by the culture results at T0 with an absence of bacterial colony (CFU < 10^4 knowing that 1 bacterial colony = 10^4 bacteria).

The test cultures carried out after exposure of the contaminated bottles under DISTER-UV for 30 minutes were conclusive. After 24 hours of incubation, we observed no bacterial growth (<10^4 CFU) on all nutrient agars. In other words, UV-C can be considered as a good means of eliminating bacteria. A study by *S. Dessard et al.* in 2013 in which ultrasound probes were contaminated with two different concentrations of *E. coli* and *S. aureus* bacterial inocula (10^7 - 10^8 CFU) before being eliminated (sterilized) under UV for a dose of 239,428 mJ/cm^2 of UVC 90 seconds [3]. During our study, we excluded certain types of bacteria, namely strict anaerobes, which are not most often linked to healthcare associated infections.

UV-C is effective at around 263 nm but no source is currently able to emit mainly in this spectrum. The closest available source is the UV-C fluorescent tube at 254 nm [4].

5. Conclusion

Sterilization is the process of destroying all micro-organisms in food by heat, addition of antiseptics or irradiation, so as to prevent the transmission of pathogens and the development of spoilage. Sterilization by ultraviolet radiation is a method of sterilization based on the sensitivity of micro-organisms to exposure to low wavelengths of ultraviolet light. This method is not only safe for the user, but also environmentally friendly as it does not produce toxic waste. In addition, plastic materials that could not be sterilized by methods such as pasteurisation or autoclave can be sterilized with DISTER-UV.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Bolton, J.R. and Henke, L. (1999) Ultraviolet Disinfection: A Basic Primer. *Water Conditioning & Purification*, **41**, 34-38.

[2] Leung, W.Y. and Murray, V. (2021) L'influence de la méthylation de l'ADN sur la spécificité de la séquence des dommages à l'ADN induits par les UVB et les UVC. *Journal of Photochemistry and Photobiology B*: *Biology*, **221**, Article 112225.

[3] Dessard, S., De la Brière, F., Donnio, P.-Y., Ecoffey, C. and Wodey, É. (2013) La décontamination des sondes d'échographie par rayonnement ultraviolet est-elle efficace? *Annales Françaises d'Anesthésie et de Réanimation*, **32**, A327-A328. https://doi.org/10.1016/j.annfar.2013.07.611

[4] Rossi, M.C.A., Corrêa, T.Q., Blanco, K.C., Bagnato, V.S. and Salvio, A.G. (2021) Physiotherapy Elastic Band Disinfection by UV-C Irradiation in an Intensive Care Unit. *Photodiagnosis and Photodynamic Therapy*, **34**, Article No. 102262. https://doi.org/10.1016/j.pdpdt.2021.102262