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Inactivation of Water Containing *Escherichia Coli* by Using Ultraviolet Light

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Abstract: *Chlorine is used worldwide for disinfection of water and it's very effective on killing the micro-organism which causes the different types of water-borne diseases and directly effect on human health. But chlorine also produced their by-product when it comes in contact with water and hence different method for disinfection of water was produces. The research work is aimed to do disinfection by UV –radiation. In this UV lamp are used for inactivation of microorganisms and effect of UV-radiation on contaminated water for different seasons will be compared. The efficacy of the disinfectant is assessed through bacteriological parameters E.coli and also physico-chemical parameters viz. turbidity, total hardness, and pH. UV-radiation and many others methods discovered for water disinfection but some are costlier and some are unable to kills micro-organisms at high rate as compared with chlorine. The result obtained from the work that the physic-chemical parameters are in permissible limit and 99.999% of reduction of E-coli was found out.*
Keywords: *Disinfection, E-coli, In-activation, UV-radiation, Water*.

I. Introduction

Clear and contaminated free water is essential for all people for their health. As we know that water is becoming a rare source in the world. In India alone, the International Water Management Institute (IWMI) predicts that by 2025, one person in three will live in condition of absolute water scarcity (IWMI, 2003). The lack of clean water for some 1.1 billion people in this world has dramatic consequences, approximately 4 billion cases of diarrhea was reported annually, of which 2.5 million people end in death and around 6000 children died due to lack of safe drinking water every day. Use of different forms of chlorine for disinfection water was very old and effective method and it used worldwide. But chlorine produced its by-product when it reacts with water which is very harmful for people health and responsible for various life taking diseases. Hence different government and non-government agencies finding the alternative source of water disinfection which not causing any health hazards and gives a clear and safe drinking water for peoples in both rural and urban areas. Now a day's UV-radiation for water disinfection is very popular and interesting field for researchers. Though it is not a new technique, UV-radiation for water disinfection discovered far year ago but due to chlorination results and some technical using issues it not preferred for water disinfection. After the discovery of health effects of chlorine disinfection and chlorine by-products, UV-radiation again making interest of different agencies which are works in water fields. Because, UV-radiation effective in inactivation of micro-organisms which are responsible for contamination of water and mainly it not required external chemicals also not produced any by-products when react with water. Numbers of research is carried out over UV-radiation for finding out the range of UV rays, time of exposure, intensity of UV-lamps, UV apparatus, factors affecting on UV-radiation, characteristics of waters for getting better result from UV-radiation, taking precaution while using UV apparatus, advantages and disadvantages of UV-radiation, and finding better way of using UV-radiation apparatus for domestics, municipal and industrial used, etc. This project gives an alternative disinfectant source on contaminated water disinfection for developing countries and the sustainable development of rural and urban areas is achieved. [1][2][3]

Chlorine kills bacteria by reacting with all types of biological molecules. Exposure to chlorine, hypochlorous acid, and hypochlorite ion through ingestion of household bleach occurs most commonly in children. Intake of a small quantity of bleach generally results in irritation of the esophagus, a burning sensation in the mouth and throat, and spontaneous vomiting; damaging the tissues, asthma can be triggered. The chlorine and calcium in drinking-water may interact and affect lipid level and increases risk of bladder cancer. [4][5]

Most significantly, UV is able to inactivate pathogens, which are chlorine-resistant. Key benefit of UV over gaseous chlorine or liquid sodium hypochlorite is that it doesn't add anything to the water. No disinfection byproducts are generated with UV, and it is a safer option for the operator and the community than chlorine gas, which is toxic if released. [6][7]

Ultraviolet (UV) light has become an established water treatment disinfection technology due to its extremely effective ability to kill or inactivate many species of disease-causing microorganisms. Ultraviolet

light disinfection is effective on bacteria, protozoan parasites (e.g. Giardia, Cryptosporidium), and can also be effective for most viruses, providing sufficiently high UV dosage rates are used. UV disinfection is suitable for a number of residential and commercial uses of water such as: (i) Agriculture: Livestock, Irrigation, Dairy, etc (ii) Domestic drinking water, residential use (iii) Domestic drinking water, municipal use (iv) Food and Beverage Industry (v) Breweries, Wineries (vi) Secondary treatment of municipal wastewater.

The main objective of this research work is to find the disinfection efficacy of UV-disinfectant. The efficacy will be monitored through bacteriological parameter E-coli and physic-chemical parameters viz. turbidity, pH and total hardness of contaminated water.

II. Methodology

The samples used for this research work was collected from three different points (shown in fig.(2-a)) of Ambazari-lake (Nagpur) in one liter plastic bottles which are properly sterilized by hot water. The characterization of raw water was finding in college laboratory (G.H.R.C.E, Nagpur). In characterization of raw water pH, turbidity and total hardness determined and the results so obtained was compared with the drinking water standard IS-10500.The characterization of raw water was determined for different seasons of fifteen days intervals by APHA standard testing equipments. From the characterization results, sample water from location three was use for disinfection because it shows slightly higher values than other two sample water. MPN/MTD test are performed for finding the quantity of E-coli present in water before and after disinfection by UV-radiation (from December to April 2014-15). Pre-treatment was not given to the sample water.

Figure: (2-a) (from Google satellite map image)

2.1 UV Model for Micro-Organisms Inactivation

The effect of UV-radiation on E-coli was investigated in college laboratory at bench scale. A black coated covered glass box model of size 30cm X 18 cm X 15 cm containing two 6 watt low pressure UV germicidal lamp are used for disinfection, emitting monochromatic wavelength. The E-coli in water sample was calculating by performing MPN/MTD test in college Environmental Engineering laboratory. First the E-coli in raw water sample were measured (before disinfection) and compare it with the E-coli present in water sample after the disinfection by UV-radiation. The disinfection of water sample by UV-radiation was conducted on different time intervals for finding the minimum time for disinfection. Similar process was carried out for all water samples.

III. Results And Discussion

The results of characterization of water sample i.e. pH, turbidity and total hardness obtained with in permissible limits as per ISO10500.

Fig. 3.1 represents the turbidity is one of the main factors which directly effect on the disinfection property of UV-radiation. If water is highly turbid the particles scattered the rays emitted from UV-lamp and long time exposure required for disinfection of water. The value of turbidity is high in rainy seasons.

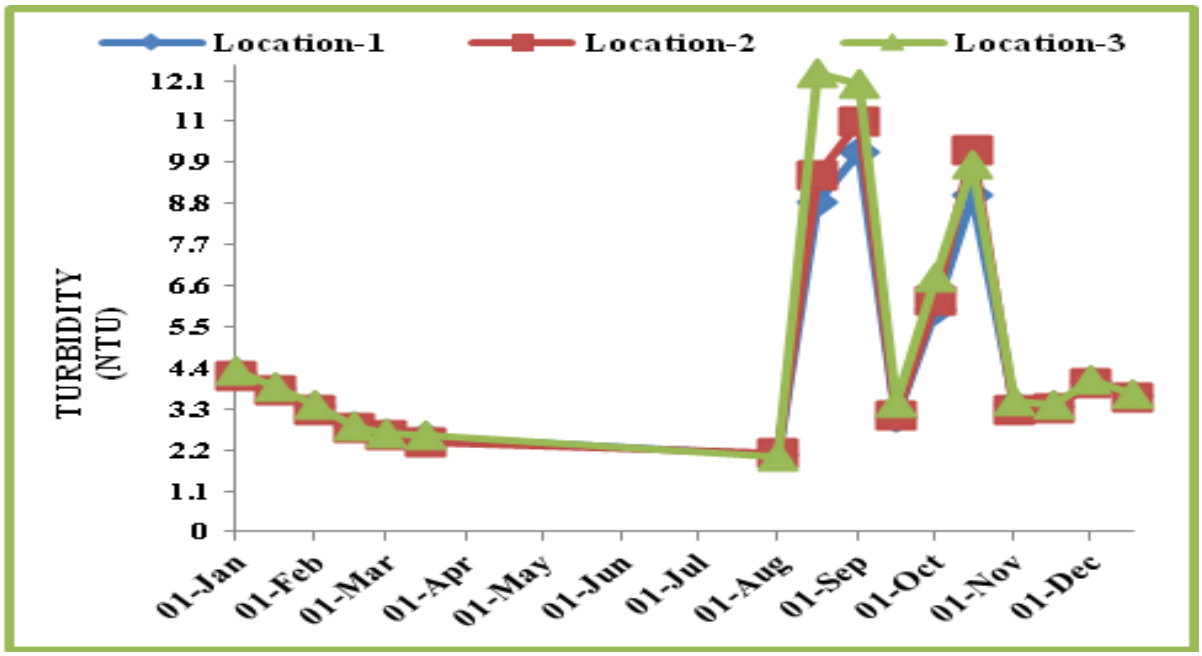

Figure: 3.1 Variation in turbidity at different location

Fig. 3.2 shows that the pH of the water was slightly high due presence of algae which present in huge quantity near the sample location but it not cause any effect on the disinfection capacity of water by both UV-lamp and chlorine.

Figure: 3.2 Variation in pH at different location

Fig. 3.3 represents the total hardness of water is not such higher and it is in a permissible limits. If water was contained high hardness then before disinfection process pre-treatment of water was necessary. The sample water contain less amount of hardness hence pre-treatment not given to it.

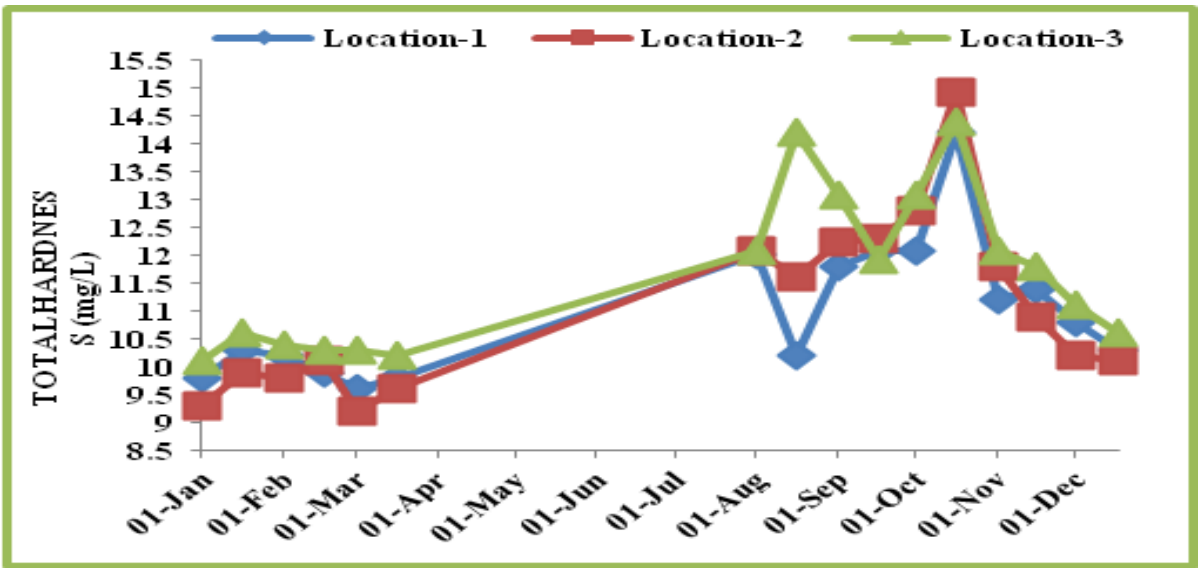

Figure: 3.3 Variation in total hardness at different location

Table: 3.1 & Table: 3.2 shows the following result of MTD/ MPN test of raw water and UV treated water on different time intervals obtained are shown below:

Table: 3.1 Result of MPN test of raw water

Sr. No.	Raw Water Sample (one litre)	MPN per 100 ml of raw water
01	1	130
02	2	240
03	3	350
04	4	350
05	5	920

Table: 3.2 Result of MPN test of UV treated water

Sr. No.	Treated Water Sample (one litre)	Time interval in hours	MPN per 100 ml of UV treated water
01	1	8	0
02	2	4	0
03	3	2	0
04	4	1	0
05	5	0.5	0

IV. Conclusion and suggestion

An effective result was observed for E-coli inactivation at different time interval during the bench scale experiments. Both UV and chlorine was effective on killing or inactivation of micro-organisms but chlorine produced by-products and in excess intake of these by-products causes health effects. In UV-radiation, by-products are not formed and additional chemicals also not required. UV-radiation are effective on small basis but for large basis it expensive than chlorine. If water is turbid the action of UV-radiation on micro-organisms get slow and such water required more time of exposure for complete disinfection. If water is pretreated the efficiency of UV disinfection shows effective results. Other disinfectants combined with UV should be considered for disinfection of water and in future this type of combined disinfection system has more effective and gives better results than single disinfectant. UV is substitute for disinfection of water against the chlorine.

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