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SODIS AN EMERGING PARADISE FOR TREATING ROOF-TOP HARVESTED RAINWATER

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Abstract- Man's hunt for pure drinking water began long back in primeval times to avail proper benefits of life and health but sustainability in purity of potable water these days is scorned with multiple disputes owing to huge pollution loads of industrial and domestic effluents. Rooftop rainwater harvesting has emerged as a gratuity in this present era even after facing long decades of ignorance due to the ease it offers in its collection and for being celestially known as a hygienic and neat form of water relatively in all the conventional civilizations. This work highlights on the quality of rooftop harvested rainwater with time in the most nibbled way by confabbing the most essential Indian standards for potable water suitable for human consumption on the grounds of the material used for storage and effect of SODIS as well on the quality of stored water. In this study polyethylene, terephthalate material has been used for storing roof-top harvested rainwater in sunlight and away from sunlight and different drinking water parameters have been checked out for their stability and deterioration with time at a fixed interval of one month for duration between September 2015 to April 2016. This demonstration not only involves foremost drinking water parameters as if hardness, turbidity, dissolved oxygen, chloride etc but also the scrutiny of microbiological quality of water. The study area taken up for this investigation is esteemed Indian Institute of Technology, Roorkee. The consequence of this demonstration will lead to an explication of a proper storage and treatment layout for harvested water so as to keep the quality safe and flawless for the consumers even after long storage durations.
Keywords: SODIS-effect, microbiological quality, hardness, dissolved oxygen, roof-top

1. Introduction

Disinfection of water by using solar rays is almost known since last 30 years, which comprises of using translucent glass or plastic containers and putting them into the sun for about 6-48 hours. It is a simple and economical method and is used in about more than 50 nations of Asia among million of people for disinfecting their water (1). The rays of sun decrease the concentration of bacteria present in the water and hence prove out to be an impressive method for carrying out disinfection without any skilled supervision and enormous resources. Disinfection of water through solar radiation even reduces rate of morbidity in areas with inadequate sources of treating water or where some natural disaster has occurred (2). Rays of sun are even known for nullifying the effect of fecal bacteria in seawater, wastewater, bathing water as well as fresh water. The method primarily involves the use of a plastic container or using a translucent glass and then exposing the container full with water to the hard sunlight for few hours so as to kill the various microbes present including even E-coli bacteria and Salmonella typhi apart from other general microbes. Usually solar disinfection method is used as an alternative method in absence of proper treatment works (3). The water treated from solar disinfection is even said to cure stomach problems up to an appreciable extent [4]. Even applicable for extreme turbid waters under temperature greater than 45°C. The execution of their study assured that in presence of strong sunlight the solar disinfection of the harvested rainwater or even any sort of stored water proves to be adequate and even enhances its quality. Being a very cost effective method can be widely used in camps of disaster areas to serve the mankind (5). The solar disinfection method is even known to improve the microbiological quality of water which is widely used at domestic level to treat water for drinking purposes and making it potable in use. More than one third population of most of the countries round the globe doesn't get pure potable water.

Microorganisms are found to be sensitive towards heat and UV rays (6),(7).Tarnished water is the main cause of illness resulting due to gastrointestinal problems usually occurring in rural areas where resources of water are contaminated and poor sanitation is there(8). The lethality and foreboding pace due to Shigella dysenteriae type I contamination is rising in world and can be controlled by solar disinfection up to an appreciable extent. It is also known to reduce the effects of dysentery in children and diarrhea as well (9)

Roof-top rainwater harvesting is an upcoming technology for meeting the vast demand for water , though it's existence is since civilization but still it is not that much into regular practice due to lack of proper awareness regarding its collection and the ay to store it to keep it pure. It's like a boon for the dry periods round the year as well as at the places with shortage of rainfall but the main thing is its treatment. Therefore this study was carried out to analyze the quality of stored rainwater by using SODIS method after storage in polyethylene terephthalate storage container and borosilicate container so as to successfully implement this practice in all the places facing crisis for drinking water and to involve more masses into this healthy practice for a better society.

2. Study Area and Sampling Stations

The area taken for the current study is Indian Institute of Technology, Roorkee, and the finest institution in technological advances in Asia situated in Roorkee, Uttarakhand. The locations chosen were such that one was near to the vehicular emissions G.P Hostel and other Sarojini

Bhawan was within the campus in the proximity of green cover so as to check out the proper effect of treatment from pollutant aspect in water as well. The rainwater was hoarded using downpipes through roof-tops.

3. Methodology

The rainwater hoarded from the roof-tops was stacked in partial sunlight in two different materials polyethylene and borosilicate glass. The experiments were carried out at duration of one month from September to February to determine its quality in accordance with the drinking water specifications as given in IS 10500: 2012 for analyzing parameters like turbidity, hardness, pH, acidity, alkalinity, chloride, dissolved oxygen, specific conductivity and total dissolved solids. The main priority was to collect rainwater in the single event of rainfall itself while harvesting the rainwater. The specific conductivity and pH were measured by using digital testers. The very first testing was carried about after one hour of storing rainwater at about 11 AM and all the testing was done at the same time only. The various parameters for the water quality analysis were evaluated by using Pack test containing chemical analysis products for water. Total dissolved solids were determined by taking the product of specific conductivity value with the constant 0.65. Bacteria and Coliform were even tested at an interval of four weeks. The main precaution taken was was that there should not be any addition of fresh water in the stored water during entire storage stage (*10).* The different values of parameters while experimentation has been shown in Table 1 (a & b).

4. Results

After testing the water for few months it was noticed that there was absence of turbidity in all the samples with passing time as well as acidity and pH was under control as per the Indian Standards (11). Hardness was found to be in a lower limit as per standards but there is no effect on human health. Chloride and alkalinity were also in limits. All the values of different parameters were under acceptable limits. Microbiological aspect even showed improvement with time though in starting there were some contaminates affecting the rainwater quality but with time it improved due to effect of solar radiation ad tests for analyzing microbiological quality came out to be negative.

5. Conclusion

Potable water should be such that it is free from any sort of undesirable matter and contaminants, which might deteriorate its properties and health of the consumers. From the present study we can come to a conclusion that quality of water improves by the effect of solar radiation even for the case of stored water as well as proves out to be promising for improving microbiological quality of water, which is going to be a boon for low income sectors who can’t afford expensive technologies for treating water and will not be deprived of a fine quality potable water. This method requires almost negligible cost as an investment as well as no need of advance skilled supervision; therefore, SODIS (solar disinfection) can be concluded to be as an emerging paradise for treating such waters and every drop of natural water will thus be in approach of common sector with utmost purity.

References

[1] McGuigan, Kevin G., et al. "Solar water disinfection (SODIS): a review from bench-top to roof-top." Journal of hazardous materials 235 (2012): 29-46.

[2] Conroy, Ronán M., et al. "Solar disinfection of drinking water and diarrhoea in Maasai children: a controlled field trial." The Lancet 348.9043 (1996): 1695-1697.

[3] Reed, Robert H. "The inactivation of microbes by sunlight: solar disinfection as a water treatment process." Advances in applied microbiology 54 (2004): 333-365.

[4] Rainey, Rochelle C., and Anna K. Harding. "Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal." International journal of environmental health research 15.5 (2005): 361-372.

[5] McGuigan, K. G., et al. "Solar disinfection of drinking water contained in transparent plastic bottles: characterizing the bacterial inactivation process." Journal of applied microbiology 84.6 (1998): 1138-1148.

[6] Wegelin, Martin, et al. "Solar water disinfection: scope of the process and analysis of radiation experiments." Aqua 43.4 (1994): 154-169.

[7] Sommer, Be, et al. "SODIS- an emerging water treatment process." AQUA(OXFORD) 46.3 (1997): 127-137.

[8] Caslake, Laurie F., et al. "Disinfection of contaminated water by using solar irradiation." Applied and environmental microbiology 70.2 (2004): 1145-1151.

[9] Kehoe, S. C., et al. "Batch process solar disinfection is an efficient means of disinfecting drinking water contaminated with Shigella dysenteriae type I." Letters in applied microbiology 38.5 (2004): 410-414.

[10] Martinson, B., & Thomas, T. (2003). Improving water quality by design. In11th International Conference on Rainwater Catchment Systems.

[11] IS 10500: 2012 : Drinking Water Specifications.

Table 1(a): Range of parameters in different materials at high temperature
HIGH TEMPERATURE

PARAMETERS	25/9/2015		1/11/2015		1/12/2015		2/1/2016		5/2/2016		4/3/2016		5/4/2016	
	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG
TURBIDITY	1	1	0	0	0	0	0	0	0	0	0	0	0	0
ACIDITY	10	10	10	10	10	10	10	10	10	10	10	10	10	10
PH	6.5	6.5	5.5	7.5	5.5	7	7	7	7	9	7	9	10	10
HARDNESS	30	30	28	36	32	38	24	40	22	50	22	50	20	30
ALKALINITY	50	50	20	30	20	30	40	30	30	40	30	40	30	40
CHLORIDE	30	30	10	10	10	10	10	10	10	10	10	10	10	10
DISSOLVED OXYGEN	7.15	7.15	6.5	1.95	1.3	7.8	1.95	7.15	7.8	9.1	7.8	9.1	4.55	4.6
SPECIFIC CONDUCTIVITY	5	5	6	12	6	11	6	13	7	23	7	23	7	7
TDS	32.5	32.5	39	78	39	71.5	39	84.5	45.5	149.5	45.5	149.5	45.5	46
MICROBIOLOGICAL QUALITY	P	P	P	P	P	P	N	N	N	N	N	N	P	P

PET: Polyethylene terepthalate container
BSG: Borosilicate glass

Table 1(a): Range of parameters in different materials at high temperature
HIGH TEMPERATURE SAROJINI BHAWAN

PARAMETERS	25/9/2015		1/11/2015		1/12/2015		2/1/2016		5/2/2016		13/3/2016		13/4/2016	
	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG	PET	BSG
TURBIDITY	5	5	0	0	0	0	0	0	0	0	0	0	0	0
ACIDITY	10	10	10	10	10	10	10	10	10	10	10	10	10	10
PH	6	6	5.5	5.5	5.5	5.5	5.5	5.5	9	9	9	9	9	9
HARDNESS	40	40	40	75	50	50	50	75	50	50	50	50	50	50
ALKALINITY	40	40	200	200	200	200	200	200	40	40	40	40	40	40
CHLORIDE	20	20	20	20	20	10	10	10	10	10	10	10	10	10
DISSOLVED OXYGEN	5.2	5.2	6.5	1.95	5.85	7.8	3.9	1.3	8.45	6.5	7.15	7.15	5.2	3.9
SPECIFIC CONDUCTIVITY	5	5	7	4	4	4	3	3	4	5	5	5	4	5
TDS	32	32	45.5	26	26	26	19	19	26	32.5	32.5	32.5	26	32.5
MICROBIOLOGICAL QUALITY	P	P	P	P	P	P	N	N	N	N	N	N	P	P

PET: Polyethylene terepthalate container
BSG: Borosilicate glass