The use of SODIS for treating Harvested Rainwater

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Introduction

- Pathogenic enteric bacteria are a major cause of drinking water related morbidity and mortality in the developing world (WHO, 2008).

- Solar water disinfection (SODIS) is one of the effective affordable means for drinking water treatment.

- In this study polyethylene terephthalate (PET) bottles (1.5L) were tested under different field weather conditions for the treatment of harvested rainwater (HRW) from Makondo Sub-parish.

Solar Disinfection Method

Objectives

- To evaluate the microbial quality of harvested rain water (HRW) through the different seasons

- To assess the effectiveness of SODIS to treat harvested rain water through the different seasons of the year

Several Types of Harvested Rainwater Systems

Methodology: Map of study area

➢47 Systems were randomly selected based on size of the system, durability of HRW, nature of the system

➢A base line study was done focusing on microbial quality

➢Households using the selected HRW systems were trained in use of SODIS

➢Provided with PET bottles

➢Samples of raw and treated HRW were then taken for microbiological analysis *e.g E. coli, Enterocci, Salmonella and C. perfringens*
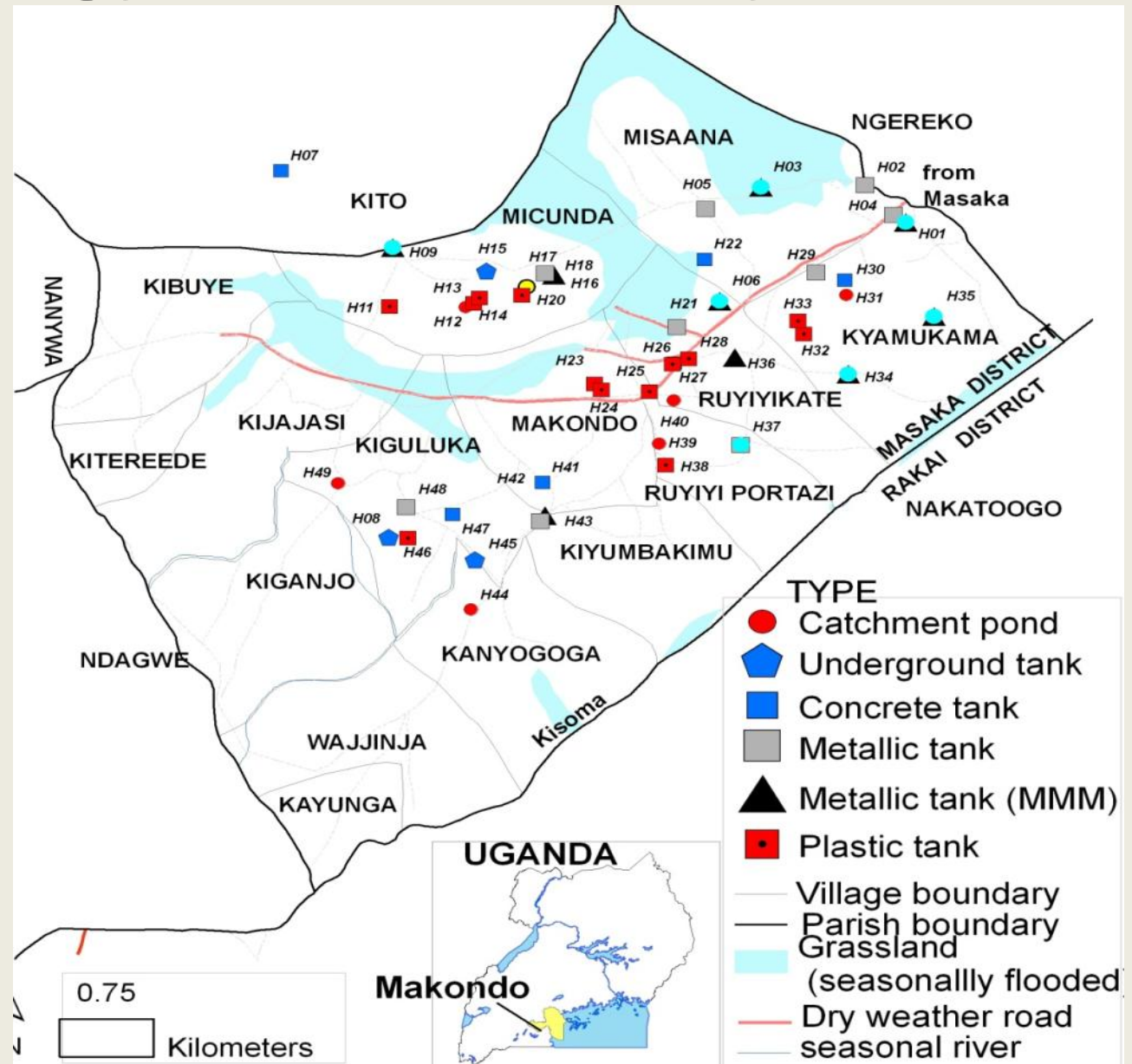
Microbial analysis

- Water was tested for *E. coli, Enterococci, Salmonella and Clostridium perfringens* using Membrane Filtration.

- Selected isolates were tested for antibiotic sensitivity

- Other parameters measured included conductivity, pH, temperature and turbidity
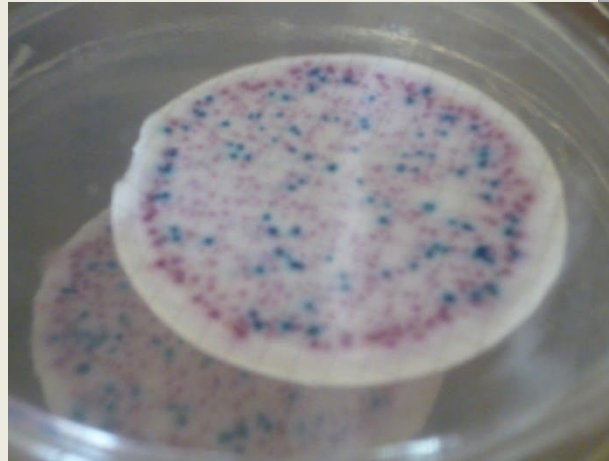
Microbial analysis

- Chromogenic agar was used to detect *E. coli* at 37°C

- *Enterococci* were tested using Slanetz and Bartley medium incubated at 44.5^{o}C

- *Salmonella* were tested using pre-enrichment procedure with Buffered peptone water at 37^{0}C, Rappaport and selenite at 42^{0}C on day 2, XLD at 37^{0}C on day 3, TSI on day 4 and biochemical tests on the following days

- *Clostridium perfringens* was tested using *C. Perfringens* agar

Total Rainfall received during the study period

Month	Total monthly Rainfall mm	Month	Total monthly Rainfall mm
Wet season 1		**Wet season 2**	
August/2011	43.3	March/2012	44.2
Sep/2011	64.7	April/2012	64.4
Oct/2011	135.9	May/2012	138.8
Nov/2011	81.6		
Dry seasons 1		**Dry season 2**	
Dec/ 2011	32	June/2012	2.9
Jan/2012	5.3	July /2012	4.2
Feb/2012	12.9		

Percentage of systems with un safe drinking HRW according to UNBS/WHO drinking water standards
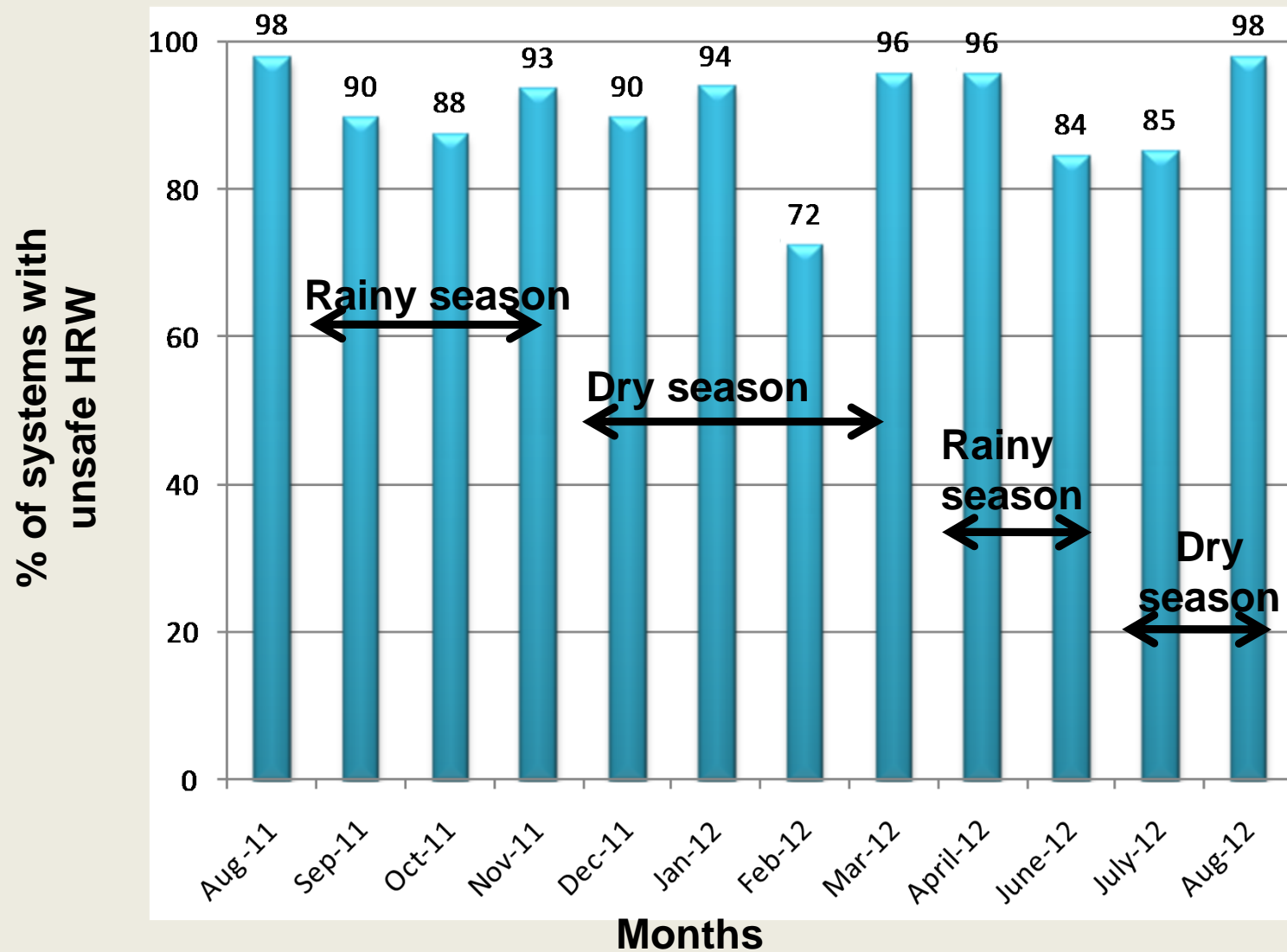
➢WHO (2008): *E. coli* and *Enterococci* not detectable in 100ml. UNBS (2008): *E. coli* and Enterococci not detectable in 100ml

Categorization of HR water systems for drinking in Makondo according to WHO (2008)

Proportion (%) of samples positive for *E. coli* if the population using the water source for drinking is <5000	Quality of water system
10	Excellent
20	Good
30	Fair
40 or more	Poor

Adapted from WHO (2008)

- ➢ HRW systems in Makondo are categorized as poor according to WHO, 2008.
- ➢ Majorly caused by poor design of the tank and human practices which lack flush through systems after the first rains (Evans *et al*., 2006)
- ➢ Lack of coarse and fine mesh filters (O'Hogain *et al*., 2012).

Treatment efficiency of SODIS PET Bottles for drinking HRW (According to WHO and UNBS standards for drinking water)
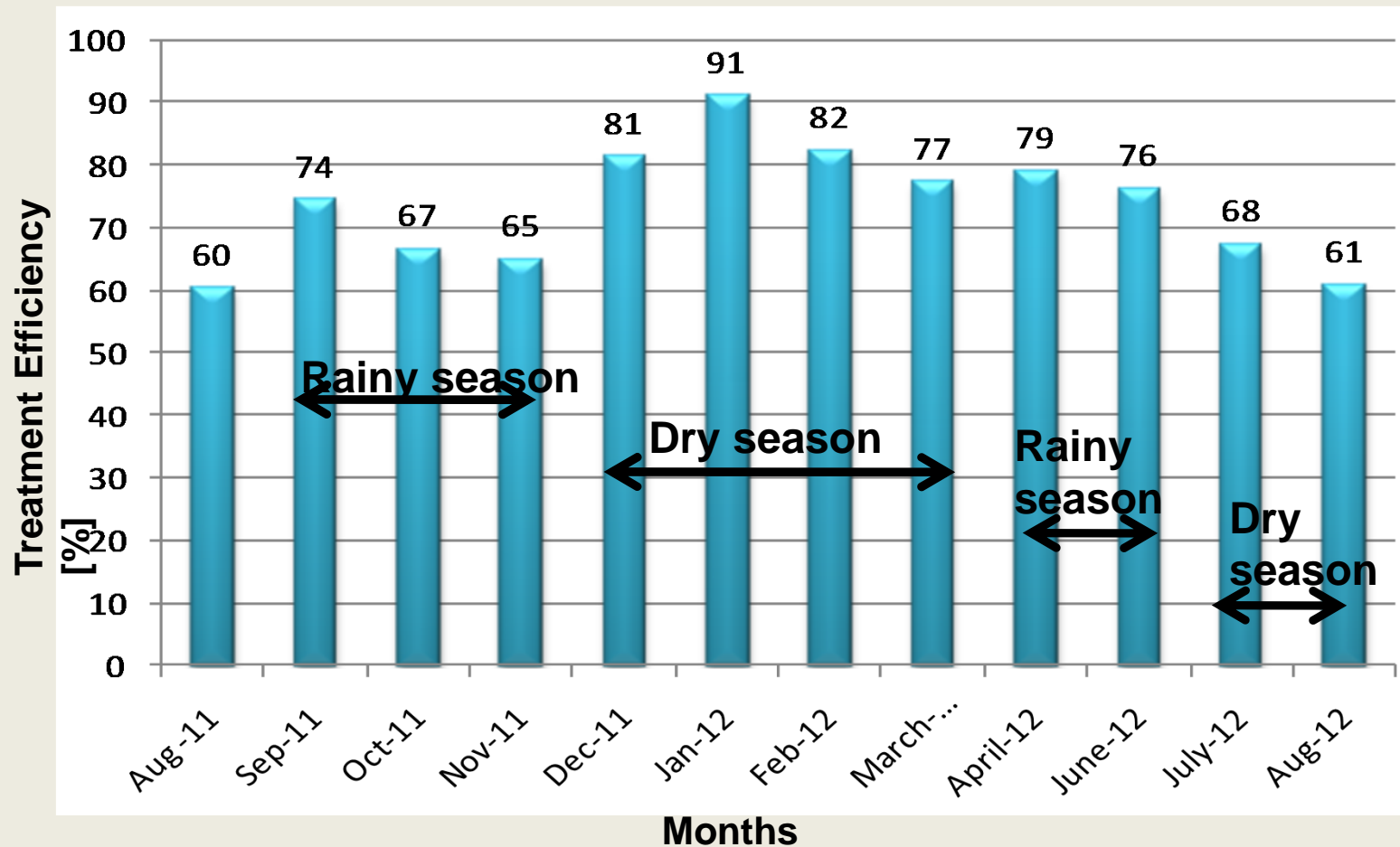

Water to be suitable for drinking, *E. coli* and feacal *Enterococci* should not be detectable in 100ml sample (WHO, 2008; UNBS, 2009)

Treatment efficiency

- SODIS has a significant effect on microbial quality of HRW (p ≤0.05). Both in cloudy and clear (sunny) weather conditions. SODIS effectively treated water to safe levels

- However, there was a significant (p≤0.05) difference in the treatment efficiency between the different seasons. The treatment efficiency in dry season was significantly higher than that in cloudy seasons (p≤0.05)

The occurrence of Salmonella in HRW

Occurrence of salmonella [%] vs Months bar chart:
sept 6.5, Oct 10.4, Nov 4.1, Dec 10.2, Jan 4.9, Feb 0, August 16.3
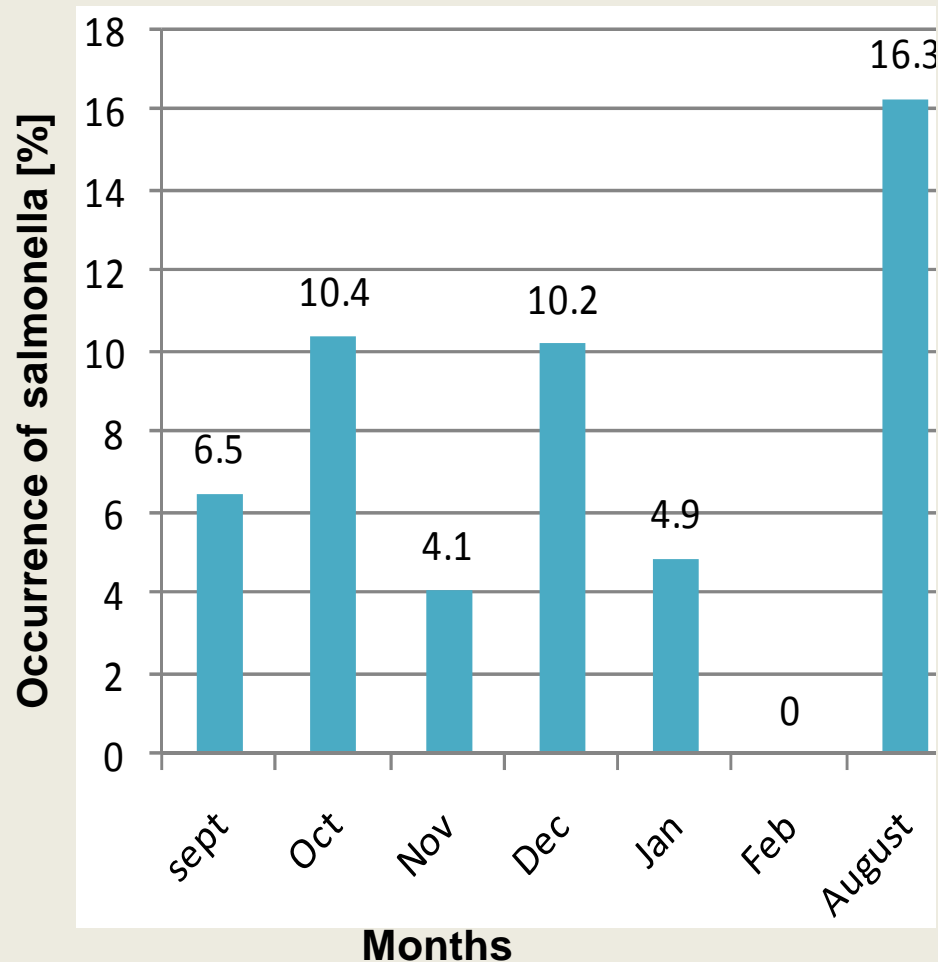
➢ August showed the highest percentage for presence of salmonella

> ➢ Reasons for August: feaces of Birds and reptiles are reservoirs of salmonella Ahmed *et al.*(2010), Evans *et al.*, (2006)

➢ Simmons *et al.* (2001), also showed postive results for *Salmonella spp.* in Roof HRW water (19% of 125 samples)

➢ Ahmed *et al.*(2010) reported the same results

The low occurrence in Jan and feb. suggests low dust deposition during the dry season and there fore the main source could be feaces of animals (Birds and reptiles)

serotypes (Somatic O-antigens)

Month	No. of positive samples	Serotype							
		O1+	O2+	O4+	O6+	O7+	O8+	O9+	non-sero typable
Aug.	7	1	1	2	0	1	1		3
Sept.	3	0	0	2	0		0	0	1
Oct	5	1	0	3	1	1	0	0	1
Nov	2	1	0	1	0		0	0	0
Dec	5	0	0	3	0	1	0	1	0
Jan	2	0	0	1	0	1	0		0
Feb	0	0	0	0	0	0	0	0	0
Total	24	3	1	12	1	4	1	1	5

O4+ was the most prevalent followed by O-antisera non-typable

Sensitivity of *E.coli* and *Enterococci* isolates(from a four month period) to a range of antibiotics

TE(30)=TETRACYCLINE	
PRL(100)=PIPERACILLIN	
CXM(30)=CEFUROXIME	*Enterococci* sensitive
CIP(5)=CIPROFLOXACIN	
C(5)=CHLORAMPHENICOL	
E(15)=ERYTHROMYCIN	*E. coli* sensitive
CN(10)=GENTAMICIN	
NA(30)=NALIDIXIC ACID	*Enterococci* highly sensitive
VA(30)=VANCOMYCIN	*E. coli* highly sensitive
SXT(25)=SULFAMETHOXAZOLE	
CRO(30)=CEFTRIOXONE/ CTX=CEFTAXIME	*Enterococci* highly sensitive
AM(10)=AMPICILLIN	*E. coli* highly sensitive

Conclusions

- HRW is not safe for drinking without treatment and its quality varies with season

- Among micro-organisms of high health risk was salmonella

- SODIS PET Bottle treatment is an effective treatment method for drinking HRW however, its efficiency varies with weather conditions.