WHO International Scheme to Evaluate Household Water Treatment Technologies

Drop2Drink Unit

Product evaluation report

WHO performance classification	Comprehensive protection two-star (★★)
Manufacturer	D2D Water Solutions B.V. Bruchterweg 88 7772BJ Hardenberg the Netherlands www.d2dwatersolutions.com
Evaluation procedure	Abbreviated laboratory test
WHO report issue date	Round III, 2020
WHO reference	28/8/2019-R3-7

Summary of evaluation

This report summarizes the evaluation results of a combined multistage filtration and ultraviolet (UV) water treatment device known by the tradename 'Drop2Drink Unit', under Round III of the World Health Organization (WHO) International Scheme to Evaluate Household Water Treatment Technologies (the Scheme). Evaluation of the Drop2Drink Unit followed the requirements of the WHO protocol for (UV) technologies, and investigated the ability of the device to reduce bacteria and viruses. Inactivation of protozoa was assigned based on the mean bacterial inactivation achieved. Based on the evaluation results, the Drop2Drink Unit meets WHO performance criteria and is classified as providing *Comprehensive protection* (★★).

1   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 methods outlined in the WHO *Guidelines for Drinking-water Quality* (2017) and set out $\log_{10}$ reduction targets against bacteria, viruses and protozoa, as shown in the table below.

WHO performance criteria for household water treatment technologies

Performance classification	Bacteria ($\log_{10}$ reduction required)	Viruses ($\log_{10}$ reduction required)	Protozoa ($\log_{10}$ reduction required)	Interpretation (with correct and consistent use)
★★★	≥ 4	≥ 5	≥ 4	Comprehensive protection
★★	≥ 2	≥ 3	≥ 2	
★	Meets at least two-star (★★) criteria for two classes of pathogens			Targeted protection
–	Fails to meet criteria for one-star (★)			Little or no protection

Product description

The Drop2Drink Unit uses a combination of multistage filtration and UV disinfection for removal of microbial pathogens. The assembled unit comprises a membrane microfilter, an active carbon filter, a membrane ultrafilter, a UV-C disinfection chamber and an electric pump. The device is intended to treat rainwater. To operate, the device is connected to a rainwater harvesting system and electric power, and the pump draws the water through the multistage filters and UV-C chamber. The full product description, illustrations and use instructions can be found at www.d2dwatersolutions.com.

2   Evaluation approach

Product-specific test plan: A product-specific test plan was developed based on the manufacturer's instructions for use; the *WHO Scheme Harmonized Testing Protocol: Technology Non-Specific V 3.0* (WHO,2019); the *Testing Protocol for Ultraviolet Technologies ((with or without pre-filtration and/or disinfection addition) V 3.1* (WHO, 2020), and the manufacturer's use instructions. Testing was conducted at a WHO-designated laboratory, KWR Watercycle Research Institute, in the Netherlands.

Test organisms: Evaluation of the Drop2Drink Unit investigated its performance in reducing bacteria and viruses. The test organisms were *Escherichia coli* (*E. coli*) to represent bacteria, and bacteriophages MS-2 and phiX-174 to represent viruses. Based on the available evidence on protozoan inactivation by UV, testing against this microbial group was not conducted (WHO, 2019). The protozoan inactivation is assigned based on the mean bacterial inactivation achieved.

Test waters: The device was tested in two simulated natural waters: General Test Water (GTW), simulating high quality groundwater, and Challenge Test Water (CTW), simulating surface water. Refer to the *Testing Protocol for Ultraviolet Technologies ((with or without pre-filtration and/or disinfection addition) V 3.1* for details on physicochemical characteristics of the test waters.

Test set-up: Three new production units were provided by the manufacturer for the test. 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 two days, in GTW on Day 1 and in CTW on Day 2, with microbial sampling at the start and end of each test day. This resulted in a total of 12 sample points for each organism (i.e. 2 days × 2 test waters × 3 test units).

3 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.
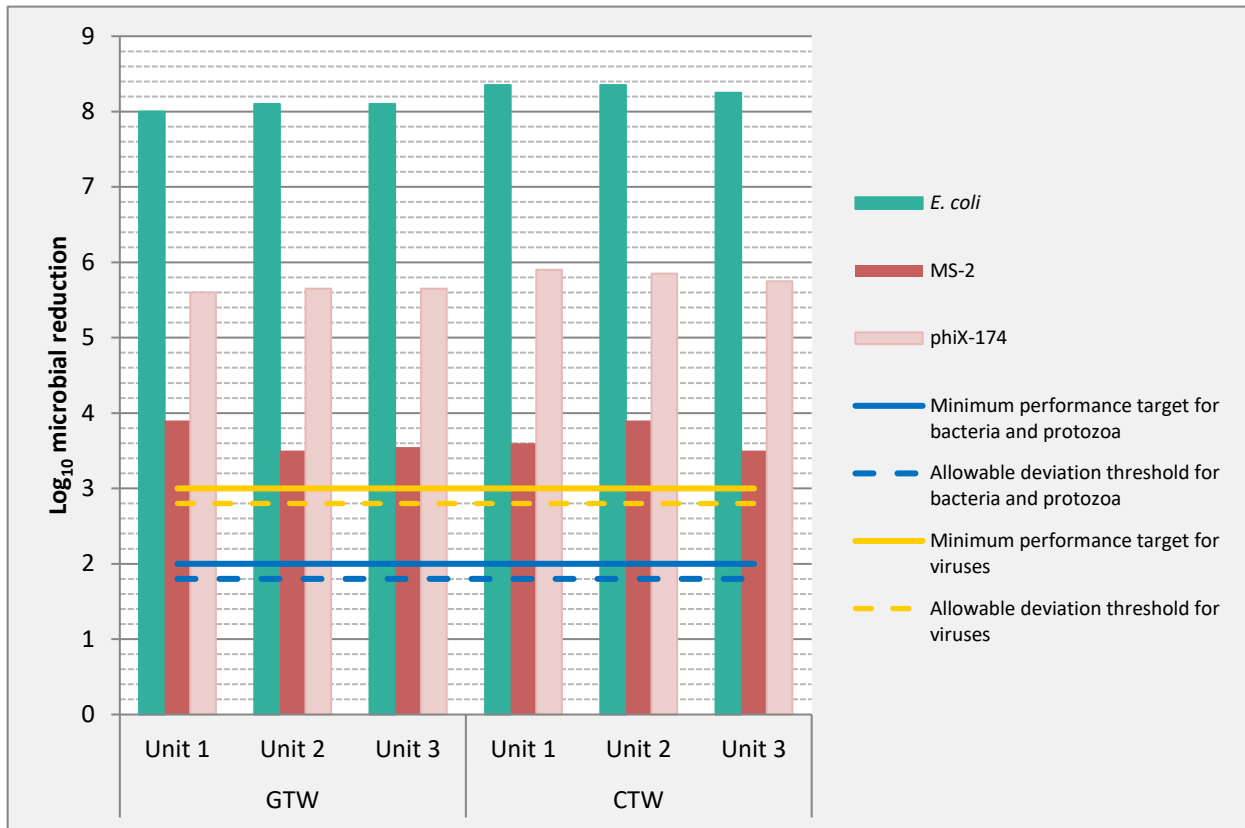

Fig. 1: Performance across test units[1]

[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.

The Drop2Drink Unit achieved a mean $\log_{10}$ reduction of 8.2 for *E. coli*; 3.7 for MS-2; and ≥ 5.7 for phiX-174. Performance was generally consistent across the three units.

4 Interpretation and application of results

Performance is classified in three ascending tiers: ★ (one-star); ★★ (two-star); and ★★★ (three-star), as shown in the table outlining performance criteria. 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 in both test waters (GTW and CTW). However, 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[1]. This means that for classification as a two-star product, up to three of the 12 sample points can achieve a minimum 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, and the overall claim for viruses is based on the lower performing phage.

Performance classification

The Drop2Drink Unit fully met minimum performance targets for bacteria and viruses. For the protozoan reduction, a value of 8.2 $\log_{10}$ is assigned, based on the mean bacterial reduction achieved. As such, the Drop2Drop Unit is classified as providing *Comprehensive protection* (★★) against all three microbial groups.

Considerations for product selection

Microbial conditions	Effective against bacteria, viruses and protozoa; can be used under all microbial water quality conditions
Physico-chemical water characteristics	Can be used in both turbid and non-turbid water
Product information and labelling	Check that the product is appropriately labelled and has clear instructions for use

References

Evaluating household water treatment options: health-based targets and microbiological performance specifications. Geneva: World Health Organization; 2011 (http://www.who.int/water_sanitation_health/publications/household_water/en/).

Guidelines for drinking-water quality, fourth edition incorporating first addendum. Geneva: World Health Organization; 2017 (http://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/).

Harmonized Testing Protocol: Technology non-specific version 3.0. Geneva: World Health Organization; 2019 (http://www.who.int/water_sanitation_health/water-quality/household/household-water-treatment-scheme-resources/en/).

Ultraviolet Technologies ((with or without pre-filtration and/or disinfection addition) Testing Protocol: version 3.1. Geneva: World Health Organization; 2020 (http://www.who.int/water_sanitation_health/water-quality/household/household-water-treatment-scheme-resources/en/).

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[1] These cut-off values were determined using QMRA modelling and selecting ranges that still resulted in appreciable health gains within a specific performance tier