ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

COMPARATIVE ANALYSIS OF SOLAR AND IONIC DISINFECTION OF POTABLE WATER SAMPLES FROM DISPARATE PESHAWAR VENUE, PAKISTAN

Salman Shehzada[1*], Farah Shireen[2], Usman Shahzada[3], Hamayun Khattak[4]

1. Aga Khan University and Hospital, Karachi, Pakistan
2. Center of Biotechnology and Microbiology, University of Peshawar, KPK, Pakistan
3. Center for Disaster Preparedness and Management, University of Peshawar, KPK, Pakistan
4. Dept. of Biotechnology and Genetic Engineering, KUST, KPK, Pakistan

Manuscript Info

Manuscript History:

Received: 12 December 2013
Final Accepted: 19 January 2014
Published Online: February 2014

Key words:
Potable water, Peshawar, Solar Disinfection, Ionic Disinfection

Corresponding Author

Salman Shehzada

Abstract

Ten potable water samples were collected from circadian sources of Peshawar domains. Water samples corroborated higher bacterial counts at each 0, 1/10, 1/100, 1/1000, 1/10,000 dilution and were charged to be diabolical bacteriologically. These samples were put through solar and ionic (silver and gold) disinfection practices. From the result it was authenticated that solar dynamism was preferable over ionic exuberance providing reduced plate counts at every dilution. Therefore, solar disinfection contrivance can render lucrative and secure drinking water to the community.

INTRODUCTION

Water is crucial and imperative requisite of existence. But due to current catastrophic state of the world quality of potable water had become a serious issue, as it directly affect aquatic and land entities (Khalid et al., 2011). Currently the world, more specifically Pakistan is confronting deliberately momentous ascending epidemics of water borne ailments (Nollet, 2000). In Pakistan, Central Peshawar localities acquire potable ground water via tube wells, while Northern areas of district generally consume water from springs. Facsimile water pollution as a result of human exploitations, had limited aquatic resources including fresh drinking water. Provision of potable water is estimated to be 0.002% of the total planet water supply. Substandard hygiene practices are also accountable for umpteen diseases including acute respiratory infection, gastro-enteric illnesses, cholera, gastroenteritis, hepatitis A & E, malaria, typhoid fever, polio, scabies, goiter and tuberculosis. According to World Health Organization (WHO) documentation, there are estimated 100 million children ranging below the age of five sustain complications of diarrhea in developing countries each year. Across the Peshawar district, caliber of drinking water is minimized due to lack of treatment plants and insalubrious facilitation (Zia, 2013). Prehistorically, Romans and Greeks would use silver coins prior to disinfect and long term storage of water and milk (Andrea, 2011). Along with silver, copper and gold ions and their colloidal solutions are subjected to water decontamination procedures and authenticated to have microbicidal potency (Khaydarov et al., 2005). A novel effective water purification method, solar water disinfection which is also termed as solar ultra-violet water disinfection or SODIS, is recommended by World Health Organization using solar energy to minimize cases of water borne infections (Clasen, 2010). SODIS is burgeoning worldwide and awareness is bloomed in numerous progressing countries (Meierhofer and Wegelin, 2002).

The blueprint of our research work was to hound comparative survey of solar and ionic disinfection (silver and gold ions) of drinking water samples from distinct suburbs of Peshawar, Pakistan.

MATERIALS AND METHODS

SAMPLE COLLECTION

Ten drinking water samples from quotidian sources were collected in 1000ml sterile transparent collector bottles from distinct regions of Peshawar, KPK, Pakistan. Sample designation and sources are displayed in (Table 1).

Table 1: Sources and venue of drinking water sample cumulated for analysis

Sample Number	*Source*	*Venue*
1	Tap water	Hayatabad (Residential Area)
2	Tap water	Hayatabad (Slum Area)
3	Tap water	Hayatabad (Industrial State)
4	Tap water	University Road (University Department)
5	Tap water	University Road (Restaurant)
6	Tap water	University Road (Mosque)
7	Tap water	Canal Town (Agricultural Area)
8	Tap water	Kohat Road (Residential Area)
9	Tap water	Saddar (Resturant)
10	Tap water	Ring Road (Agricultural Area)

pH AND TEMPERATURE ANALYSIS

Water samples were held in sterile sample collector bottle having sodium thio-sulphide to neutralize pH and maintain bacterial count. pH was analyzed using commonly available comparator indicator strip concluding pH range of 7.0 - 8.5 for the test water samples. All the water samples were stored at room temperature before analysis.

TOTAL BACTERIAL COUNT

Bacterial counts were manifested following documented pour plate strategy (Csuros et al., 1999). 10ml water sample were placed from the collector bottle in sterile test tube. Further by 1ml sample transfer, 1/10, 1/100, 1/1000 and 1/10,000 serial dilutions were made utilizing autoclaved test tubes containing 9ml sterile water. From all test samples 1ml were poured and spread in sterile petri-plates. Spread the poured sample evenly with aid of sterilized spreader. Then prepared sterile nutrient agar medium were poured on the test samples in laminar flow hood. Plates were allowed to rest undisturbed at room temperature to solidify. Then inverted plates were incubated using incubator at 37^{o}C for 24 hours. After 24 hours of incubation, number of colonies was computed utilizing colony counter.

SOLAR WATER DISINFECTION

Solar disinfection of drinking water samples were conducted as per reported method (Meierhofer et al., 2002). 250ml drinking water samples from each sample collectors were transferred to other sterile collector bottle and were subjected to direct solar energy during summers. Incessant exposure occurred for 6 hours at recorded ≥40^{o}C. After 6 hours of exposure, similar pour plate strategy was preceded establishing serial dilutions for all the test samples as discussed earlier (Csuros et al., 1999). Bacterial counts were then calculated utilizing colony counter.

IONIC WATER DISINFECTION (SILVER AND GOLD IONS)

A classical method for disinfection of water entails silver and gold ions. For ionic disinfection, 24K gold coin and pure silver coin were sanitized using 100% commercial grade ethanol. These coins were then placed in collector bottle consisting 250ml water samples. Allow it to stand in shade for 6 hours at room temperature. Now for bacterial count analysis, repeat the same pour plate strategy involving serial dilution stride (Csuros et al., 1999).

RESULTS

TOTAL BACTERIAL COUNT

From the estimated result of pour plate method, it was concluded that drinking water samples from miscellaneous localities of Peshawar district at inconsistent dilutions i.e. 0, 1/10, 1/100, 1/1000, 1/10,000 have higher bacterial count limit as documented by World Health Organization, and therefore evinced that the samples are not bacteriologically satisfactory. Bacterial counts for each sample dilution are displayed in Graph (1-10). The samples might contain many water borne pathogens including *E.coli*, *Enterococci*, *Faecal Streptococci* etc. which are responsible for many gastro-enteric illnesses.

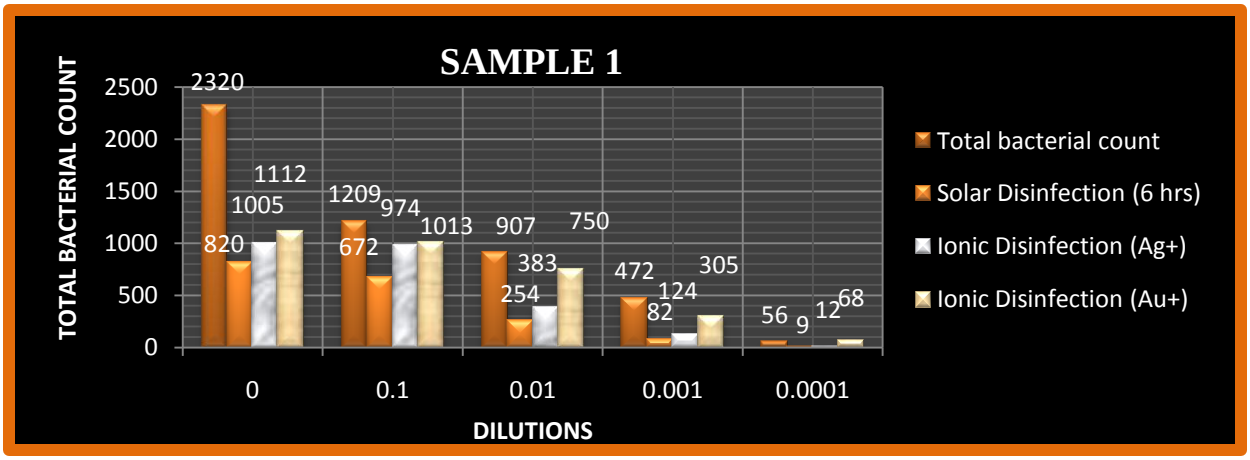
SOLAR WATER DISINFECTION

The bacteriologically abysmal test samples at vacillating dilutions i.e. 0, 1/10, 1/100, 1/1000, 1/10,000 were subjected to solar disinfection procedure, and from the results it was manifested that solar energy had pre-eminent bactericidal potency due to melding robustness of bactericidal ultra-violet and infrared beams. At all dilutions in each sample descending bacterial counts indicate that solar rays have the capacity to disinfect water in inexpensive and eco-friendly way. Results are summarized in (Graph 1-10).

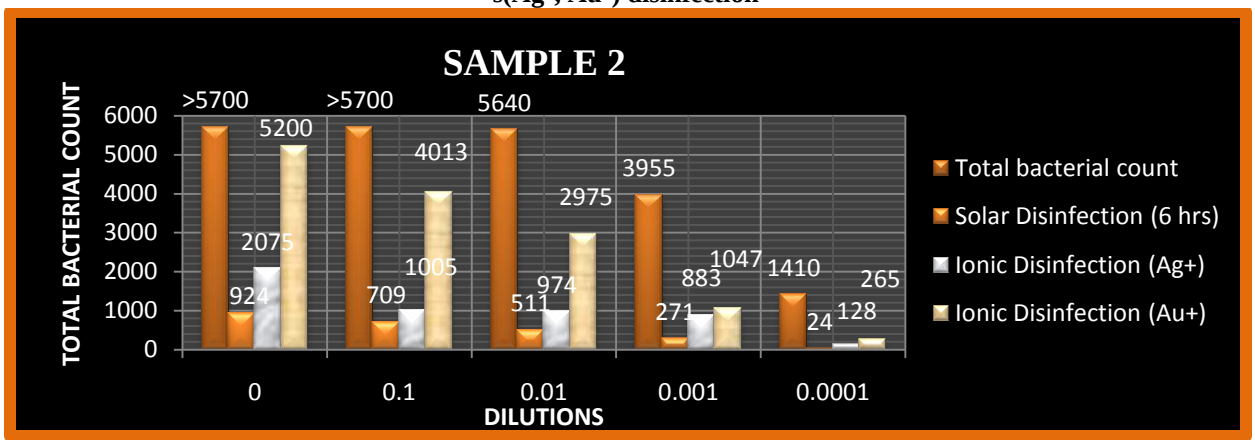
IONIC WATER DISINFECTION (SILVER AND GOLD IONS)

From the result it was scrutinized that in comparison to gold ions, silver ions have better capacity to disinfect drinking water samples. At different dilutions i.e. 0, 1/10, 1/100, 1/1000, 1/10,000, a constant graphical drop as shown in (Graph 1-10) revealed that silver ions and gold can aid to limit water borne infections and provide safe potable water as possessing bacteriostatic and bactericidal potency.

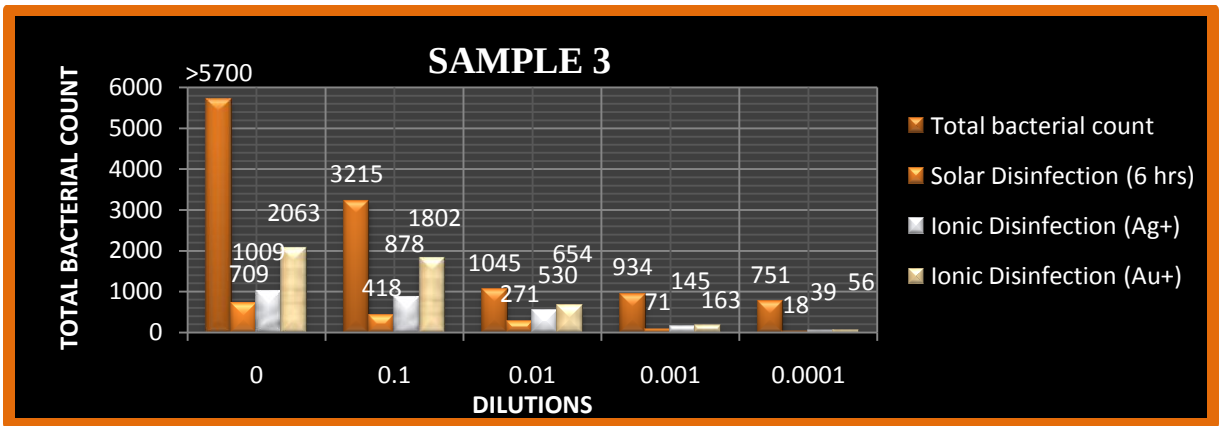
Graph 1: Total bacterial count of sample 1 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



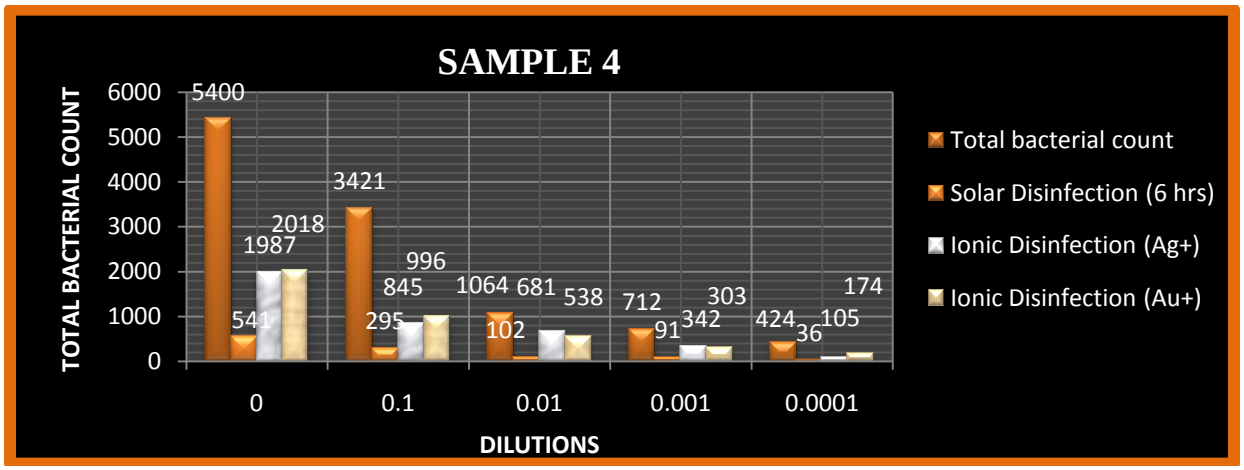
Graph 2: Total bacterial count of sample 2 at variable dilutions hitherto and antecedent to solar and ionic s(Ag^+, Au^+) disinfection



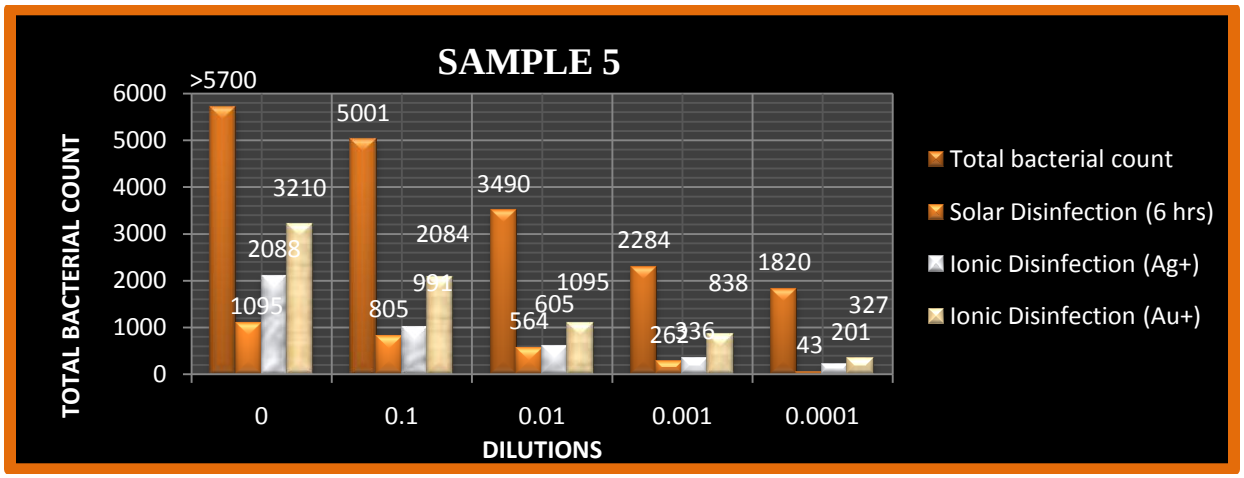
Graph 3: Total bacterial count of sample 3 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



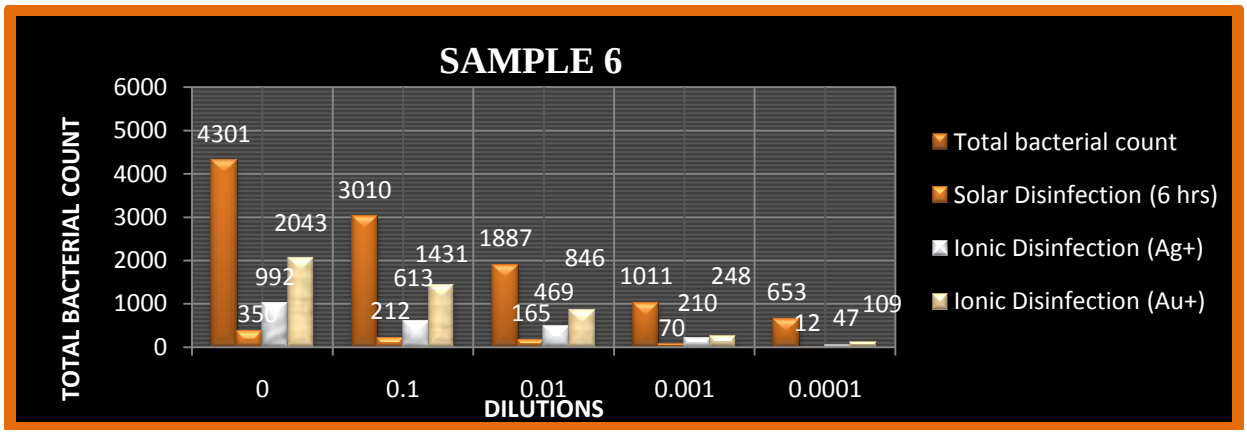
Graph 4: Total bacterial count of sample 4 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



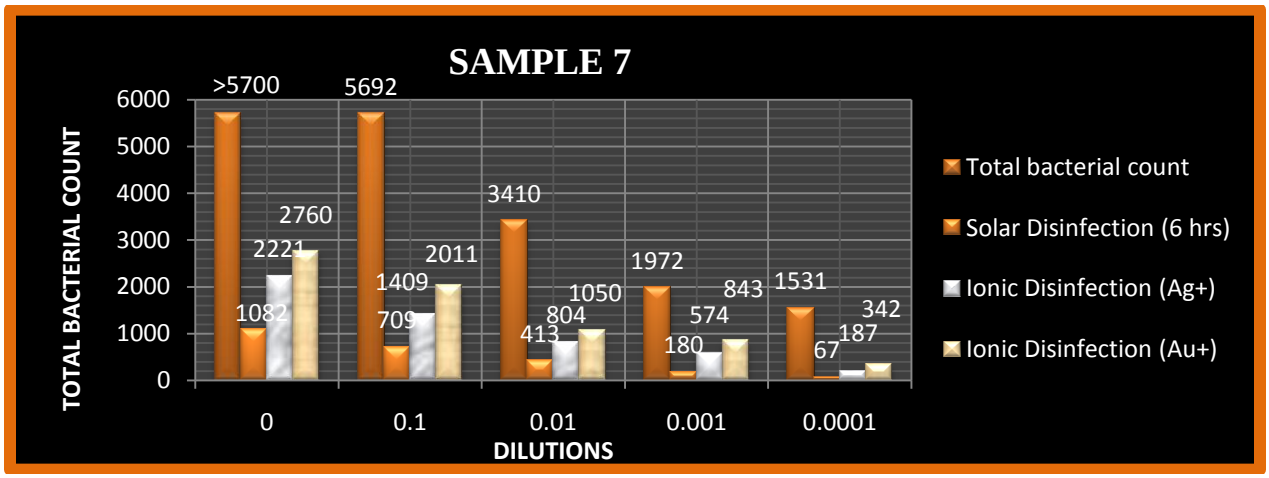
Graph 5: Total bacterial count of sample 5 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



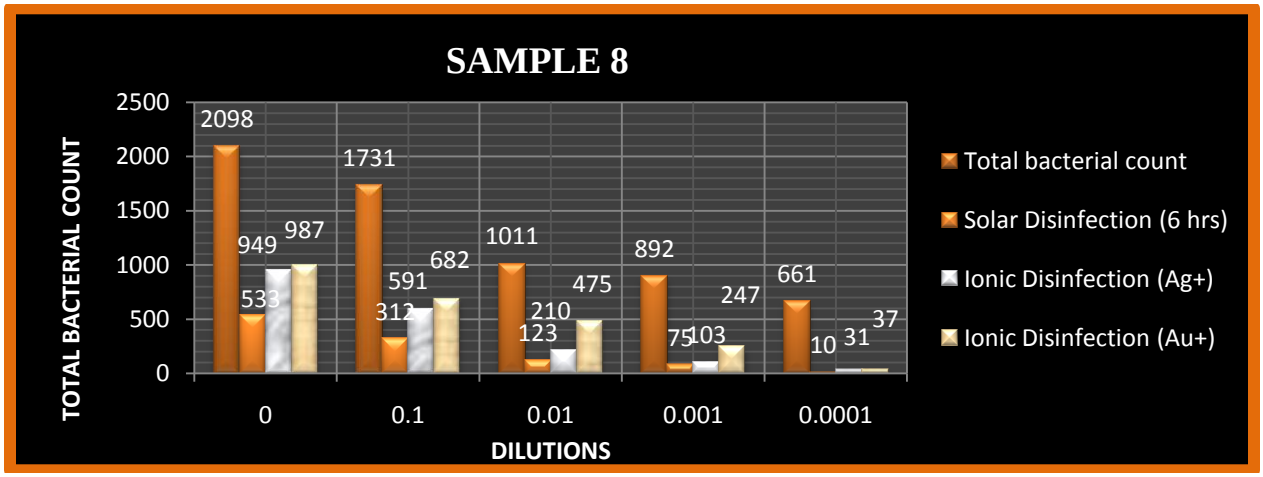
Graph 6: Total bacterial count of sample 6 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



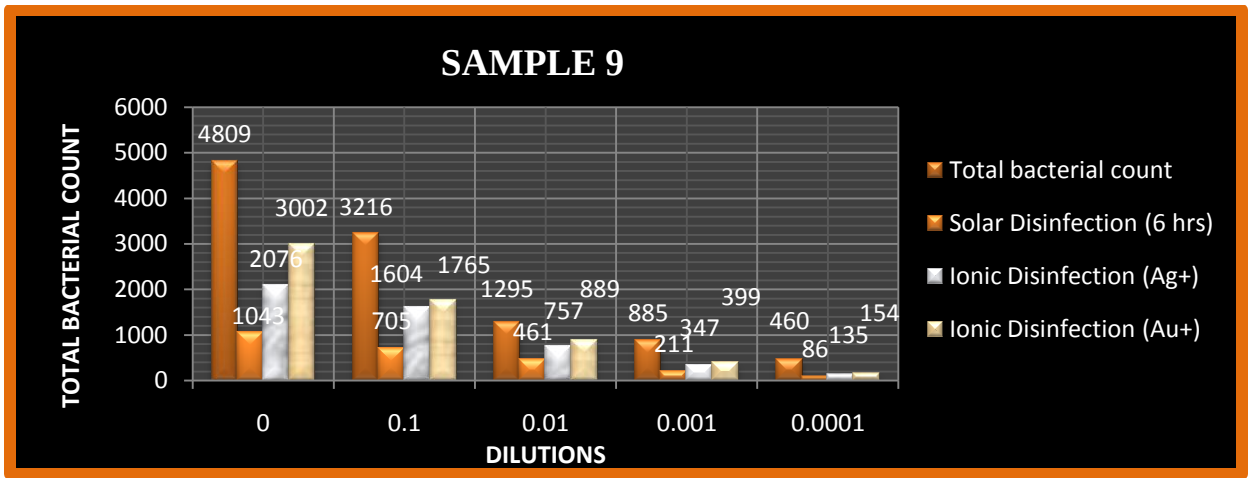
Graph 7: Total bacterial count of sample 7 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



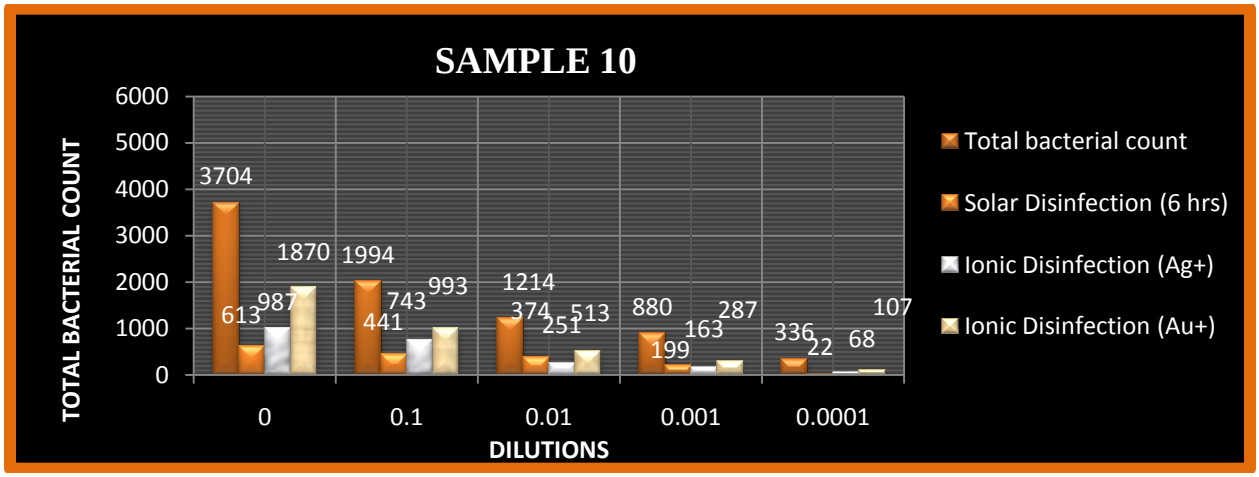
Graph 8: Total bacterial count of sample 8 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



Graph 9: Total bacterial count of sample 9 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



Graph 10: Total bacterial count of sample 10 at variable dilutions hitherto and antecedent to solar and ionic (Ag^+, Au^+) disinfection



DISCUSSION

Formerly in Switzerland solar disinfection protocol was conducted to treat potable water at house hold level to avoid many gastro-enteric illnesses caused by *Rotavirus, Picarnovirus, E.coli* and *Enterococci* etc. (Wegelin et al., 1994). This method had been executed and familiarized in many developing countries for the provision of cost effective and safe drinking water (Sommer et al., 1997). In North-East Brazil, contaminated water samples were treated utilizing bactericidal effects of solar radiations, hence providing 80-100% efficiency. Early studies evaluated that silver (Ag^+) and gold (Au^+) also possessed bacteriostatic and bactericidal prospects and therefore were implemented in water treatment plants to prevent bloom of water borne ailments (Khaydarov et al., 2005). Previously in 2011, microbicidal efficacy of silver and gold ions were scrutinized to prevent nosocomial *Legionnaires* disease, and thus prove to halt breakout of infection up to some extent (Lin et al., 2011).

CONCLUSION

From the research study it was concluded that solar disinfection signifies remarkable results than ionic (silver and gold) disinfection method. And thus this method should be implanted in all developing countries to access innocuous potable water via environment-friendly and economical route.

REFERENCES

Andrea. (2011): Silver for water purification and health.Learning the Frugal Life.

Clasen. T. (2010): Household water treatment and safe storage. Scaling up household water treatment among low-income populations. WHO, pp. 84.

Csuros. M. and Csuros. C. (1999): Microbiological Examination of Water and Wastewater. pp. 186.

Félix, L., Orellana S., Lima, A., De Souza. L. and Araújo. P. (2009): Solar water disinfection in Northeast Brazil: kinetics of the process and the study for the development of a pilot plant. Journal of Engineering Science and Technology. Vol. 4(3): 328 – 343.

Khalid, A, Malik A.H., Waseem, A., Zahra, S. and Murtaza. G. (2011): Qualitative and quantitative analysis of drinking water samples of different localities in Abbottabad district, Pakistan. Int. J. Phy. Sci., Vol. 6(33): 7480 – 7489.

Khaydarov. R. and Khaydarov. A. (2005): Water disinfection using silver and copper ions and colloidal gold. In. Omelchenko, A., Pivovarov. A. and Swindall .J. modern tools and methods of water treatment for improving living standards. NATO Science Series., Vol. 48: 159-166.

Lin, Y., Stout. J. and Yu. V. (2011): Controlling *Legionella* in Hospital Drinking Water: An Evidence-Based Review of Disinfection Methods. Infection Control and Hospital Epidemiology. Vol. 32(2): 166-173.

Meierhofer. R. and Wegelin. M. (2002): Solar water disinfection - A guide for the application of SODIS. Swiss Federal Institute of Environmental Science and Technology (EAWAG) Department of Water and Sanitation in Developing Countries (SANDEC), Switzerland: ISBN 3-906484-24-6.

Nollet, L. (2000): Handbook of Water Analysis. Marcel Dekker. New York: USA, pp. 87-99.

Sommer, B., Marino. A. and Solars. Y.L. (1997): SODIS - an emerging water treatment process. J. Water SRT-Aqua. 46: 127-137.

Wegelin, M., Canonica, S., Mechsner, K., Fleischmann, T., Pesaro. F. and Metzler. A. (1994): Solar water disinfection: Scope of the process and analysis of radiation experiments. Aqua 43: 154 169.

Zia, A. (2013): World Water Day: Water-borne diseases prove deadly killer. *The Express Tribune*.