Summary of evaluation

This report summarizes the results of laboratory testing of an ultraviolet (UV) disinfection device known by the tradename ‘Water Elephant’ under Round II of the World Health Organization (WHO) International Scheme to Evaluate Household Water Treatment Technologies (the Scheme). Testing followed the requirements of the WHO protocol for UV disinfection technologies. Testing investigated the ability of the device to inactivate bacteria and viruses. Reduction against protozoa was assigned based on the bacterial reduction achieved. Based on the evaluation results, the Water Elephant meets WHO performance criteria and is classified as providing Targeted protection (★) against bacteria and protozoa only.
Background

Evaluation under the Scheme is based on performance criteria set out in *Evaluating Household Water Treatment Options: Health-based targets and microbiological performance specifications* (WHO, 2011). The criteria were determined by applying quantitative microbial risk assessment (QMRA) methods outlined in the *Guidelines for Drinking-water Quality* (WHO, 2017) and set log$_{10}$ reduction targets against bacteria, viruses and protozoa, as shown in Table 1.

Table 1. WHO performance criteria for household water treatment technologies

<table>
<thead>
<tr>
<th>Performance classification</th>
<th>Bacteria (log$_{10}$ reduction required)</th>
<th>Viruses (log$_{10}$ reduction required)</th>
<th>Protozoa (log$_{10}$ reduction required)</th>
<th>Interpretation (with correct and consistent use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★★</td>
<td>≥ 4</td>
<td>≥ 5</td>
<td>≥ 4</td>
<td>Comprehensive protection</td>
</tr>
<tr>
<td>★★</td>
<td>≥ 2</td>
<td>≥ 3</td>
<td>≥ 2</td>
<td>Targeted protection</td>
</tr>
<tr>
<td>★</td>
<td>Meets at least 2-star (★★) criteria for two classes of pathogens</td>
<td></td>
<td></td>
<td>Little or no protection</td>
</tr>
<tr>
<td>—</td>
<td>Fails to meet criteria for 1-star (★)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Product description

The Water Elephant is a manually operated UV disinfection device. The device comprises a 5 L jerrycan with a UVC lamp that is powered by a manual crank. An integrated prefilter removes larger particles prior to UV disinfection. The Water Elephant has an integrated fail-safe mechanism; if UV transmittance is low, that is, too cloudy for the UV light to penetrate and sufficiently disinfect the water, a red lamp flashes and water is not dispensed. The full product description, illustrations and use instructions can be found at www.yearofwater.com.

Test methods

**Product-specific test plan:** A product-specific test plan was developed based on the manufacturer’s instructions for use; the Harmonized Testing Protocol: Technology Non-Specific V 2.0 (WHO, 2018a); and the UV Batch Systems Technology Protocol V 2.0 (2018b). Testing was conducted at a WHO-designated laboratory, NSF International, in the United States of America.

**Test organisms:** Evaluation of the Water Elephant investigated its performance in inactivating bacteria and viruses. The test organisms were *Escherichia coli* (*E. coli*) and coliphages MS2 and phiX174. Based on the available evidence on UV disinfection of bacteria and protozoan cysts, testing against this microbial groups was not conducted (WHO, 2018). Performance for the protozoan microbial group was assigned based on the performance outcome of the bacterial microbial group.

**Test waters:** The device was tested in two test waters: General Test Water (GTW), simulating high quality groundwater, and Challenge Test Water (CTW), simulating low UV transmittance / cloudy water. Due to the aforementioned fail-safe mechanism, the CTW created for the test was GTW with para-hydroxybenzoic acid added to reduce the UV transmittance to just below the alarm point. Details on the physicochemical characteristics of the test waters are available in the UV Batch Systems Technology Protocol V 2.0 (WHO 2018b) for details on the physicochemical characteristics of the test waters.

**Test set up:** Three production units were used in the test, with daily test volumes of 25 L. All units were operated according to the manufacturer’s use instructions. Pretreatment and posttreatment water grab samples were analysed using methods identified in the product-specific test plan. Testing was conducted over 4 days (in GTW on Days 1 and 2 and in CTW on Days 3 and 4), resulting in a total of 12 sample points for each organism (i.e. 2 days × 2 test waters × 3 test units).
Results

Fig. 1 presents the results of the bacterial and viral testing for the three units in GTW and CTW. All test water characteristics were within specifications.

**Fig. 1 Performance across test units**

![Graph showing performance across test units](image)

The Water Elephant achieved mean $\log_{10}$ reductions of 5.8 $E.\ coli$, 2.7 for MS2 and $\geq 5.9$ for phiX174.

Performance across the three units tested was generally consistent for all organisms tested. MS2 reduction was significantly higher in GTW than in CTW; none of the test units met the minimum viral reduction target of $3 \log_{10}$ in CTW.

**Interpretation and application of results**

As shown in Table 1, performance is classified in three ascending tiers: ★ (one-star); ★★ (two-star); and ★★★ (three-star). Both three- and two-star products provide Comprehensive protection against all three microbial groups. One-star products meet performance targets for only two of the three microbial groups, providing Targeted protection.

Each production unit should consistently meet or exceed the performance target for each microbial group, and in both test waters (GTW and CTW). A maximum deviation of $0.2 \log_{10}$ is acceptable for 25% of sample points at the two-star performance tier, and $0.4 \log_{10}$ at the three-star performance tier. This means that for classification as a two-star product, up to three of the twelve sample points can achieve a reduction of $1.8 \log_{10}$ for bacteria or protozoan cysts (instead of $2 \log_{10}$), or $2.8 \log_{10}$ for viruses (instead of $3 \log_{10}$). Each phage is treated separately for evaluating acceptable allowance; the overall reduction for viruses is based on the lower-performing phage.

---

1 The maximum microbial reduction that can be demonstrated is limited by the pretreatment challenge concentration delivered. For each organism tested, the pretreatment concentration must be sufficient to allow for the demonstration of the performance targets in the table showing the performance criteria. Due to the complexity of using viable organisms, there may be variation in these pretreatment concentrations above what is sufficient, which may lead to demonstrated reductions reported that far exceed the performance targets. However, the emphasis is on whether the performance target has been met and not the extent by which the target was exceeded.

2 These cut-off values were determined using QMRA modelling and selecting ranges that still resulted in appreciable health gains within a specific performance tier.
Performance classification

The Water Elephant met the minimum performance target of $2 \log_{10}$ for bacteria. For protozoa, performance was assigned based on the bacterial reduction achieved. The viral reduction was based on the lower performing phage MS2, which did not meet the minimum performance target of $3 \log_{10}$ in CTW. As such, the Water Elephant is classified as providing Targeted protection ($\star$) against bacteria and protozoa only.

Considerations for product selection

<table>
<thead>
<tr>
<th>Microbial conditions</th>
<th>Use where contaminants of concern are known to be bacterial / protozoan microbes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physico-chemical water characteristics</td>
<td>Use in nonturbid source water or as a secondary treatment for water that has been pretreated through e.g. filtration to reduce turbidity</td>
</tr>
<tr>
<td>Product information and labelling</td>
<td>Check that the device is appropriately labelled and has clear instructions for use</td>
</tr>
</tbody>
</table>

References


Disclaimer

Reference to any company or product in this report, particularly those listed in any of the figures and tables, does not constitute an endorsement, certification or warranty of fitness by WHO of such company or product for any purpose, and does not imply any preference over companies or products of a similar nature that are not mentioned.

WHO does not warrant that any products included in the figures and tables are of acceptable quality; have obtained regulatory approval in any country; or that their use is otherwise in accordance with the national laws and regulations of any country, including but not limited to patent laws. Evaluation under the Scheme is intended to guide UN Member States and procuring UN agencies in the selection of household water treatment (HWT) technologies. Inclusion of any products in this report, particularly in any of the figures and tables listed in the report does not furthermore imply any approval by WHO of these products (which is the sole prerogative of national authorities).

The results in this report reflect the performance level that the product was found to meet at the time of testing. WHO cannot represent that the products reported herein will continue to meet the stated performance levels. Furthermore, the results contained in this report may not be used by manufacturers, suppliers or any other parties for commercial or promotional purposes.