

Inactivation of fecal bacteria and water borne pathogens by solar heating in Karachi

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ABSTRACT

Sunlight is a very rich source of energy and it's now widely used in many fields. Another use of it is purification or disinfecting the water, as sunlight is capable of penetrating in water and have ability to purify it also by killing the microbes present in it. This method is applicable in some areas mostly in those which are nearer to equator because intensity of sunlight is highest at equator and reduced as we go down or up to the equator. The main purpose of this research was to check the affectivity of sunlight in disinfecting water in the city of Karachi; it may differ because of geographical differences in countries. In this research a laboratory made bacterial suspension of *Escheracia coli* and *Salmonella typhimirium* is added in sterilized water. Water is then exposed to sun and cfu/0.1ml is checked after every hour. The results obtained are showing a significant decrease in microbial load after sun exposure of 3 hours. This technique can be a blessing for many under developed countries which are suffering from water borne illnesses due to poor hygiene maintenance in developing countries. Moreover, this method is very simple and can be apply by people themselves locally, but before its application further more testing is required on this method efficiency.

Keywords

CFU (colony forming unit), Disinfecting, Water Borne Illnesses, Geographical Difference, Sterilized, Microbial Load, Bacterial Suspension.

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INTRODUCTION

Water is essential for all the life forms exist on earth. Without water life cannot exist. It was necessary to adding fresh water to our body in order to keep it properly hydrated. Water makes up almost 85% of your brain, around 80% of your blood and around 70% of your slender muscle. Water can be a wonder cure for some normal illness for example cerebral pain, weakness, joint torment and considerably more. We can go for weeks without food however, but only 3 days without water. Absence of water can be a trigger of daytime weakness. A negligible 2% drop in body water can trigger the fluffy here and now memory ,issue with fundamental math ,and

troubling concentrating on the PC screen or on a printed page (1,2)

Water is considered to be a basic human right and comes under responsibility of government to provide it to citizens of a country. Drinking is important for health and is emerging issue in national, local and neighborhood specialists. (3). If quality of water is transported is not maintain it can lead to a number diseases in consumers. Access to safe drinking water is essential for health, a basic human right and component of health protecting policies. Contamination related to water disease is one of the most important health problems worldwide especially

in under developed countries. Annually 4 billion diarrhea cases was represented 5.7% of the global diseases burden in the year 200(WHO 2002) (4).

In developing region drinking water is a major sources of microbial pathogens due to the poor water quality, sanitation and hygiene. Major enteric pathogen include: rotavirus, *Campylobacter jejuni*, enterotoxigenic *Escherichia coli*, *Shigella* spp. and *Vibrio cholerae* O1, and possibly entero pathogenic *E. coli*, *Aeromonas* spp. *V. cholerae* O139, enterotoxigenic *Bacteroides fragilis*, *Clostridium difficile* and *Cryptosporidium parvums*. In addition to the traditional pathogens (helminths, *Entamoeba histolytica*, *Giardia lamblia* hepatitis A and E) various enteroviruses, *C. jejuni* and *H. pylori* are emerging issues in adults (5). These pathogens cause multiple infections in adults and children such as Cholera, Botulism, Typhoid, Hepatitis A, Dysentery, Cryptosporidiosis and Giardia.

The situation has still being worse and contaminated water is still main cause of diseases in both developed and under developed countries (7). There is the need to apply necessary steps to provide healthy water. Therefore, many water purification techniques are standardized according to the need. This technique involves the passing of water from a filter paper which has small size pore which allow only selected particles to pass from it. This technique separates out solid particles as well as pathogen contaminants from water and is thought to be a very efficient in purifying the water. This technique involves heating of water up till its boiling temperature (bubbling up) which is 100°C, this method can kill number of biological contaminants as they can't survive at this temperature but not the spores as they are more resistant towards temperatures. Reverse osmosis (RO) is a water cleansing innovation that uses a semi porous layer to evacuate particles, atoms, and bigger particles from drinking water. In reverse osmosis, an applied pressure is used to overcome osmotic pressure. Reverse osmosis can expel many sorts of broke up and suspended species from water, including microscopic organisms, and is utilized as a part of both mechanical procedures and the creation of consumable water (7,8).

Researchers have started utilizing bright radiation to help lessen the spread of water borne sicknesses in creating nations. In numerous ranges of the nation, safe drinking

can be rare. The development of sun oriented water purification systems has brought clean drinking water to many individuals. This techniques eliminate germs, if the water is now tainted with chemicals from contamination, the will remain .In the event that the water is shady and grimy; it ought to be separated first to permit the UV-A beams to successfully infiltrate into the water. The plastic water bottle should be no bigger than 2 liters. In moderately cloudy water UV-A will lose 50 percent effectiveness at a depth of 10 mm (about 0.5 inch), whereas UV-A will only lose 25 percent effectiveness at a depth of 10 mm in clear water. Just use a typical size soda bottle or water bottle. With these procedures, individuals fill plastic bottles with water and abandon them in coordinate daylight for no less than six hours. The suns UV radiation and expended water temperatures cooperate slaughter hurtful micro organisms in the water. Obviously, these methods require solid daylight and little volumes of water. Be that as it may, they have demonstrated very compelling so far in decreasing water borne infections (10).

MATERIALS & METHODS

Bacterial Suspension Preparation:

Two test samples were used in this research *Escheracia coli* and *Salmonella typhimirium*. *Escheracia.coli* used in this research is wild type strain collected from local laboratory whereas, *Salmonella typhimirium* is isolated from chicken meat.

Preparations of Test and Control Samples:

For samples 500 ml transparent pet bottles (soft drink bottles) were used, labeled were removed from bottles and washed with detergents and sterilized water. Take two pet bottles Label each as control and test, Sterilized tap water samples of 297ml added in both bottles along with 3 ml of bacterial suspension which made the total volume of 300 ml in each sample (9).

Field Measurements:

The exposure of sunlight to the samples took place at Karachi in North Nazimabad town (The Latitude of North Nazimabad town Karachi is 24.9333. The Longitude of North Nazimabad town Karachi is 67.0333.) (10). The test

sample bottles were kept under the sunlight and control samples were placed inside the laboratory in a shady area. The samples were placed under sunlight at 12 pm every day and kept there for three hours. The bacterial load in samples is checked by simple CFU/0.1ml. CFU/0.1ml in both test and control is checked at 0 minute, 1 hour, 2 hour and 3 hour after that test samples were also kept in shady area along with control samples and CFU/0.1ml is checked after 20 hours to check suspected increase in level of microbial load in test sample after placement in a shady area. For CFU, the agars used were selective, depending upon test organisms. In case of *Escherichia coli*, Eosin Methylene Blue agar (EMB) was used whereas, in case of *Salmonella typhimurium*, Salmonella Shigella agar (SS) was used. Only the agars were changed with respect to the test organisms. The rest of the protocols followed were similar in both test organisms(11,12).

RESULTS

Eighty water samples were exposed to the sunshine of Karachi in 2016. The weather conditions of each day were recorded as per the weather forecast. Among all 80 sample , 6 samples were selected to sum up all the effects been observed in study. In which 3 samples are of *E. coli* and other 3 are of *S. typhimurium* giving estimation of all samples. In all samples a clear decrease in load of test organism is observed by cfu/0.1ml.

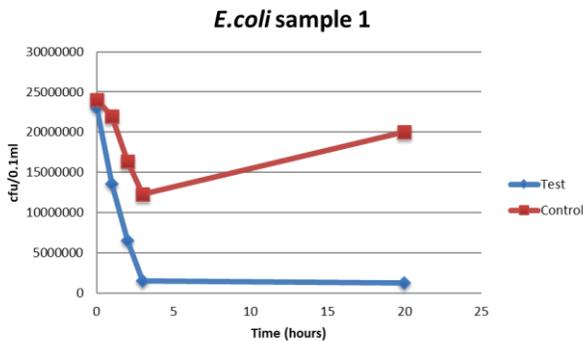


Fig 1: The graphical representation of *E. coli* sample 1

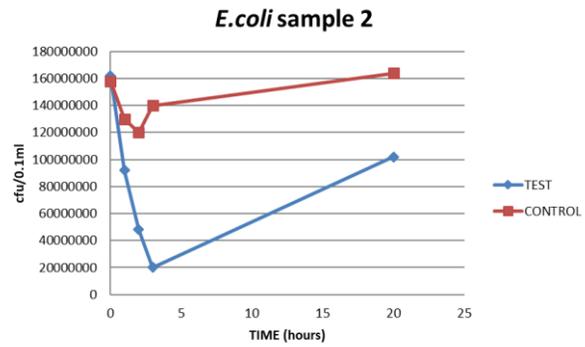


Fig 2: The graphical representation of *E. coli* sample 2

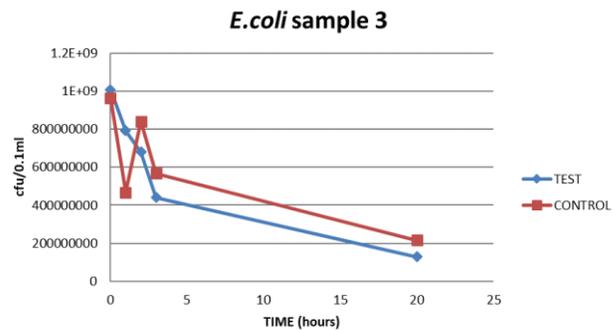


Fig 3: The graphical representation of *E. coli* sample 3

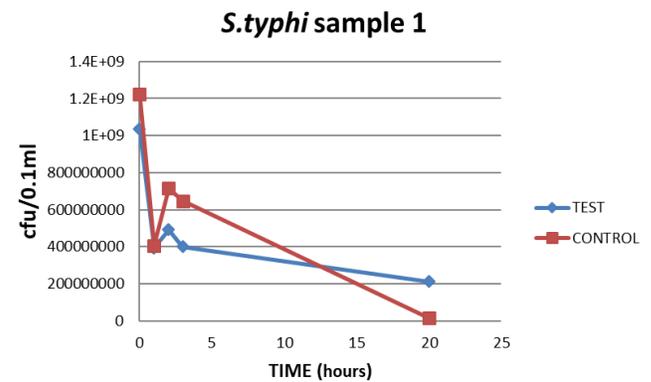


Fig 4: The graphical representation of *Salmonella typhi* sample 1

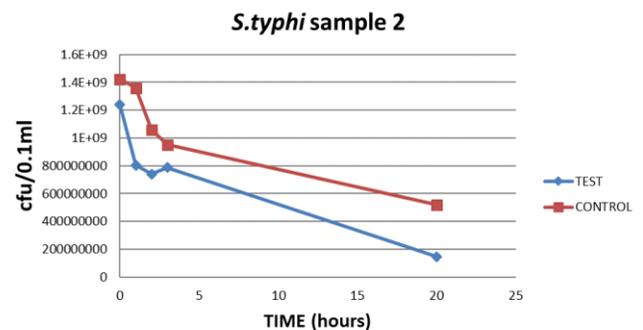


Fig 5: The graphical representation of *Salmonella typhi* sample 2

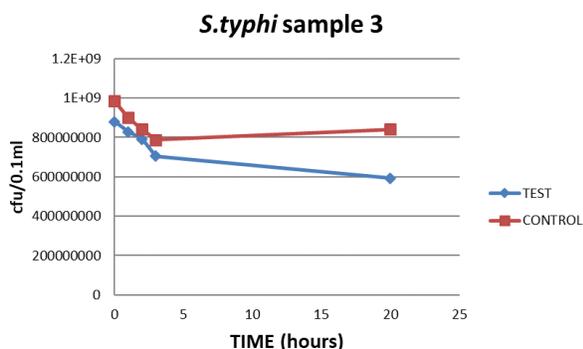


Fig 6: The graphical representation of *Salmonella typhi* sample 3



Fig 7: showing results of cfu/0.1ml after 2 hours, the difference in microbial load is significantly lesser in test (downward) then control (upward)

DISCUSSION

Solar disinfection is not a new trait in science it's renewed decades ago but still not under practice. Solar disinfection has been effective to remarkable extent and has remained focal point of many studies that indicate true potential of solar disinfection. In October 2000, *Salmonella typhimurium* was suspended in water exposed to UVA for 8 hours. After 8 hours colony forming unit dropped by six logs and activity of bacteria was reduced to 5% only. Water obtained at the end fulfilled requirements of drinking water (13). Our study provides clear indications

that intermediate level irradiation, compatible with many environments in which use of solar disinfection has been proposed, renders a standard laboratory strain of *Salmonella typhimurium* non infective.

Batch solar disinfection (SODIS) inactivation kinetics are reported for suspensions in water of *Campylobacter jejuni*, *Yersinia enterocolitica*, enteropathogenic *Escherichia coli*, *Staphylococcus epidermidis*, and endospores of *Bacillus subtilis*, exposed to strong natural sunlight in Spain and Bolivia. Inactivation time of these bacteria was found to be *C. jejuni*, 20 min; *S. epidermidis*, 45 min; enteropathogenic *E. coli*, 90 min. This is indicating a successful inactivation of number of pathogens by sunlight. Effectiveness of this method for inactivation of spores is not fully known (14). In our study a fecal strain of *E. coli* was used and in few sample after 3 hours load of *E. coli* in sample reduced below half as suspension used in our research was of log 10 concentration which is very high. Study was held in an urban slum of Vellore published in 2006. In this study inactivity of diarrhea causing bacteria was checked and solar treated water was given to a group of 100 children and then cases were reported. Water treated by solar heating reduced risk of infection up to 40% in children (15). In this study treated water was given to groups of people to check whether it resulted in any infection or not. This practice was not held in our research.

In 2003 study tested that in less than 30 min in midday sunlight; the unit eradicated more than 4 log₁₀ U (99.99%) of bacteria contained in highly contaminated water samples(16). In research we performed sterilized water was inoculated with test samples of known log cycles instead of using already contaminated water from any locality but results obtain were similar at least 4 log₁₀ reduction in numerous samples was observed despite of the high microbial load inoculated in samples.

A research was first published in 2006, in Journal of Applied Microbiology in which test organisms were exposed to 3 different types of light mild heat, direct sunlight and artificial UVA. Here along with affectivity of sunlight in killing enteric pathogens it's also shown that *s. typhi* appears to be most sensitive to sunlight and that's why here it is suggested that for solar disinfection *s. typhi* should be used as test organism (17). Where as in our case *S. typhi* turns out to be more resistant to sunlight

comparative to *E.coli* and less log cycle reduction was seen in it. The most major similarity found in all above researches and in ours also is that, after sun exposure the water samples regardless of test organisms and amount of microbial load inoculated have a decrease of at least 4 log₁₀ in their microbial load and in few cases it reached below the line of detection.

CONCLUSION

After analyzing all of the results the concluded statement is solar heating are capable of killing/decreasing fecal contaminants (*E.coli*) and water borne disease pathogens (*S.typhimurium*). The study provides the basic knowledge about water borne pathogens and the basis to attain elimination of these pathogens which can be beneficial for health care workers and different water purifying agencies.

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