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COMPARATIVE ANALYSIS OF WATER QUALITY STORED IN CONCRETE AND STEEL TANKS IN IJEBU ODE, OGUN STATE, NIGERIA

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ABSTRACT

Storage facilities are commonly used to ensure that, there is adequate water for the societal need. This study examined the effect of water quality stored in concrete and steel tanks in different location of Ijebu-Ode Water Corporation, Ogun State, Nigeria. The effect of storage from different tanks was assessed by comparing the water stored in steel tanks to concrete tanks, and the result is compared with World Health Organization (WHO, 2017) drinking water guidelines. The result showed that the water was polluted with lead and Zinc at concentrations that could result in deleterious health effect in human. Result also showed that, iron (Fe) and nikel (Ni) were higher than the permissible guideline with the result given as (0.41, 0.38) in concrete tank and (0.23, 0.48). The bacteriological analysis obtained revealed that there was high concentration of bacteria found in all the water samples. Bacterial isolates such as *Escherichia coli, Bacillus specie* and *Aeromonas specie, Salmonella specie* were present in the water samples. Therefore, there is a need for further treatment of the water, before it is distributed to the end users.

Keywords: *water storage, bacterial load, concrete tanks, steel tanks, water quality*

Introduction

Water is considered as the source of living for every creation as it is a crucial element for healthy living. Safe drinking water is one of the basic elements for human to sustain a healthy life. High demand for safe and clean water is rising day by day as one cannot live without water. Thus, it becomes necessary to store water, water is stored generally in concrete water tanks and later on it is pumped to different areas to serve community (Abdul Aziz, 2017)

The quality of the water supply in human communities is important since it plays a prominent role in determining where people can live, their quality of life, and the extent to which development will occur (Solley *et al*, 2018).

According to Pradhan, 2012, Water quality problems in storage facilities can be classified as microbiological, chemical or physical. Excessive water age in many storage facilities is probably the most

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important factor related to water quality deterioration. Long detention times, resulting in excessive water age, can be conducive to microbial growth and chemical changes. Today, a large percentage of the rural population in developing countries, including Nigeria, continues to live without adequate access to safe and convenient water supply (Dada, 2009).

Tanks were used to provide storage of water for use in many applications, drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other uses (Walski, 2009).

The excess water age is caused by underutilization (i.e., water is not cycled through the facility), and short circuiting within the storage facility. Poor mixing including stratification can aggravate the water quality problems by creating zones within the storage facility where water age significantly exceeds the average water age throughout the facility (Rokade, and Ganeshwade, 2005).

However, this study focused on the effect of water stored in steel and concrete tanks using Ijebu-Ode Water cooperation as case study. The objectives are to: investigate the impact of storage tanks on water quality and its resulting effect on human health.

RESEARCH METHODOLOGY

Study Area

Ijebu-Ode is a town in Ogun State, Southwestern geopolitical zone in Nigeria, close to the A121 highway. Geographically, Ijebu-Ode is located between latitude 6° 49′ 0′ North and longitude 3° 56′ 0′ East. It has an area of 192km² and a population of 222,653 according to 2007 National population census in Nigeria. The city is located 110 km by road north-east of Lagos; it is within 100 km of the Atlantic Ocean in the Eastern part of Ogun State. The study area is located in Ibeju East Local Government areas, the samples were collected from the following areas which are Alapo, Igbeba, Itamapako, Ijebu-ife. Ijebu-Ode is a town in Ogun State, Southwestern geopolitical zone in Nigeria, close to the A121 highway as shown in (Figure 1).

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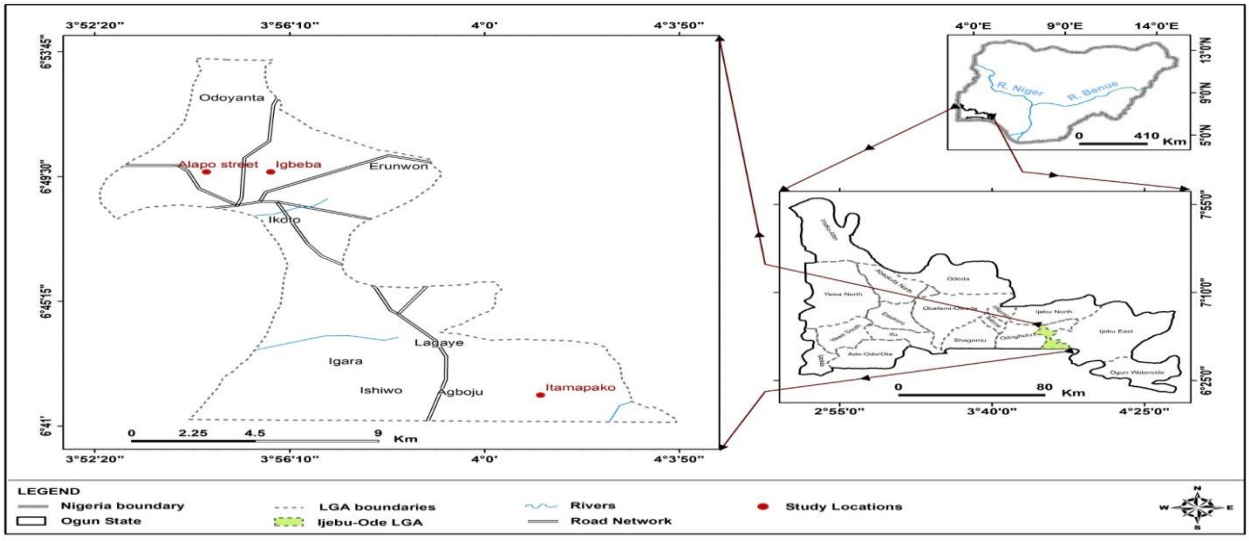

Figure 1: Map of the sampling points located at Ijebu-Ode Local Government.

Sample Collection and Analysis

Water samples from storage and steel tanks were collected from (4) points which are: Alapo, Ijebu-Ife, Itamapako and Igbeba respectively. Global Positioning System were used to determine the actual positions of each location and referenced to ensure consistency in sampling point. Parameters analyzed are; pH, electrical conductivity, temperature, total dissolved solid (TDS), calcium(Ca), magnesium (Mg), Total Hardness ($CACO_3$), heavy metals such as Iron (Fe), Lead (Pb), Manganese (Mn), Cadmium (Cd), Zinc (Zn). Bacteriological analysis was also carried out for total coliform count and feacal coliform count on each samples using APHA 2005.

Statistical Analysis

Data collected was analyzed using descriptive statistics which consists of (Minimum, Maximum and Mean, range, standard deviation and variance) and one sample t-test using SPSS version 23 software.

Results and Discussion

The pH value of water samples collected from concrete tanks ranged from 5.43-7.51 while for steel storage tanks ranged from 5.36-7.50. The result showed that the water sample is acidic, and this could be as a result of the high secretion of acid by dead bacteria which can cause aesthetic problems. (Jerry, 2014)

This result conforms with the findings of) for stored water samples, which reported that “acidic water encourages corrosion of

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pipes Electrical Conductivity of water in steel tank is higher than that of concrete tank and this is as a result of dissolved metal ion caused by gradual corrosion in steel. The higher the metal ion concentration in water, the higher the conductivity of water. The Electrical conductivity of the water samples fell within the World Health Organization (WHO, 2017) guideline for drinking water.

Temperature, Total Dissolved Solids, Total Hardness

The temperature of water samples from concrete tanks ranged from 26.0-26.8 ^{o}C and steel storage tanks ranged 26.6-27.0 ^{o}C. The temperature for the storage tank are slightly different from each other and the result fell within WHO guideline for drinking water. (Olajire and Imeokparia 2001)

Table 1 shows the result of the Total Dissolved Solid (TDS) recorded for concrete and steel tank which fell within the WHO guideline for drinking water. The value of TDS in concrete tanks was higher than that of the steal tank which is considered as soft hardness (Agbede and Morakinyo, 2001).

Calcium and Magnesium

The mean value obtained for concrete and steel storage tanks ranged from (30.18-39.68mg/L) and (1.96-, 5.49 mg/L). Both parameters fell within (WHO, 2017) guideline for drinking water.

Heavy Metals

Table 1 and 2 showed the result of Iron in the water samples of concrete storage tanks ranged from (0.3-0.41) and in steel storage tanks ranged from (0.46-0.50 mg/L).The result obtained for Iron was detected in all the water samples. Which were higher than the WHO guidelines for drinking water. Iron is present in steel tanks because it is constructed with iron sheet and when it comes in contact with water corrosion takes place. Result also showed that, Zinc in water samples of concrete storage tanks ranged from 0.37-0.45 and in steel storage tanks ranged from (0.01-0.45 mg/L). The presence of Zinc was detected for all the water samples, except for water sample from Ijebu-Ife. The presence of Zinc can cause undesirable tastes in drinking water". Lead was detected from underground storage tank in Itamapako water samples which could be as a result of plumbing material that is contained in lead corrosion. (Herbert Nwoke, 2019). Cadmium,

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Manganese and Chromium were not detected.

Total Coliform Count

Table 3 also showed the result obtained for Total coliform count. Micro-organism such as: *Escherichia coli, Bacillus specie* and *Aeromonas specie and Salmonella specie* were present in all the water samples. This result agrees with the work of (Rogbesan *et al*., 2002) who reported the presence of total coliform count higher than the WHO guideline for drinking water, and cannot be consumed **.**Total bacteria count was also higher in all the water samples from the storage tank. This could be due to the sanitary condition of a water storage tank, which is not looked into. (Atuanya *et al*., 2014)

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Table 1: Result of the physical and chemical analysis of Steel Tanks in Ijebu-Ode Water Corporation

Parameters	Range	Min.	Max.	Mean	Std. Deviation	Variance	WHO STD 2017
pH	2.14	5.36	7.50	6.43	1.51	2.29	6.5-8.5
Temperature(°C)	0.4	26.6	27.0	26.8	0.28	0.08	<40°C
Electrical Conductivity	23	304	327	315.5	16.26	264.5	1250
Total Dissolve Solid (mg/l)	58.0	2.0	60.0	30.05	42.36	1794.00	<500
Total Hardness (mg/l)	22.81	15.93	38.74	27.34	16.12	260.15	100
Calcium (mg/l)	17.57	30.89	48.46	39.68	12.42	154.35	100
Magnesium (mg/l)	8.12	1.43	9.55	5.49	5.74	32.97	100
Lead (mg/l)	0.00	0.00	0.00	0.00	0.00	0.000	0.01
Cadmium (mg/l)	0.00	0.00	0.00	0.00	0.00	0.000	0.003
Manganese (mg/l)	0.03	0.00	0.03	0.02	0.02	0.000	0.4
Chromium (mg/l)	0.00	0.00	0.00	0.00	0.0	0.000	0.05
Zinc (mg/l)	0.44	0.01	0.45	0.23	0.31	0.10	0.01
Iron (mg/l)	0.04	0.46	0.50	0.48	0.03	0.00	0.3
Total Bacterial Count (cfu/ml)	$5.85x10^7$	2000	$5.85x10^7$	$1.05x10^8$	$4.14x10^7$	$1.7x10^{16}$	Not detectable in 100ml of samples
Total Coliform Count (cfu/ml)	$2.56x10^7$	3.0x10	$2.56x10^7$	$1.05x10^9$	$1.81x10^7$	$32.7x10^{13}$	Not detectable in 100ml of samples

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Table 2: Result of the physical and chemical analysis of concrete tanks in Ijebu-Ode Water Corporation

Parameters	Range	Min	Max	Mean	Std. Deviation	Variance	WHO STD 2017
pH	2.08	5.43	7.51	6.25	0.95	0.91	6.5-8.5
Temperature (°C)	0.8	26.0	26.80	26.25	0.38	0.14	<40°C
Electrical Conductivity	201	108	309	137.25	48.16	2318.92	1250
Total Dissolve Solid (mg/l)	14	55.00	69.00	63.50	5.97	35.67	<500
Total Hardness (mg/l)	17.07	17.65	34.72	22.16	8.38	70.22	100
Calcium (mg/l)	25.16	18.23	43.39	30.18	11.05	122.04	100
Magnesium (mg/l)	2.29	1.13	3.42	1.96	1.07	1.15	100
Lead (mg/l)	0.12	0.00	0.12	0.02	0.05	0.003	0.01
Cadmium (mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.003
Manganese (mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.4
Chromium (mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Zinc (mg/l)	0.08	0.37	0.45	0.41	0.04	0.00	0.01
Iron (mg/l)	0.07	0.34	0.41	0.38	0.03	0.00	0.3
Total Bacterial Count (cfu/ml)	$1.1x10^6$	$5.3x10^7$	$6.4x10^7$	$5.85x10^7$	$3.90x10^6$	$1.51x10^{13}$	Not detectable in 100ml of samples
Total Coliform Count (cfu/ml)	$1.8x10^7$	$1.9x10^7$	$3.7x10^7$	$2.56x10^7$	$6.50x10^6$	$4.22x10^{13}$	Not detectable in 100ml of samples

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Table 3: Comparison of Concrete and Steel Storage Tank in Ijebu – Ode Water Corporation, Ogun State, Nigeria in 2021 .

S/n	Parameters	Concrete	Steel	P value	WHO STD 2017
1	pH	6.25	6.43	0.903**	6.5-8.5
2	Temperature (°C)	26.25	26.8	0.386**	<40°C
3	Electrical Conductivity	137.25	315.5	0.048**	1250
4	Total Dissolve Solid (mg/l)	63.50	30.05	0.368**	<500
5	Total Hardness (mg/l)	22.16	27.34	0.821**	100
6	Calcium (mg/l)	30.18	39.68	0.043*	100
7	Magnesium (mg/l)	1.96	5.49	0.190**	100
8	Lead (mg/l)	0.02	0.00	0.576**	0.01
9	Cadmium (mg/l)	0.00	0.00	NIL	0.003
10	Manganese (mg/l)	0.00	0.02	0.117**	0.4
11	Chromium (mg/l)	0.00	0.00	NIL	0.05
12	Zinc (mg/l)	0.41	0.23	0.225**	0.01
13	Iron (mg/l)	0.38	0.48	0.360**	0.3
14	Total Bacterial Count (cfu/ml)	$5.85x10^7$	$1.05x10^8$	0.322**	Not detectable in 100ml of samples
15	Total Coliform Count (cfu/ml)	$2.56x10^7$	$1.05x10^9$	0.497**	Not detectable in 100ml of samples

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Conclusion

From this study, the result of pH of water samples obtained from Igbeba, Ijeju-Ife, Alapo were acidic and does not fall within WHO guideline while pH of water samples from Itamapako fell within WHO guideline. This is due to low pH which encourages corrosion of pipes and can cause aesthetic problems. Temperature, Electrical conductivity, Total Dissolved Solid, Total hardness, Magnesium, Cadmium, Chromium and Manganese, fell within WHO guideline for drinking water.

Lead was detected from underground storage tank in Itamapako water samples which could be as a result of plumbing material that is contained in the steel pipe. The effect of Lead in human can cause a rise in blood pressure, kidney damage and brain damage, when such water is consumed.

Total bacterial count and Total coliform count was also detected in all water samples analyzed before and after storage. The positive results related to total bacterial count and total coliform cunt might be due to both leakage and contamination in the distribution system or inadequate treatment. However, the result from this study showed that all water from the storage tanks are not suitable for drinking and this can result in harmful effect on human health.

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Data availability Statement

The data will be made available based on request.

Conflict of Interest

The authors declare no conflict of interest

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Declarations

Author contribution statement

Adekitan, Abimbola .Adetoun and Dada, Victoria. Oluwadamilare : Carried out the experiment in the laboratory, Data analyses and interpretation of data obtained from the field were discussed

Oyewumi, Johnson. Performed the statistical analyses and the interpretation of the set data.

Aderemi Tolkulope: Performed the laboratory analysis and materials used for this experiment

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