PASTEURIZATION OF WATER USING SOLAR AQUAPAK: A CASE STUDY

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FINAL REPORT

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1.0 INTRODUCTION

Water is one of the most abundant and important substances which nature provides to sustain life for man, animals and plants. Lyold and Helmer (1991) described 'safe' water as one that is free from chemical substances and organisms, which could cause illness in any form. Safe drinking water is one of the primary requisites for healthy human life.

In the developed countries, safe water is taking for granted as untainted water is collected from the taps of millions of householders. The rivers, streams, ponds and lakes are for pleasure and enjoyment during leisure period of urban dwellers and rural inhabitants (Green and Trett, 1989). However, in the developing world, the situation is different. Apart from some urban areas that enjoy intermittent services as provided by the Water Boards, the urban slums and rural areas depend on water from sources such as springs, wells, rivers, ponds or brooks for the day-to-day needs of the family, livestock and crops. During the dry season, women and children feel the pinch by trekking many kilometres in search of water. This situation has resulted in varying degrees of water-related diseases such as diarrhoea, malaria, cholera, typhoid, guineaworm, onchocerciasis and schistosomiasis. One billion people have no access to safe drinking water, while over two billion have no access to proper sanitation. As a result of this, more than five million people die every year from water-related diseases (Henry, 2002).

Water intended for human consumption must undergo stringent control of water contaminants and higher quality standards than for other uses (Cairncross and Feachem, 1993). The standards are expressed in terms of microbiological, chemical and physical characteristics.

Nigeria, Africa's most populous country south of the Sahara is endowed with abundant surface and underground water reserves estimated to be 267 billion cubic metres and 57 billion cubic metres respectively (World Resource Institute (WRI), 2001). Despite this huge water reserve, a large proportion of the population still lack access to safe water.

There is a general lack of adequate safe drinking water in Ibadan metropolis, despite the fact that the Oyo State government has been at the forefront of water provision since 1946 when the first water pipe was laid in the city. An assessment by Agbede (1991) revealed that majority of the rivers in Ibadan city is highly polluted because many of them are used for disposal of solid waste. Between 1991 and 1995, the World Bank/African Development Bank responded to the government's request for assistance in water supply but this project failed due to management problems, thus making the provision of this essential commodity a mirage. Cursory observation showed that majority of the households recourse to the use of wells, springs, boreholes, brooks, water from leaking pipes and even packaged water (in bottles or sachets) for drinking and domestic use.

The project aims at providing potable water for Ajibode community in Ibadan Metropolis with the aid of Solar AquaPak. The main objective is to investigate the effectiveness and efficiency of Solar AquaPak.

Solar water pasteurization is the most economical and safe way to eliminate pathogens (bacteria, viruses, parasites etc.) like cholera and salmonella from fresh water sources. If the temperature and time defined on the adjacent pasteurization chart are achieved the system is almost ‘goof proof’ (Cairncross and Feachem, 1993). For this reason pasteurization is the process of choice for millions of gallons of milk, beer, wine, honey and many other beverages in the industrialised world.

The key to solar water pasteurization is to ensure that the water gets hot enough for long enough time. The Aqua Pak is a polyethylene solar water pasteurizer designed to achieve water temperature of 65^0C which will reduce all pathogens by 99.999%.

Pasteurization is the process of disinfecting food or liquid by heat or radiation. Disinfection means the destruction of disease-causing micro-organism.

The word ‘pasteurization’ was named after the French doctor Louis Pasteur, the father of modern medicine. In 1864, Pasteur demonstrated that diseases are caused by micro organisms that can by killed by heating to 55^0C or 131^0F for several minutes. Applied to wine, beer and milk, this process called ‘pasteurization’ soon came into use throughout the world.

Pasteur's research proved that sufficiently heating a substance destroys all disease causing germs. Pasteurization has been accepted as completely safe for more than 134 years. Today, throughout the world, beverages such as milk, fruit juice, beer and wine are disinfected through pasteurization. Consumers are familiar with and trust the process of pasteurization.

Pasteurization is a function of time and temperature. If heat is applied for a long period of time, disinfection will occur at lower temperature. At higher temperatures, disinfection occurs in a shorter period of time.

Water Purification

Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water. The goal is to produce water fit for specific purpose. Most water is purified for human consumption (drinking water) but water purification may also be designed for other purposes, including meeting the requirements of Chemical and industrial applications. In general, the methods used include physical processes such as filtration, sedimentation and distillation; biological processes such as slow sand filter or biologically active carbon and chemical processes such as fluctuation, chlorination and the use of electromagnetic radiation such as ultraviolet light.

The purification process of water may reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae, viruses, fungi; and a range of dissolved and particulate material derived from the surface that water may have made contact with after falling as rain.

The standards for drinking water quality are typically set by governments by international standards. These standards will typically set minimum and maximum concentration of contaminants for the use that is to be made of the water.

It is not possible to tell whether water is of appropriate quality by visual examination. Simple procedures such as boiling or the use of a household activated carbon filter are not sufficient for treating all the possible contaminants that may be present in the water from an unknown source. Even natural spring water considered safe for all practical purposes in 19th century must now be tested before determining what kind of treatment, if any, is needed. Chemical and microbiological analysis, while expensive, are the only way to obtain the information necessary for deciding on the appropriate method of purification.

2.0 METHODOLOGY

To effectively and efficiently make use of the Solar Aquapak, some steps are to be strictly taken. These are done in a sequential order as below:

- Collection of Samples
- Testing of Raw Samples

- Pasteurization with AquaPak
- Testing of Pasteurized samples.

The water samples were collected from

- A borehole at Fanawole,
- Well at Oju Oja,
- Stream at Adeosun area.

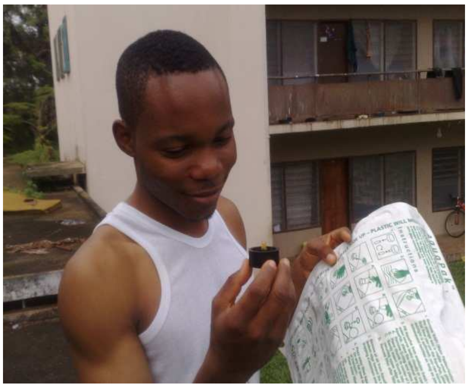
The samples collected with two liters containers for the chemical tastings while sterile bottles were used to collect samples for bacteriology laboratory tests with the aid of syringes to avoid introduction of external organism into the water samples. The Well samples were collected using drawer while borehole samples was collected directly from the borehole tap while the stream sample was collected with tilting of collection bottles inside the stream in its line of flow.

The pasteurization of samples was done using the Solar AquaPak. After collection of samples, the next and important stage is the pasteurization of the samples using the AquaPak. This was done by pouring the water samples into the AquaPak though not filled up but enough to enhance unison in heat distribution over the AquaPak panel. The indicator at the back of the Solar AquaPak is the most essential part of it since it has been experimented that pasteurization of water takes place at a minimum of 65^0C which is the temperature at which the Orange color on the indicator disappears and turn colorless. Sometimes, the samples spent four, six hours, and even two days before the pasteurization temperature could be reached. It simply means that the use of AquaPak is weather dependent.

The tests were carried out to know the chemical and bacteriological components of the samples before and after using the solar Aqua Pak. Therefore, testing was done twice on each sample to ascertain the chemical and bacteriological composition before and after using the Aqua Pak.

The samples were tested for chemical elements such as Chloride, Calcium, Aluminium, Iron, Lead, Total hardness, pH of the water samples and the before and after results were compared using World Health Organization (WHO) and the National Agency for Food and Drugs Administration and Control (NAFDAC) standards.

Examining the Solar Aquapak



Confirming if the indicator was truly orange

Aquapak placement during pasteurization

Checking if the orange indicator has disappeared

Adding reagents to samples during laboratory testing

3.0 RESULTS AND DISCUSSION

The entire experiment was done or carried out with few assumptions made due to the fact that the experiment was actually to test for the efficiency and effectiveness of the Solar Aqua Pak in providing a potable water for rural communities, therefore a small quantity of each water sources were collected to represent the entire water sources.

The results obtained from the analyses are as presented in Tables 2 - 4.

Table 2: Results of Laboratory analysis of water from the Stream at Adeosun

Parameter	**Before Pasteurization**	**After Pasteurization**	**WHO Standard**	**NAFDAC Standard**
Total Hardness (mg/l)	756.0	2.49	75-150	75-150
Ph	5.2	7.73	7.0-8.5	6.5-8.5
Cl (mg/l)	77.99	16.5	200	200
Ca (mg/l)	612.0	1.73	75-200	75-150
Al (mg/l)	1.487	0.35	0.5	
Fe (mg/l)	2.096	0.04	0.05-0.3	
Mg (mg/l)	144.0	0.76	50	30
Mn (mg/l)	0.827	0.76	50	30

Coliform count (ml)	18	0	Must not be detectable in any 100ml sample	1 (Max)
Mackonkey Agar (cfu)	10	0		
Swarzt Differential Agar (cfu)	11	0		
Streptococcus Agar (cfu)	10	0		
Lauryl Sulphate Agar (cfu)	20	0		

Table 3: Results of Laboratory analysis of water from Oju Oja Well

Parameter	**Before Pasteurization**	**After Pasteurization**	**WHO Standard**	**NAFDAC Standard**
Total Hardness (mg/l)	184.0	3.83	75-150	75-150
pH	6.81	7.95	7.0-8.5	6.5-8.5
Cl (mg/l)	155.98	20.60	200	200
Ca (mg/l)	100.0		75-200	75-150
Fe (mg/l)	0.024	0.02	0.05-0.3	
Mg (mg/l)	84.0		50	30
Mn (mg/l)	0.676	0.85		
Coliform count (ml)	43	0	Must not be detectable in any 100ml sample	1 (Max)
Mackonkey Agar (cfu)	0	0		

Swarzt Differential Agar (cfu)	22	0		
Streptococcus Agar (cfu)	0	0		
Lauryl Sulphate Agar (cfu)	10	0		

Table 4: Results of Laboratory analysis of water from Fanawole Borehole

Parameter	Before Pasteurization	After Pasteurization	WHO Standard	NAFDAC Standard
Total Hardness (mg/l)	230.0	6.25	75-150	75-150
Ph	6.25	8.10	7.0-8.5	6.5-8.5
Cl (mg/l)	141.8	0.05	200	200
Ca (mg/l)	140.0	5.28	75-200	75-150
Fe (mg/l)	0.06	0.02	0.05-0.3	
Mg (mg/l)	9.0	0.97	50	30
Mn (mg/l)	0.868	0.79		
Coliform count (ml)	0	0	Must not be detectable in any 100ml sample	1 (Max)
Mackonkey Agar (cfu)	70	0		
Swarzt Differential Agar (cfu)	48	0		
Streptococcus Agar (cfu)	0	0		
Lauryl Sulphate Agar (cfu)	0	0		

The chemical analyses showed changes for all the tested parameters to lower values after pasteurization. The pH values were raised to meet WHO and NAFDAC standards. Bacteriological results also indicated that Aqua pasteurization technique was very effective. There was almost no Coliform after pasteurization.

In general, AquaPak apparatus has proven highly effective and efficient. It has multi- use benefits (i.e. pasteurize water using only solar energy, removal of debris and chemicals by using the cloth and charcoal activated filters, as well as providing its own storage and carrying container for pasteurized water).

Additional and significant benefits of the AquaPak include its ability

(a) To provide its own storage container,

(b) To produce hot potable water that can be used for hot beverages or personal hygiene,

(c) To include AquaTabs for use on cloudy days, and

(d) To eliminate the need to collect and burn firewood for boiling water.

Some of the challenges faced during the study include:

1. Frequent and heavy rainfall affected atmospheric temperature.
2. Accessibility to water sources especially the stream.
3. Variation in daily temperature which consequently affected pasteurization time.
4. Unstable power supply which rendered the water samples unfit for testing after 24 hours.

4.0 CONCLUSION

From the research methodology and results presented, it can be concluded that the use of Solar AquaPak to provide potable water for people especially in rural areas should be encouraged because it has been used to effectively disinfect some water samples to acceptable standards. It has also been proved to have multi-purpose benefits apart from providing potable water.

The following recommendations are made:

- The use of Solar AquaPak should be encouraged with a view to solving problems of contaminated water especially in a continent like Africa.
- The Solar AquaPak should be made available for every home especially the rural dwellers.
- There should be enlightenment programmes on the usage of the Solar AquaPak.

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