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# AN ASSESSMENT OF EXISTING COMMON TRADITIONAL METHODS OF WATER PURIFICATION

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***Classical water purification methods include boiling, filtration, irradiation and the use of chemicals while traditional water purification methods in use are boiling, filtration, sedimentation, long storage and solar radiation. Waterborne diseases are m ore common in the rural communities where potable water supply coverage is usually low. Therefore, this study was designed to assess and modify existing water purification methods in use in the rural communities so as to encourage their regular use.***

***Water samples collected from various sources serving six rural communities in Agege, Epe and Ikorodu Local Government areas of Lagos State were purified using each of the traditional methods. Viable counts were carried out on each of the water samples before and after the purification process. Water samples contamination with known pathogens were also included in the test.***

***The boiling method was the most efficient giving 100% decontamination after three minutes of continuous boiling. The solar method gave varying degrees of decontamination of the water samples (42-100%) depending on the turbidity of the water and the type of container used for the test. The long storage method and the cloth filtration methods decontaminated the water by (0.6-4.2%) and 41% respectively.***

***The solar water purification method should be encouraged. Turbid water samples should be cloth filtered prior to exposure to the sun for maximum efficiency.***

## INTRODUCTION

It is often said, "water has no enemy" This emphasizes the importance of water to living things. For men, access to potable water greatly affects disease burden. The focus of the water decade (1981 – 1990) activities in developing areas of the world was on changing the overall emphasis from capital intensive projects to low cost locally maintained alternative technologies (1). Therefore building on traditionally known and used water treatmen practices is expected to have the potentials for reducing morbidity and mortality rate of waterborne diseases. Water treatment is purifying water to a level safe for drinking, free of all pathogens and toxic substances, having pleasant appearance and being tasteless and odourless (2). The presence of 10 or less coliforms in 100ml of water in unchlorinated water is usually disregarded (3). Classical purification methods in use are filtration, boiling, long storage, irradiation, the use of metals like silver an copper, use of oxidants such as the halogens and halogen compounds, ozone, hydrogen peroxiden and potassium permangenate.

Traditional methods of water purification include cloth filtration, sedimentation and boiling. Coagulants of plant and soil origins have been used for water purification in developing countries are in form of such fluvial clays earth from termite hills, seed of *Moringa oliferia* (2), potash alum (trona) (4,5). Trona, a naturally occurring grey or yellowish white deposit used locally as tenderizer, oil-emulsifier, preservative and a food condiment that is alkaline (pH 9.0) and water soluble is made up of hydrated acid sodium carbonate $Na_2Co_3NaHCo_32H_2O$. Trona has also been reported to contain potassium, chloride and sulphite ions (5).

Storage of water reduces the number of bacteria by 90% in five to ten days (6). Pioneering studies in Beirut reported that the near ultra-violent region (A) of the sun in tropical and sub-tropical regions destroyed 99.9% of Coliforms in water contained in transparent plastic or glass bottles in 90 minutes provided the volume of the water was three litres or less (7,8,9). Pathogens such as *Salmonella typhi, Shigella spp*, and *Vibrio Cholerae* were repoted to be more sensitive to the sun rays than coliforms (10,11). The minimum dosage of solar intensity recommended to inactivate vegetative bacteria is 0.44KWh/m$^2$, (12) and in Nigeria an average solar intensity of 3.7KWh/m$^2$ per day in the semi-arid areas of the country.

The fruits of Xylopea aethiopica are sometimes put into jars of water to purify the water (13). The leaves of *Ocimum gatissium, Psiditum guagjava (guava)* and *Anacardium occidentale* (cashew) are used in the management of diarrhoea in the eastern part of Nigeria (14). *Terminalia avicennoides,* was reported to possess vibriocidal properties (15) and Lennea *welwischii* and *Phyllantus discoideus* were reported to show anti-bacteria activities against the *Enterobacteraceae* (16). The need to purify water in our rural communities and other developing countries is of utmost importance in the reduction of morbidity and mortality due to waterborne diseases, this study was therefore designed to search for and validate simple, cheap and practicable methods of water purification using locally available materials.

## MATERIALS AND METHODS

*Water samples*: water samples from wells, river, stream, and pond sources serving six rural communities in Lagos State which in an earlier study were found to be contaminated were coded S1-S10 a potable water sample coded SC served as control. All the samples were purified by each of the purification methods as described. Water samples were contaminated in the laboratory with 1.5 x 10$^4$/ml E. coli (ATCC 25922).

*Boiling*: one hundred millilitres of each water sample were heated to 100°C and 1ml each was withdrawn at the start of boiling, after 1,2,3,4 and 5 min-

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utes. Viable counts of all the samples were performed as described by Miles and Misra (17) using nutrient agar, blood and Maconkey agar (Oxoid) and incubated at 37°C for 24 hrs.

*Filtration:* one hundred millilitres of each water sample were filtered through sterile white cotton material and viable counts performed on the filtrates.

*Long storage:* two and a half litres of each eater sample were stored in sterile clay pots and plastic containers with fitted lids at room temperature. Viable counts were then performed on the water samples withdrawn from each container after 2, 5 10, 15, 21 days of storage.

*Addition of local materials*: Plants parts used (bark, leaves, or seeds, table 1) were weighed, washed in distilled water, rinsed in methylated spirit and dried in the oven at 60oC for 30 minutes and then macerated in a clean sterile mortar. The plant parts were then put the water samples.

Samples to give a final concentration of 1% w/v and left for 4hrs before viable counts were performed. Viable count were repeated after 24hrs. For Trona (potash alum), various concentration, 0.05, 0.1,0.25 and 1.0% and for aluminium sulphate (alum) 50mg/lit concentrations were tested likewise.

*Use of sunlight:* water samples S1 – S10 put in plastic and glass bottles, (1.5L) were kept in the sunlight for 4hrs. A duplicate set of bottles was left in a cupboard in the laboratory away from sunlight for the same period of time as controls. Viable counts were performed on all samples and repeated after 24hrs.

Large volume of water (8L) put in different wide shallow containers (enamel, aluminium and plastic), and covered with thin clean transparent polythene sheets, knotted firmly at the sides were also exposed to sunlight. Some known water pathogens like *Salmonella typhi, Shigella dysenteriae, Vibrios cholerae*, (local strains), *Escherichia coli* (ATCC 25922) were introduced into the water samples and the solar decontamination process repeated. On cloudly days, the containers were half filled and exposed to the low intensity of sunlight for solar decontamination. The containers were aerated by shaking them at intervals.

Solar and cloth filtration: samples S1 – S10 were passed through a clean white cloth for filtration. The filtrates were then put in the enamel container and purified by the solar decontamination method.

| Botanical Name (Family) | Voucher Sample | Local Name | Plants part |
|---|---|---|---|
| Lennea welwitschii (Hievn) Engl. (Anacardiae) | LUTH 020 | Orira (Y) | Bark |
| Phyplianlia dixoideus Mueli-Arg (Euphorbiaceae) | LUTH 2021 | Ashasha(Y) | Bark |
| Terminalia avicennoides (Combretaceae) | LUTH 376 | Idi (Y) | Bark |
| Moringa oilefiera | IDIKA 1 | Ewe igbale (Y) | Seed |
| Xylopea aethiopica (Annonaeceae) | IDIKA 2 | Uda(I) | Fruit |
| Momordica foetida | IDIKA 3 | Ejirin (Y) | Leaves |
| Ocumum gratissimum | IDIKA 4 | Efirin (Y) Nchanwu(I) | Leaves |
| Ocumum gratissimum Parinari spp | IDIKA 5 | Abere (Y) | Leaves |
| Agerantum conyzoide | IDIKA 6 | Imisu (Y) | Leaves |
| Psidium guagjava | IDIKA 7 | Guava (E) | Leaves & stem |

**Table 1: Parts of Local herbs selected for testign water purification ability**
**KEY:** *Y = Yoruba* *I = Igbo* *E = English*

## RESULTS

*Boiling method:* A 1005 decontamination of all the water samples tested was obtained after three minutes of boiling (Table 2).

*Solar decontamination method:* water samples S1 – S10 were decontaminated by 40-94% while laboratory water samples contaminated with known pathogens were decontaminated by 95.4-100% (Table and 3).

| Method | Duration | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiling | At boiling | 0 | 8 | 7 | 24 | 3 | 3 | 6 | 4 | 5 | 20 | 0 |
| | 1 min | 0 | 3 | 4 | 10 | 3 | 0 | 2 | 0 | 1 | 10 | 0 |
| | 2 min | 0 | 2 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| | 3 min | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cloth filtration Long storage (clay pot) | 2 days | 97 | 272 | 280 | 480 | 364 | 386 | 196 | 280 | 398 | 288 | 0 |
| | 5 days | 70 | 210 | 280 | 350 | 270 | 300 | 120 | 200 | 190 | 350 | 0 |
| | 10 days | 50 | 150 | 180 | 320 | 200 | 280 | 100 | 180 | 170 | 300 | 0 |
| | 15 days | 40 | 150 | 200 | 320 | 202 | 280 | 80 | 150 | 170 | 280 | 2 |
| | 21 days | 80 | 170 | 200 | 350 | 200 | 350 | 60 | 150 | 200 | 200 | 8 |
| Long storage (Plastic can) | 2 days | 95 | 180 | 200 | 400 | 200 | 350 | 60 | 150 | 200 | 200 | 8 |
| | 5 days | 82 | 210 | 230 | 380 | 300 | 320 | 120 | 300 | 200 | 380 | 0 |
| | 10 days | 80 | 190 | 200 | 380 | 280 | 300 | 100 | 250 | 200 | 320 | 7 |
| | 15 days | 100 | 188 | 200 | 400 | 280 | 250 | 100 | 250 | 210 | 320 | 4 |
| | 21 days | 150 | 180 | 200 | 450 | 250 | 250 | 120 | 250 | 200 | 400 | 2 |
| Solar | 4hrs | 6 | 10 | 60 | 300 | 200 | 30 | 15 | 10 | 12 | 12 | 0 |
| 0.5% Potash alum | 4hrs | 220 | 220 | 50 | 70 | 100 | 60 | 50 | 120 | 20 | 50 | 0 |
| | 24hrs | 200 | 200 | 40 | 50 | 50 | 60 | 50 | 100 | 20 | 40 | 0 |
| viable count prior to purification | 100 | 280 | 290 | 500 | 500 | 380 | 400 | 500 | 350 | 300 | 500 | 0 |

Viable Counts cfu/ml of water

**TABLE 2**
**Comparison of the effects of the different purification methods employed on the water samples from the six communities in Lagos.**

| Purification method | Duration | HEC | HST | HSD | HVO | HVI |
|---|---|---|---|---|---|---|
| | | Viable counts cfu/ml of water | | | | |
| Boiling | At boiling | 0 | 95 | 4 | 2 | 2 |
| | 1 min | 0 | 10 | 0 | 1 | 1 |
| | 2min | 0 | 3 | 0 | 0 | 0 |
| | 3 min | 450 | 0 | 0 | 0 | 0 |
| Cloth filtration Long storage in clay pot | 2 days | 400 | 350 | 300 | 370 | 380 |
| | 5 days | 150 | 300 | 300 | 350 | 350 |
| | 10 days | 220 | 250 | 280 | 290 | 300 |
| | 15 days | 250 | 250 | 280 | 250 | 280 |
| | 21 days | 250 | 200 | 280 | 250 | 280 |
| Long storage in Plastic container | 2 days | 350 | 350 | 300 | 400 | 380 |
| | 5 days | 200 | 300 | 280 | 370 | 320 |
| | 10 days | 250 | 280 | 280 | 300 | 300 |
| | 15 days | 250 | 250 | 300 | 300 | 300 |
| | 21 days | 300 | 250 | 300 | 300 | 300 |
| Solar energy | 4 hrs | 25 | 10 | 15 | 0 | 0 |
| Use of 0.5% Potash alum | 4 hrs | 80 | 100 | 300 | 200 | 150 |
| | 24hrs | 20 | 95 | 60 | 50 | 40 |
| Viable count prior to purification | | 470 | 510 | 612 | 500 | 508 |

**TABLE 3**
**The effect of the difference purification methods on water pathgens introduced into sterilized water from a well.**
Key:
HEC – Water contaminated with E. coli (150 x $10^4$/ml)
HSD - Water contaminated with Shigella dyseteriae (150 x $10^4$/ml)
HST - Water contaminated with Salmonella typhi (150 x $10^4$/ml)

HVO - Water contaminated with V. cholerae (Ogawa) (150 x $10^4$/ml)
HVI - Water contaminated with V. cholerae (Inaba) (150 x $10^4$/ml)

After filtration of S1-S10 with cotton cloth, 80-96% solar decontamination was obtained Water samples in aluminium and enamel containers were deconminated by 93-100% (Table 4) solar and air combination used by cloudly days gave 98.2-100% decontamination (Table 5) of the water pathogens.

| Type of container | Viable counts cfu/1ml of water | | | |
|---|---|---|---|---|
| | Day temp. | HEC | HST | HSD |
| 1.5L Plastic Bottle | 36°C | 0(100) | 0(100) | 0(100) |
| 1.5L glass jar | 36°C | 10(98) | 8(98.4) | 10(98) |
| 1.5L Plastic Bottle | 32°C | 0(100) | 4(99.2) | 0(100) |
| 1.5L glass jar | 32°C | 18(98) | 20(96) | 18(98) |
| 1.5L Plastic Bottle | 30°C | 10(98) | 10(98) | 8(98.4) |
| 1.5L glass jar | 30°C | 22(95) | 12(97.6) | 2(99.6) |
| viable counts of samples prior to purification | | 480 | 500 | 500 |

**TABLE 4:**
**Effect of four hours exposure of Laboratory contaminated water samples to sunlight**
Key:
HEC – Water contaminated with 150 x $10^4$ E.coli
HST - Water contaminated with 150 x $10^4$ S. Typhi.
HSD - Water contaminated with 150 x $10^4$ S. dysnteriae
( ) = % Bacterial Reduction.

*Addition of local plant and natural compounds*: Local plant parts and soil materials like limestone used in this study failed to exhibit anti-bacterial activity. Aluminimum sulphate (alum) at 50mg/L, the concentration used in water treatment, did not destroy the bacteria in water. However trona at 0.5% w/v concentration was found to be inhibitory to the bacteria in the water samples by 50-80% and by 78.7-96% after 4 and 24hrs respectively (Table 2). Water pathogens showed 40-80% decontamination (Table 3).

| | Viable counts cfu/1ml of water | | | | |
|---|---|---|---|---|---|
| Plastic Bottle | 0(490) | 100 | 25(490) | 94.9 | 0.781 |
| | 0(500) | 100 | 20(500) | 96.0 | 0.775 |
| | 0(220) | 100 | 17(220) | 92.3 | 2.694 |
| | 2(400) | 99.5 | 100(400) | 75.0 | 3.076 |
| Enamel Basin | 0(490) | 100 | 20(400) | 95.8 | 0.781 |
| | 0(500) | 100 | 14(500) | 97.2 | 2.775 |
| | 0(220) | 100 | 10(220) | 95.5 | 2.694 |
| | 0(300) | 100 | 40(400) | 90.0 | 3.076 |

**TABLE 5:**
**The effect of the combination of Solar Irradiation and Oxygen (Aeration) on the Decontamination of Water.**
*Values in bracket are viable counts of water samples prior to exposure to sunlight*

Key:
½ FC = Half filled container
FC = Completely filled container
1 = Irradiation

*Long storage method:* the water samples in clay pots and plastic containers showed in average bacterial reduction of 41% after 5 days of storage (Table 2). The counts remained constant or increase in some cases by the 21st day of storage.

*Cloth filtration method*: the bacterial count in the water samples tested was reduced by 0.6 –4.2% using this method (Table 2).

## DISCUSSION:

This study has shown boiling as the most efficient of the five methods tested. Though a very effective methods of destroying bacteria, viruses, spores, cercaria, amoeba cyst, worms and parasitic eggs (2) it alters the taste of water and consumes a large amount of fuel, and leads to deforestation where wood is used (2). The fumes can be injurious to health by causing damage to the lungs and eyes (2). It is pertinent to note that *S. typhi and S. dysenteriae* survived after 1 min and 2min of boiling respectively suggesting that water should be allowed to boil for at least five minutes for effective water purification. It is also expensive as a report from India stated that boiling drinking water required about 33% of the income of most of the inhabitants(18).

The efficiency of the solar purification method in this study agrees with the views of Odeyemi that peasants living in cholera endemic areas may achieve considerable reduction in the incidence, prevalence, morbidity and morality of waterborne diseases by merely exposing their domestic water supplies to solar radiation for about 5 hours(19). In this study, the effect of the soal radiation on turbid water samples was very much lower than its effects on the laboratory contaminated water samples. This is probably due to the exerted attenuating effects on the transmission of the sun rays by the particles present in the water which tend to shield and protect the bacteria as was earlier explained by Odeyemi (20). This was confirmed by our finding where a combination of the cloth filtration and solar decontamination methods yielded better results than either method when used alone. This study also validated the solar and air combination for water purification on cloudy days.

The local herbs used in this study failed to exhibit anti-bacteria property. It is possible that their active ingredients are not water soluble. On the other hand, trona which decontaminated the water samples was found to increase the blood pressure of rats in separate study (21).

## CONCLUSION

Boiling and solar methods were found to be suitable for purifying domestic water in the rural areas. However solar method being simple, practicable and cheap is therefore recommended for use in the rural communities. The use of potash alum (trona) which is cheap and effective would require further studies on its subsequent toxicological effect invivo using animal models such as rats. The other methods were not found suitable in this study.

## REFERENCES


1. Taylor S. Clean Water for all Canadian International Development Agency (CIDA) 1985. Hull. Quebec. Canada
2. Heber, G. simple methods for the treatment of drinking water. A publication of DT Zemtrum for Tedin Eusommener Entiwick lungs technologien – GATE in Dt. Gresfyr Techn Eusommener Biet (GTZ) 1985. GmbH/ Gabriele Heber, Brausher e.g. Wiesbaden: Vieweg.
3. Khan M.U. Alum Potash in water to prevent cholera. Lancet 1984 2: 1032 (Letter).
4. Khin New, O.O. Khin-Sann-Aung and Myat-Thida. Effectiveness of Potash Alum Decontaminating Household Water. Diarrhoea. Dis. Res, 1993. 11(3): 171-174.
5. Osagie, O.L. The preliminary investigation of Kanwa (trona) as a parmaceutical Excipient B. Pharm. Dissertation 1989. University of Lagos, Nigeria.
6. Taylor, E.W. the examination of water and water supplies J.A. Churchill Ltd. 104 Gloucester Place, W.I. (Thresh, Beale and Suckling) 7th edition 1958.
7. Acra, A., Karahagopian, Y., Raffoul, Z. and Dajani R Disinfection of Oral Rehydration Solutions by sunlight The Lancet 1980: 2: 1255-58.
8. UNICEF Solar Disinfection of Drinking water and Oral Rehydration Solution Aleph Beirut UNICEF 1984.
9. Alward, R., Ayoub J. and Brunet, E. Solar Water Disinfection 1994. Article number 225 Brace Research Institute Macdonald Campus of MacGill University Ste. Anne de Bellevue Quebec, Canada.
10. Morley, D. Sunlight and Drinking Water. Lancet 1988. 17:86
11. Feachem, R.G. Muller C and Drasar, B. Environmental Aspects of Cholera Epidemiology 11. Occurrence and Survival of V. cholerae in the Environment Trop. Dis. Bull. 1981. 78(10): 865-880 (78 Ref).
12. Sobsey, M.D. Inactivation of Health Related Micro – Organisms in Water by Disaffection Processes. Water Sci. and Tech. 1989: 21: 179-196.
13. Dazliel, J.M. Useful Plants of West Africa, Tropical Africa. 1937. Crown Agents for the Colonies, London.
14. Asobie, FC. Igboeli, CC. And Okeibunor, JC. Indigenous perceptions of Childhood Diarrhoea in Enugu Implications for Diarrhoea Prevention. Nig. J. of Paed. 1994. 2 (suppl). 55-65.
15. Akinsinde, K.A. and Olukoya D.K. The vibrocidal activity of some local herbs J. Diarrh. Dis. Res. 1995 June 13(2) 127 – 129.
16. Olukoya, D.K. Idika, N and Odugbemi, T. Antibacterial Activity of some Medicinal Plants from Nigeria J. Ethnopharmacology, 1993, 39: 69-72.
17. Miles, A.A. Misra, S.S. and Irwinc, J.O. Estimation of Bactericidal Power of Hyg. Camb. 1938: 732-749.
18. Kristof N. Sanitation and water raging Third World. New York Times Service 1997.
19. Odeyemi O. Use of Solar radiation for water Disinfection Publication of INRESA Secretariat, 1986 Brace Research Institute, McGill University, Montreal, Canda.
20. Odeyemi, O. An Assessment of Solar Disinfection of Drinking Water in Nigeria Report M.R.P. No. 1C A86/ 120. 1984 The UN. University Tokyo Japan 34.
21. Idika , N: Odugbemi, T: Anigbogu, C: Adegunloye, BJ, Ojuminiyi, F: Elesha, S.O. and Azinge, EC. Water purification properties, cardiovascular and metabolic effects of potash alum (trona). Nig. Qt. J. Hosp. Med. (in press).