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The Effect of Short and Long Term Storage on Water Quality in Port Harcourt, Nigeria.

Arimieari, L.W.[1*] and Jaja, G.W.T[2].
1,2. Department of Civil Engineering, Rivers State University, Port Harcourt, Nigeria.
Corresponding Author: Arimieari, L.W

ABSTRACT: *A study was conducted to determine the water quality problems associated with short and long term storage using some physico-chemical and bacteriological parameters such as temperature, pH, total hardness, total alkalinity, chloride, total dissolved solid, turbidity, conductivity, sulphate, BOD, DO, total heterotrophic bacteria and total coliform bacteria. Water distributed from storage tanks in 4 locations, namely Mile 3, Agip, Borokiri and RSU within Port Harcourt city in Rivers State, Nigeria was examined. The BOD of the samples are slightly above the set standard by WHO and increases as the days of storage increases from 1-30 days. With increase in storage days the stored water exhibited dissolved gas and large quantities of minerals which may cause health problems if not treated before consumption. The study revealed that the quality of water in the storage system depend on the source from which the water is drawn and the handling of the tank by the users. On this basis and where necessary water meant for drinking should only be subjected to short term storage before release to consumers.*
KEYWORDS: *Water quality, Storage, Period, Port Harcourt, Nigeria.*

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I. INTRODUCTION

Water is a universal solvent. It has the ability to dissolve many substances be it organic or inorganic. With this property, it is impossible to have water in its pure form since it cannot be held up in a vacuum. Following abstraction and treatment water becomes a vulnerable and perishable product. Good quality water is odourless, colourless, tasteless, and free from faecal pollution [1].

Water related diseases continued to be one of the major health problems globally as water consumers are frequently unaware of the potential health risks associated with exposure to water-borne contaminants which have often led to diseases like diarrhoea, cholera, dysentery, typhoid fever, legionnaire's disease and parasitic diseases [2]. According to [3], the inadequacy of pipe borne water supply in Nigeria is a growing problem; as a result people resort to buying water from vendors, and sachet or bottled water became a major source of drinking water. It is vulnerable in that the integrity of systems used for the storage and distribution of water can be damaged and contamination through ingress can occur. It was reported that nearly half of the global population depends on in-home water storage due to a lack of adequate water supply networks. Many of the in-home solutions have improvised from available materials. It has been suggested that the lack of proper tools and equipment for construction, leads to a system more likely to contain breaches, making them more susceptible to contamination from the environment and users [4].

Water that is suitable for domestic purposes, safe for drinking, pleasant in taste, and (designated as potable water) must not contain any chemical or biological impurity [5]. Most people living in the major cities of Nigeria do not have access to pipe borne water, probably due to unavailability or inadequacy where obtainable [3].

Clean water is essential for health. In countries where water is scarce and/or treatment capabilities are inadequate, water-related diseases are major causes of death [6]. More than five million people die each year from disease caused by unsafe drinking water, lack of water for hygiene, and inadequate sanitation [7] and up to 6,000 children die each day (2.2 million children/year) from water-borne diseases [6]. Communities that lack adequate water supplies and sanitation services are especially susceptible to disease. Water pollution had generated unpleasant implications for health and economic development in Nigeria and the third world in general, consequences of which include 4.6 million deaths from diarrhea disease and a sizeable number of casualties from ascariasis [8]. Groundwater quality comprises the physical, chemical and biological; qualities of groundwater. Temperature, turbidity, colour, taste and odour make up the list of physical water quality. Most groundwater is colourless, odourless and without specific taste, we are typically most concerned with its chemical and biological qualities. Although spring/groundwater products are often sold as “pure” their water quality is different from that of pure water.

Storage tanks contain variable levels of trace metals such as Zn, Pb, Cd, Fe, etc, and since these tanks could be used for up to 20 years, any evident corrosion would affect the mineral content of the stored waters.

The effort to keep the quality of drinking water suitable for use will be to no avail, as the age of the water in the tank and distribution system increases. Short and long term storage of water in distribution and storage facilities are a strong focus since it can lead to water quality degradation.

Most water supply world-wide is unreliable because of intermittence thus household management in form of plumbing into storage tanks or alternatives which involve extensive manual handling is common. The contamination that arises is local in character, butquality changes may be extreme and respond to the extent of handling [9], [10].

Treating water at the household level is more effective than conventional improvements in water supplies in ensuring the microbiological quality of drinking water at the point of consumption because it prevents recontamination of water in the home [11].

Microbial contamination from birds or insects is a major water quality problem in storage tanks [12], [13].In year 2000, a city in Massachusetts detected total coliform bacteria in several samples at one of their six finished water storage facilities [14]. Reservoirs are potentially subject to contamination from bird and other animal excrement that can potentially transmit disease-causing organisms to the finished water. Microorganisms can also be introduced into open reservoirs from windblown dust, debris and algae.

A long detention time can allow the disinfectant residual to be completely depleted thereby not protecting the finished water from additional microbial contaminants that may be present in the distribution system downstream of the storage facility. This problem was illustrated in an investigation of storage tanks in a large North American water utility’s distribution system [15]. This study is aimed at investigating the effect of short and long term storage on water quality and to determine water quality problems associated with short and long term storage using certain important parameters.

Method of preservation of a potable water impacts not only on its quality, but also its safety. The quality of sachet water is still questionable, because many who are engaged in its production do not follow strictly the standard set by National Agency for Food, Drug Administration and Control (NAFDAC), World Health Organisation (WHO) and Standard Organization of Nigeria (SON) for safe drinking water [16].

A study revealed that storage duration and exposure conditions affect the quality of sachet water for drinking. Quality improvement of sachet water through exposure to sunlight was most effective on third day of exposure, while the maximum time of effectiveness was one week, beyond which the quality declined fast, irrespective of the storage condition. Hence, prolonged water storage beyond one week before drinking is discouraged [17].

The domestic storage tanks are the main source of the water supply in addition to the network water distribution system when available. The domestic storage tanks are exposed indirectly to the surrounding environments such as wind, temperature, dust and others, which can impact the water quality of the storage tanks.

High concentrations of heavy metals could be significant if corrosion is evident in the tanks. Many studies over the past decades investigated the corrosion and controls of metals in water distribution system [18]. The galvanized steel water storage tanks contain variable levels of heavy metals such as: Fe, Pb, Mn, Ni, Cu, Zn and many others. This contributes to the increasing concentration of these heavy metals in the drinking water. The water quality of storage tanks showed higher ionic concentrations in comparison to its source. This was attributed to dust entering the storage tanks during the dusty summer season and the elevated water temperature leading to further evaporation from the tanks. Despite the fact that the contact period between the water and the residential storage water tanks is short (less than one week), elevated levels of heavy metals were found in the drinking water indicating dissolution of these metals from storage tanks to the water [19].

II. MATERIALS AND METHODS

Water samples were collected from consumer taps in 4 locations within Port Harcourt City. Port Harcourt is located in the Niger delta Region, lying along the Bonny River (eastern distributaries). Port Harcourt is divided into several areas, with an estimated population of 2.7 million.Water samples were collected in the following locations;Sample A; Diobu (Mile 3 water), Sample B; Nkpolu (RSU water), Sample C; (Borokiri water) and Sample D; Agip water.

The samples were collected in plastic containers, previously washed with detergents and Nitric acid and later rinsed with sampled water several times. The samples were taken to the laboratory for storage and analysis in triplicates tightly covered. Duplicate sets were stored for seven days and thirty days for long term analysis. The short term samples were tested immediately in the laboratory. Parameters that were analyzed in the laboratory according to standard methods include: temperature, pH, conductivity, total dissolved solid, total alkalinity, total hardness, chloride, sulphate, dissolved oxygen, biological oxygen demand, total heterotrophic bacteria and total coliform bacteria.

III. RESULTS AND DISCUSSION

The results of the Physico-chemical and Bacteriological propertiesof water stored over 1, 7 and 30 days in 4 locations in Port Harcourt are detailed in Tables I - III.

Table I: Physico-chemical and Bacteriological Properties of Water Sources for 1 day Storage

Parameters	Sample			
	Mile 3	**RSU**	**Borokiri**	**Agip**
Temperature ^{0}C	29	28.5	28.5	30.0
pH	5.0	4.0	5.6	3.7
Conductivity µS/m)	20	10	50.0	19.0
Turbidity (NTU)	2.0	1.0	1.0	2.0
TDS (mg/l)	200	200	500	400
Total alkalinity (mg/l)	12.0	11.4	75.0	35.0
Total hardness (mg/l)	19.50	25.40	235.30	41.20
Chloride(mg/l)	178.36	196.0	333.2	214.38
DO (mg/l)	5.97	5.74	4.27	4.99
BOD (mg/l)	6.54	6.94	8.74	6.88
THB	$2.1x\ 10^{2}$	$2.0x10^{2}$	$10\ x\ 10^{4}$	$2.55\ x10^{3}$
TCH	Nil	Nil	7.0	Nil

Table II: Physico-chemical and Bacteriological Properties of Water Sources for 7 days Storage

Parameters	Sample			
	Mile 3	**RSU**	**Borokiri**	**Agip**
Temperature ^{0}C	29	28.5	28.5	29.5
pH	5.6	4.1	6.0	4.4
Conductivity µS/m)	20	10	49.0	19.0
Turbidity (NTU)	2.30	1.20	1.30	2.30
TDS (mg/l)	120	100	490	190
Total alkalinity (mg/l)	18.0	24.0	78.0	36
Total hardness (mg/l)	15.20	17.64	224.56	36.89
Chloride (mg/l)	170.0	191.50	330.5	36.89
DO (mg/l)	5.7	5.5	4.20	4.75
BOD (mg/l)	6.70	7.50	9.00	7.10
THB	$3.1x\ 10^{2}$	$3.0x10^{2}$	$12\ x\ 10^{4}$	$3.55\ x10^{3}$
TCH	Nil	Nil	9.0	Nil

Table III: Physical-chemical and bacteriological Properties of Water Sources for 30 days Storage

Parameters	Sample			
	Mile 3	**RSU**	**Borokiri**	**Agip**
Temperature ^{0}C	27	26.5	28	27
pH	6.3	4.6	6.2	4.8
Conductivity (µS/m)	20	10	48.0	18.0
Turbidity (NTU)	2.70	1.50	1.60	2.80
TDS (mg/l)	100	100	480	180
Total alkalinity (mg/l)	48	54	100	36.8
Total hardness (mg/l)	48	54	100	36.8
Chloride (mg/l)	4.08	9.62	170.58	20.05
DO (mg/l)	5.5	5.2	4.00	4.45
BOD (mg/l)	6.8	7.8	9.8	8.5
THB	$4.0\ x\ 10^{2}$	$4.0\ x\ 10^{2}$	$13\ x\ 10^{4}$	$5.50\ x10^{3}$
TCH	Nil	Nil	10.0	Nil

The temperatures of the samples are related to the surroundings. The samples have a relatively low pH values and are slightly acidic. The pHeven though may not have direct impact on the consumer the low values may encourage corrosion of the tank and supply system. There was a gradual increase of pH as the storage period increases.

The samples have low and relatively constant conductivity value even as the storage time increases. The conductivity values are within the acceptable limit for drinking water.
The samplesrecord low total dissolved solid that conform to the stipulated standard. The values increase as the storage time increases.

The total alkalinity is generally low and conforms to WHO standard for drinking water. The low alkalinity values indicated that the water is poorly buffered and pH sensitive.The values increase as the storage time increases.

Mile 3, RSU and Agip water samples record low hardness that falls within the accepted standard by WHO. While Borokiri water hasa value higher than the minimum acceptable value of 200mg/l by WHO. The hardness of the water sample decreases as storage time increases.

The turbidity values conform to the WHO standard for drinking water but increases gradually as the days of storage increases. The water in the four locations will be more suitable for drinking if further treated.

Mile 3, RSU water has a relatively high chloride concentration ranging between (160mg/l – 190mg/l) but below the 2000mg/l standard set by WHO for water suitable for drinking. Agip and Borokiri water recorded very high chloride concentrations that exceed the standard recommended by WHO. Mile 3, RSU water may be preferred by consumers as compared to Agip and Borokiri water. The chloride concentrations decrease as the days of storage increases.
The BOD of the samples is slightly above the set standard by WHO and increases as the days of storage increases.

The value of total heterotrophic bacteria (THB) increases as the days of storage increases.
The total coliform bacteria increases as the days of storage increases and non-detectable in Mile 3, RSU and Agip water samples. The water in all the four locations if not further treated may be rejected for an alternative.

IV. CONCLUSION

The effect of short and long term storage on water quality is an important issue since the quality of water degrades immediately after treatment. The quality evaluation of water sources in Mile 3, RSU, Borokiri and Agip all within Port Harcourt city indicated that the temperature is ambient. The value of pH, Total alkalinity, turbidity, BOD, TBH and TCH increases as the days of storage increases. The values of conductivity, Total dissolved solid, dissolved oxygen, Hardness and chloride are low and falls within the permissible limit by WHO. This study revealed that the quality of water in storage system depend on the source from which the water is drawn and the handling of the tank by the users. The deterioration during storage suggeststhat water suitable for drinking should be supplied at short term to the consumers. Good water quality should be stored in a clean storage tank and the user should ensure regular monitoring of the storage tank.
Water suitable for drinking should be subjected to short term storage before supply to the consumers, as long term storage can lead to water quality degradation.

Water produced in some areas in Port Harcourt in their short term contains dissolved gases and large quantities of mineral and may cause health problems if not treated before consumption.Consumers should be enlightened on the problems associated with consuming water stored for long term.

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