WATERSPOUT

Water Sustainable Point Of Use Treatment Technologies

Evaluation of transparent 20L polyproylene buckets for household solar water disinfection (SODIS) of drinking water in resource-poor environments.

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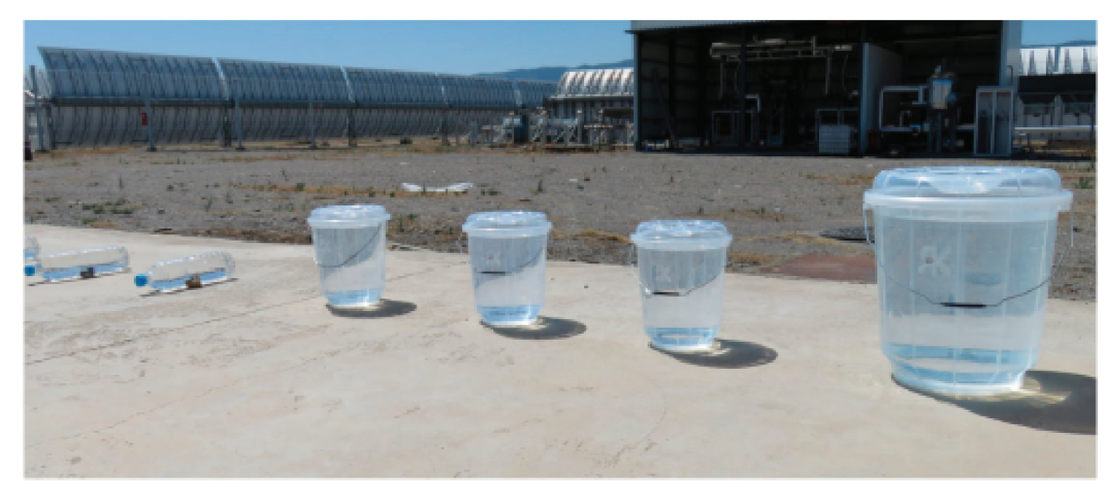
Abstract

Solar water disinfection (SODIS) is an appropriate technology for treating drinking water in developing communities, as it is effective, low- or zero-cost, easy to use.

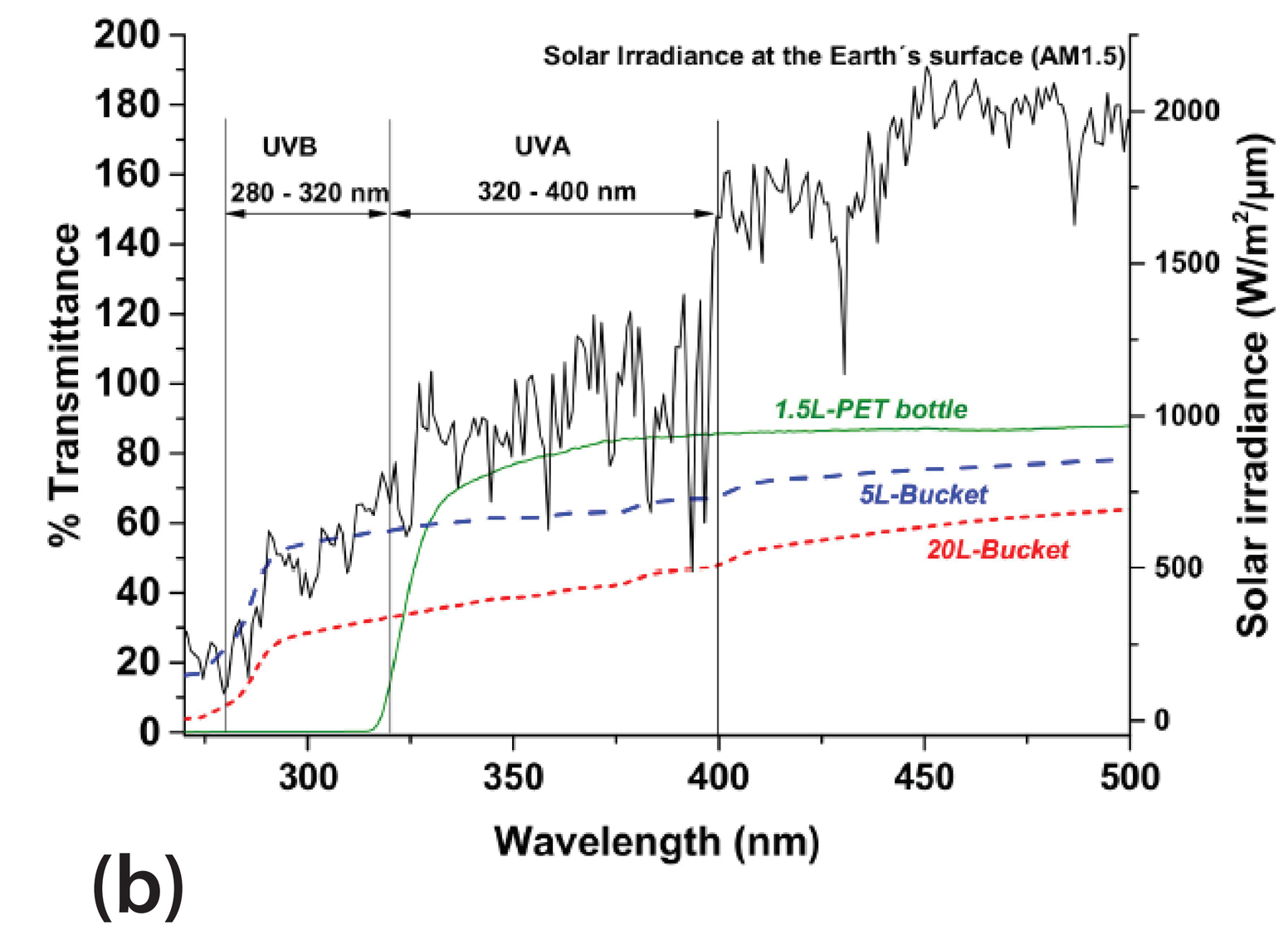
The WHO recognises SODIS as an appropriate intervention to provide drinking water after manmade or natural disasters. Nevertheless, uptake is low due partially to the burden of using small volume polyethylene terephthalate (PET) bottles (1.5-2 L).

A major challenge is to develop a low cost transparent container for disinfecting larger volumes of water.

This study examines the capability of transparent polypropylene (PP) buckets of 5 and 20 litres volume, as SODIS containers using three waterborne pathogen indicator organisms: *E. coli*, MS2-phage and *Cryptosporidium parvum* oocysts.



(a)



(b)

***Figure 1**. 5 L- and 20 L polypropylene transparent buckets and 1.5 L -PET bottles **(a)** placed at Plataforma Solar de Almeria (PSA) facilities under natural solar radiation. **(b)** Comparison of transmittance (: 250 to 600 nm) of the three SODIS containers and the local solar UV irradiance measured during one of the solar tests.*

Results

Similar inactivation kinetics were observed under natural sunlight for the inactivation of all three organisms in well water using 5 L - and 20 L -buckets compared to 1.5 L PET bottles.

A log reduction value (LRV) = 5.5 was observed under 300 kJ/m^2-UVA (3 h of solar exposure) in the 5 L - and 20 L -buckets for E. coli; 2.4 and 2.6 LRV in 5 L - and 20 L -buckets, respectively, with 500 kJ/m^2-UVA (5 h) and a reduction of *C. parvum* oocysts viability from (93.21±1.34)% to (5.92±3.73)% and (8.23±2.53)%, in the 5 L - and 20 L -buckets, respectively after 6h of solar radiation (850 Wm^{-2}-UVA).

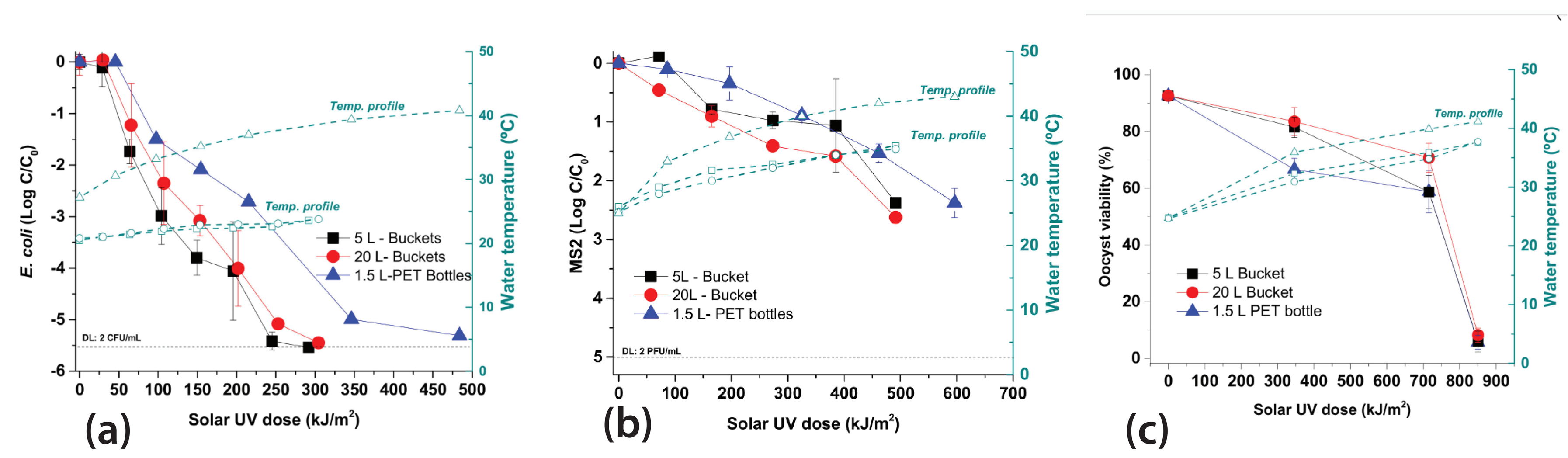


***Figure 2.** Solar inactivation of (a) E. coli, (b) MS2 coliphage and (c) C. parvum oocysts in 5 L- and 20 L-buckets against 1.5 L-PET bottles under natural sunlight.*

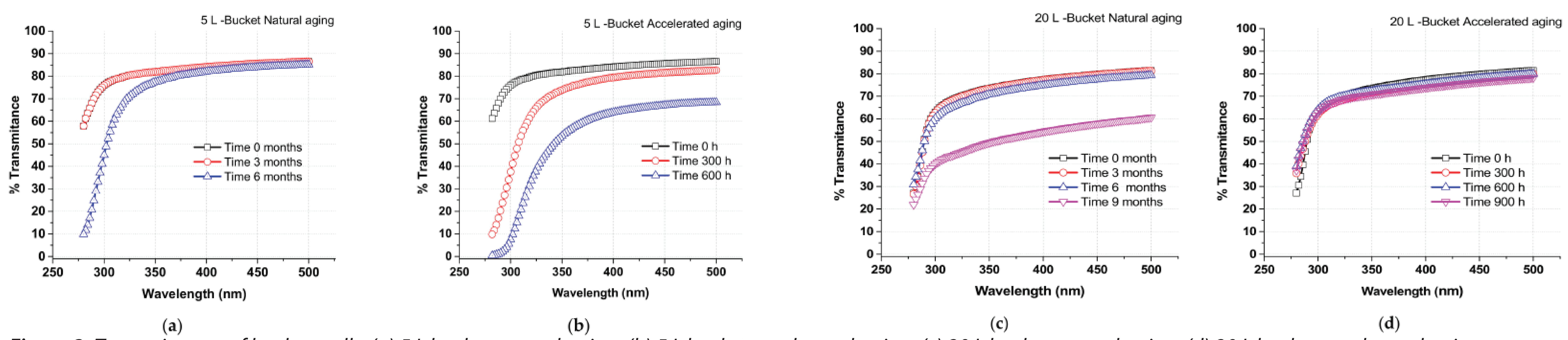


***Figure 3.** Transmittance of bucket walls. (a) 5 L bucket natural aging; (b) 5 L bucket accelerated aging; (c) 20 L bucket natural aging; (d) 20 L bucket accelerated aging. Time 0 months' symbol is sometimes overlapped with 'Time 3 months' symbol.*

The PP materials were exposed to natural and accelerated (ISO -16474) solar aging for 6 months and 600 hours, respectively. UV transmission of the 20 L-buckets remained stable and with physical integrity even after the longest aging periods.

The 5 L -buckets were physically degraded and lost significant UV-transmission, due the thinner wall (0.95mm) compared to the 20 L-bucket (1.60mm).

This works shows that transparent 20 L PP buckets represent a good alternative to PET bottles usually employed for SODIS.

***Table 1.** Constituent solar energy components after transmission through the container wall expressed in percentage*

	Ratio–Transmitted Energy Flux (W/m^2): Solar Input (W/m^2) (%)			Area (m^2)	Ratio–Spectral Fraction in a Range (W): Total Flux in the Container (W) (%)		
	UV (280–400 nm)	UV-B (280–320 nm)	UV-A (320–400 nm)		UV (280–400 nm)	UV-B (280–320 nm)	UV-A (320–400 nm)
Solar	**100**	20	80	-			
PET-1.5L	61	0	61	0.024	**100**	0.4	99.6
PP-5L	61	11	50	0.043	**100**	17.5	82.5
PP-20L	38	6	32	0.101	**100**	14.6	85.4

Conclusions

Polypropylene 20 L buckets are more robust and more UV photo-stable than 5 L PP buckets. UV induced deterioration of the thinner 5 L buckets demonstrates that they would not be suitable for SODIS use under field conditions, whereas the 20 L containers would be suitable. Transparent 20 L PP buckets are effective for solar disinfection of microbially contaminated water.

__Note:__ The results reported herein are published in Polo-López et al. Molecules 2019, 24, 2 193; doi:10.3390/molecules24112193

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688928

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