



Comparative Efficacy Of Concentrator Materials In Convergent Rays Disinfection Of Water

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Abstract: The efficacy of concentrator material in convergent rays' disinfection was analyzed using a mirror, aluminium foil paper and ordinary solar disinfection and water samples collected from Choba community of Rivers State in the Department of Microbiology Laboratory, University of Port Harcourt. 0 hour data of 3.3 log MPN index/100ml was used as a control for the study, after 2 hours of exposure, total coliform count from mirror concentrator dropped to 1.9, aluminium foil paper recorded a count of 2.5 while ordinary solar exposure recorded a count of 2.9 log MPN index /100ml. Also after 2 hours of exposure, *faecal* coliform count from mirror concentrator dropped to 1.5, aluminium foil paper recorded a count of 1.6 while ordinary solar exposure also recorded a count of 1.6 log CFU/ml. However, after 8 hours of exposure for all the concentrators, no growth was recorded from mirror and aluminium foil paper concentrators and ordinary exposure in 4 L aliquots had a population of 1.5, 10 L had 1.9 and 15 L recorded 2.0 logs MPN index/ml. The research was able to provide satisfactory and dependable data compared to regulatory bodies on drinking water standard with MPN/100ml to be 0.0logMPN/100ml and 0.9 and 1.2cfu/ml total culturable heterotrophic bacteria count after 8hour of exposure using mirror concentrator thereby affirming the efficacy of mirror as the most effective reflective material in convergent ray water disinfection.

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Keywords: Water, Concentrator, Coliform, Mirror and Aluminum foil, disinfection, Total culturable heterotrophic bacteria, Rivers State.

Introduction

From records, human diseases have been transmitted largely by water, these include amoebic dysenteries, bacillary amoebic dysenteries and infectious hepatitis (Odeyemi *et al.*, 2011) and many varieties of gastrointestinal diseases (Odeyemi *et al.*, 2011; Ibiene *et al.*, 2012). The examination bacteria species in water has thus become a pertinent and ultimate approach to detect the occurrence of microbial populations which may become a problem to health. This, however, forms the basis for quality studies on water (Omeleke, 2004).

The quality of drinking water is of the highest significance and this thus, depends on the level of contamination and source, the human population is covered by the water source also influences the level or extent pollution and contamination occurs (Acra, 1990). As a result, there is a widespread risk to human health from waterborne harmful microorganisms including bacteria, protozoa, and viruses. About 80% of diseases in the tropics for instance typhoid, diarrhoea, dysentery and cholera are as a result of water source contamination.

The effluents from industries show a high impact in contaminating the aquatic systems; the vast wastes can degenerate the biological, physical state and chemical make-up of the water bodies (Adekunle, *et al.*, 2008; Phiri, 2005). Increase environmental activities have led to negative impaction of our water resources, either a domestic source, agricultural or industrial origin (Phiri, 2005).

Waters gaining access to these aquatic systems are considered as, solid, liquid or semi-solid status. These greatly are gotten from activities such as; human domestic functions, industrial functions or agricultural functions (Ojo *et al.*, 2011). The intensity of sunlight that reaches the surface of the earth is about 1360 W m² it varies as the earth rotates around the orbit (Kevin *et al.*, 2012). These elements such as ozone, water vapour, oxygen and CO₂ add to atmospheric contaminants. (Kevin *et al.*, 2012). Thus, we have 1.12 kJ m² of optical energy available in each second to inactivate every microbial pathogen that is present in exposed water to sun-light. The efficiency of convergent rays can be improved by using reflector that enhances the inactivation of pathogens or microbial populations. This is attributed to the ability

to concentrate sunlight, increase temperature and reduce the time of disinfection to 3-4 hours (Kevin *et al.*, 2012). This paper, therefore, addresses the efficacy of different concentrator materials in water disinfection.

Materials And Method

Study Location

The study was carried out with water samples collected from Choba river located in latitude 4°53'53.16"N to latitude 4°53'52.50"N and longitude 6°54'05.63"E to longitude 6°54'04.69", Hassan well located in latitude 4°54'23.20"N to latitude 4°54'23.59"N and longitude 6°54'29.88"E to longitude 6°54'30.41"E and Omoukiri borehole (underground water) located in latitude 4°55'29.38"N to latitude 4°55'29.03"N and longitude 6°55'24.70"E to longitude 6°55'24.43"E all in Rivers State, Nigeria.

Sample Collection And Description

Water samples were collected very early in the morning from sample location in white transparent containers aseptically and transported under controlled conditions to the laboratory for analysis.

Disinfection Experiment

Water samples were dispensed into transparent bottles containers, placed in a circular-dish ray concentrator covered with Mirror and Aluminum foil paper as the reflecting material. Bottles with different volumes of water were exposed for 0, 2, 4, 6 and 8 hours intervals. The difference between the environmental temperature (Ambient) and water temperature at each interval of exposure in degree Celsius (°C), the pH reading was noted for each sample this was adopted with modification (Ojo *et al.*, 2011).

Measuring Of Convergent Rays

The converged or incident solar rays were measured by calculating the difference between the temperature of the environment (Ambient) and water temperature at different times of exposure in degree Celsius and were compared to readings of a photometer (Ojo *et al.*, 2011).

Bacterial Enumeration

Bacterial load determination in the water sample was carried out in triplicates. Plate's counts were performed using the spread plate method with Nutrient Agar. This was based on the 10-fold serial dilution of samples. The samples were pipette into the surface of each sterile plate. About 20ml of molten Nutrient Agar was cooled to 45°C and 0.1ml of the sample was spread. After 24hr of incubation at 35°C, colonies in the plates were counted. The most probable number multiple tube method was used for coliform determination (MacConkey broth, Eosin methylene

blue Agar). Presumptive tubes were confirmed with Gram staining and biochemical tests (Ibiene *et al.*, 2012).

Results And Discussion

The efficacy of convergent rays' disinfection was analyzed using a mirror, aluminium foil paper and ordinary solar disinfection. Results obtained are represented in Figure 1. O hour data of 3.3 log MPN index/100ml was used as a control for the study, after 2 hours of exposure, total coliform count from mirror concentrator dropped to 1.9, aluminium foil paper recorded a count of 2.5 while ordinary solar exposure recorded a count of 2.9 log MPN index /100ml. However, after 8 hours of exposure for all the concentrators, no growth was recorded from mirror and aluminium foil paper concentrators for all aliquots of water but 4 L aliquots had a population of 1.5, 10 L had 1.9 and 15 L recorded 2.0 logs MPN index/ml. Data analysis indicated a significant difference in population changes for the times, volumes and materials of exposure (P-values>0.05) as indicated by the P-value.

The populations decreased with increased in exposure time (Ojo *et al.*, 2011). The complete disinfection of coliform after eight (8) hour of exposure at 48°C also agrees with Alenjadra *et al.*, (2004). They reported that with solar concentrator equipment, 10⁵ coliforms for each 100ml of water can be eliminated after 4 hours of solar exposure while the 0.9 and 1.2 CFU/ml also conform to WHO (1993) and EPA (2003) 1.0×10² standard for water.

The efficacy of convergent rays' disinfection was analyzed using a mirror, aluminium foil paper and ordinary solar disinfection. Results obtained are represented in Figure 2. O hour data of 1.7 log CFU/ml was used as a control for the study, after 2 hours of exposure, *faecal* coliform count from mirror concentrator dropped to 1.5, aluminium foil paper recorded a count of 1.6 while ordinary solar exposure also recorded a count of 1.6 log CFU/ml. However, after 8 hours of exposure for all the concentrators, no growth was recorded from mirror concentrator but aluminium foil paper concentrators for all aliquots of 4 L had a population of 0.8, 10 L had 0.0 and 15 L recorded 1.3 log CFU/ml. A significant difference was observed in population changes between the times, volumes of exposure and reflecting materials (P-values>0.05) as indicated by the P-value. Acra in (1990) reported that with 95 minutes duration of sun rays in Beirut, for about 0900 to 1400h, over 99.9% decrease in population of *faecal* coliforms was recorded.

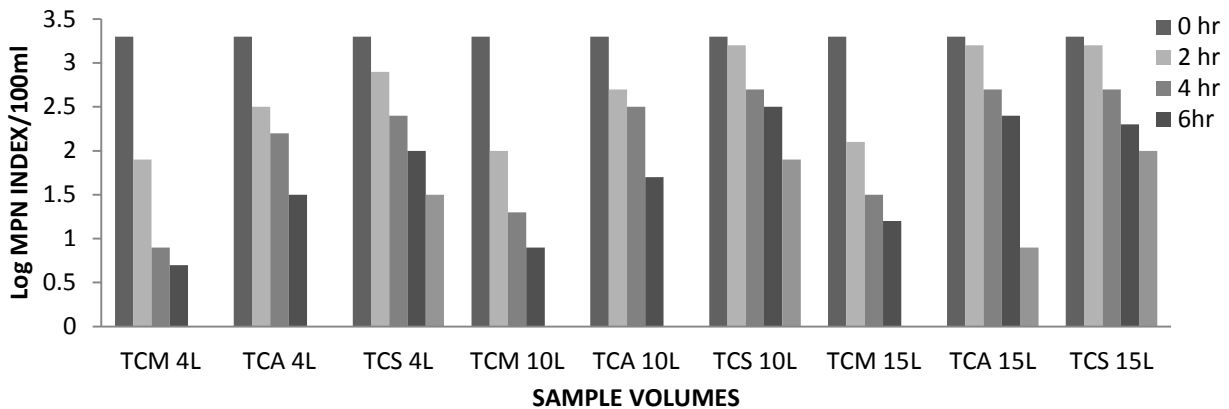


Figure 1: Comparative efficacy of concentrator material on total coliform disinfection in water

Key: TCM = Total coliform from mirror concentrator, TCA = Total coliform from Aluminum foil concentrator, TCS = Total coliform from ordinary sun exposure, Hr = Hr

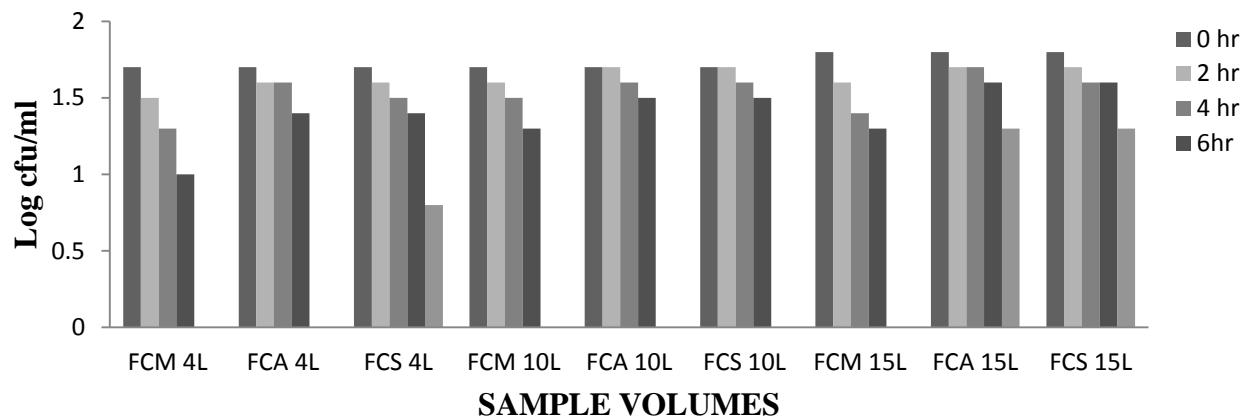


Figure 2: Comparative efficacy of concentrator material on faecal coliform disinfection in water

Key: FCM = *Faecal* coliform from mirror concentrator, FCA = *Faecal* coliform from Aluminum foil concentrator, FCS = *Faecal* coliform from ordinary sun exposure, Hr = Hour

The total culturable heterotrophic bacteria count (TCHBC) of the water samples on various concentrators' materials is shown in Figure 2. Results obtained shows 0 hour data of 2.2 log CFU/ml was used as a control for the study, after 2 hours of exposure, TCHBC from mirror concentrator dropped to 1.7, aluminium foil paper recorded a count of 2.1 while ordinary solar exposure recorded a count of 2.2 log CFU/ml. However, after 8 hours of exposure for all the concentrators, 1.2 growth was recorded from mirror and aluminium foil paper concentrators for all aliquots of water but 4 L aliquots had a population of 1.5, 10 L had 1.8 and 15 L recorded 1.8 log CFU/ml. analysis of data indicated that there was a significant difference in population changes for the times, volumes and materials used in exposure (P-

values > 0.05) as indicated by the P-value. This was in line with the report of Acra (1990). He reported that the efficiency of convergent ray's disinfection of water is dependent on the time under a clear sky, the influence of containers (Their loss of high transmittance with extended use), using sun rays treatment (for over 35°C of latitude North or South), (which varies with the time of the day, date and geographic location), and the nature of reflecting materials. The germicidal action of convergent rays was assumed to be a reflection of the concentration and intensity of light rays (Ojo *et al.*, 2011). The temperature before exposure was in the range of 27 – 29°C but increased to 44 to 53 °C after 8 hours of exposure (Figure 4).

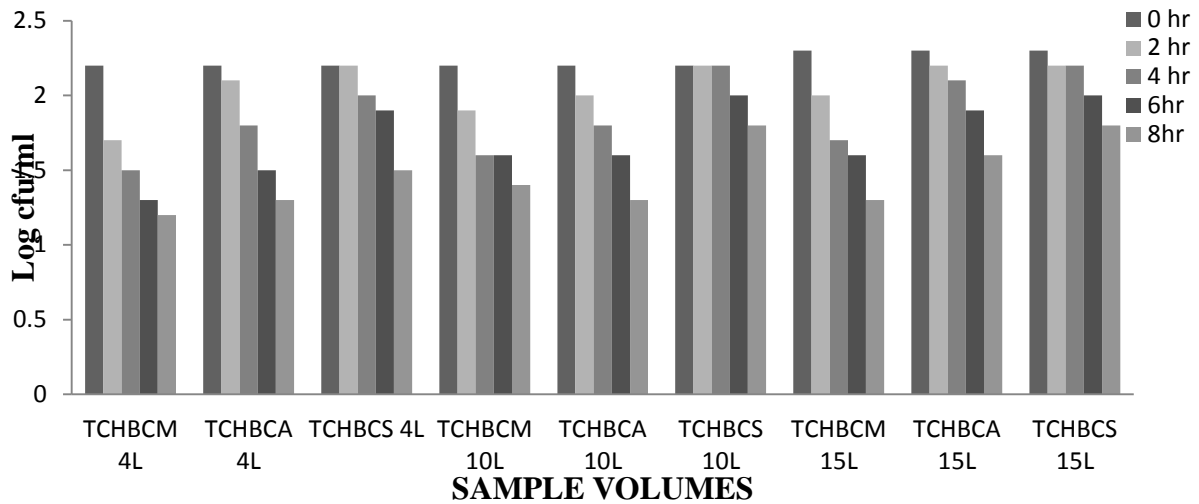


Figure 3: Comparative efficacy of concentrator material on TCHBC disinfection in water

Key: TCHBCM = Total culturable heterotrophic bacteria count from mirror Concentrator, TCHBCA = Total culturable heterotrophic bacteria count Aluminum foil Concentrator, TCHBCS = Total culturable heterotrophic bacteria count from ordinary sun Exposure, Hr = Hour

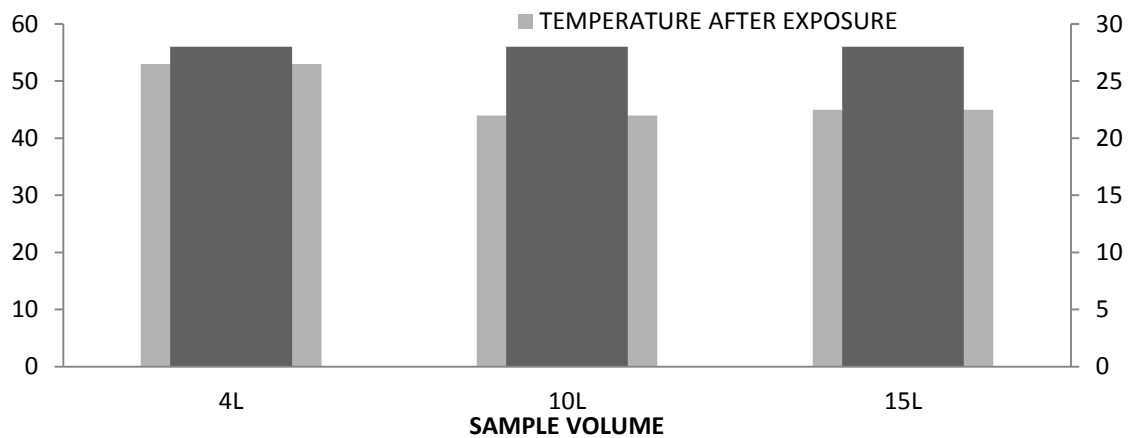


Figure 4: Temperature range before and after exposure (°C)

Conclusion

The effectiveness of the treatment process can be achieved after 6 hours of exposure and above using a mirror ray concentrator with a wide area. Bacteriological parameters responded with a decrease in population with increased in exposure time. It is therefore rational to conclude that, exposure with water samples in a circular dish ray concentrator with a mirror reflecting material for 6 hours and above can be appropriate for bacteria inactivation.

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