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EVALUATION OF PHYSICOCHEMICAL QUALITY OF PIPE-BORNE WATER IN FLOODED AREAS OF RIVERS STATE

Grace Nkemdilim Ezeagu

Department of Medical Laboratory Science, Pamo University of Medical Sciences, Port Harcourt, Rivers State, Nigeria.
DOI: https://doi.org/ 10.5281/zenodo.17045991

Abstract: This study assesses the physicochemical quality of tap water in flooded areas across selected localities in Rivers State, Nigeria, focusing on Tai, Obio/Akpor, Port Harcourt, Oyigbo, and Eleme during both dry and wet seasons. Key water quality parameters—electrical conductivity (EC), total dissolved solids (TDS), turbidity, total hardness, magnesium hardness, calcium hardness, dissolved oxygen, and pH—were analyzed to evaluate seasonal variations. Results indicated that EC ranged from 0.87±0.005 to 0.97±0.0 µS/cm² (dry) and 0.80±0.01 to 113±1.58 µS/cm² (wet); TDS from 34.2±13.3 to 65.2±31.4 mg/L (dry) and 0.85±0.04 to 140.8±33.4 mg/L (wet); turbidity from 0.13±0.004 to 0.18±0.01 NTU (dry) and 0.15±0.03 to 0.31±0.1 NTU (wet). Hardness parameters varied with total hardness between 55.6±23.9 and 151.8±43.3 mg/L (dry), and 19.6±1.1 to 103.3±9.6 mg/L (wet). Magnesium and calcium hardness showed similar seasonal fluctuations. pH ranged from slightly acidic to neutral, with 6.80±1.10 to 7.60±0.89 in dry and 5.68±0.10 to 6.78±0.13 in wet seasons. All measured parameters complied with WHO standards for drinking water, indicating that the tap water in these flooded areas is generally safe for domestic use despite seasonal variations.
Keywords: Water Quality, Physicochemical Parameters, Rivers State, Seasonal Variation, Drinking Water Safety

Introduction

Water, which has a chemical formula H_2O is an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance. It is the central component of Earth's hydrosphere. Every living organism has a large percentage of its composition to be water. It is also known as a universal solvent. It importance to life cannot be overemphasized, regardless of the fact that it provides neither food energy, nor organic micronutrients. Its chemical formula, H_2O, indicates that each of its molecules contain one oxygen and two hydrogen atoms, connected by covalent bonds (Fucke et al., 2011). Water is one of the utmost significant as well as one of the most plentiful compounds that is very important to living organisms (Tortora et al., 2002). It is used for different purposes at home and industries; which include washing, food preparation, food processing, swimming, and in heating and cooling systems in among others. Drinking of water is the most sensitive out of these uses as it could have a direct harmful effect on health of human beings. Therefore, drinking water should be potable, free from diseases, contaminants or any obnoxious substance (Pruss et al., 2000).

Freshwaters are valuable and a very rare resource (Arjen, 2010) on which our daily life is based in order to sustain on this planet. Currently, the ultimate challenge of freshwater quality is consequent from anthropogenic activities such as industrialization (Ebenstein, 2012; Temesgen & Seyoum 2018), urbanization (Pires et al., 2015; Luo et al., 2017) and intensive agricultural activities (Ren et al., 2003; Buda & DeWalle, 2009). Freshwater is now very scarce owing to over misuse and contamination (Subramanian, 2018). The extraordinary request for water has brought about increased quantity of dug wells within any living environment. Occupants, different farmers and structured groups have raised shallow wells without making an allowance for the environmental and health implications associated with such facilities which may not be built to specification (Umeh et al., 2020). Industrial and municipal solid and liquid wastes are uninterruptedly added to the water reservoirs, thus affecting the physicochemical quality of such waters making them in poor condition for consumption (Umeh et al., 2020). Most heavy metals namely, cadmium, zinc, mercury, chromium, copper, cobalt, nickel, manganese, iron, vanadium and molybdenum when present in water at high levels cause pollution (Ida, 2012).

The term water quality normally refers to the constituent of water that must be present for optimal development of aquatic organisms and humans (Karemah et al., 2014). It comprises of physical, chemical and biological features which affect the use of water for intended purposes. These factors include dissolved oxygen, pH, hardness, turbidity, alkalinity, ammonia and temperature (Karemah et al., 2014).

The ease of use of good quality water is a requisite characteristics for averting ailments and successfully improving the quality of human life. Naturally, water contains diverse sorts of filths which are introduced into aquatic structure by different ways such as rock weathering, soil leaching, precipitation of spray particles from the atmosphere and from numerous human activities, like mining, processing and application of metal based materials (Patil et al., 2012). Ground water quality is dependent on a number of chemical constituents and the quantity present, which are commonly resultant from the ecological statistics of the specific region under investigation. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water.

It is very imperative to investigation any water before its use any purpose at all. The portability of water must be ascertained with different physicochemical parameters before recommendation for use. The choice of parameters for water testing is exclusively dependent on the intended purpose of use and that forms the basis and what extent of its quality and purity required. Therefore this work was carried out to determine some physicochemical parameters pipe borne water from selected areas subjected to temporal flooding in some month of the year.

Materials and Methods

Sample Collection

A total number of fifty samples was collected, 5 from each LGA of which Twenty five was collected during the raining season and twenty five during the dry season. These water samples were collected in 75cm^3 sterile containers. Prior to sample collection, all the bottles were rinsed with the same water to be collected from the borne-hole waters. The sampling bottles were labeled with the date and collection sites. The caps of the bottle were aseptically removed and sample bottles were kept an inch away from the tap avoiding contamination while collecting the sample. The sampling bottles were capped aseptically. The water samples were kept at 4°C in an ice box and transported to the laboratory within 2 hours for immediate sample analysis. These sample waters were collected from; Eleme, Obio-Akpor, Oyigbo, PHALGA, and Tai.

Physiochemical Analysis

The physicochemical parameters evaluated were temperature, pH, dissolved oxygen, turbidity, electrical conductivity, total dissolved solids, total suspended solids, total solids, total acidity, total alkalinity, total hardness, chloride, calcium hardness, magnesium hardness. The evaluation was carried out using standard analytical methods (APHA, 2005). Some parameters (temperature, pH, dissolved oxygen, turbidity and electrical conductivity) were measured in-situ because of low stability.

Data Analysis

The data were subjected to analysis of variance to determine the level of significance among the physicochemical parameters using SPSS package. Statistical significance was accepted at $p < 0.05$ (95% confidence interval).

Results and Discussion

Physical characteristics: the values of the physical characteristics of tap water from the sampled areas are given in Table 1. **Electrical conductivity (EC)**

The values of electrical conductivity fall within the range of 0.87±0.005 to 0.97±0.0 µS/cm^2 in the dry season and 0.80±0.01 to 113±1.58 µS/cm^2 in the wet season. However, the observed values of EC in all examined samples were below the 500-1000 µS/cm^2 of WHO and SON. The least values were observed in Tai LGA and the highest values observed in Oyigbo LGA in both seasons. The values were higher in the wet season than the dry season although with significant variation in only the wet season values in PHC, Oyigbo and Eleme LGAs only. The values of EC observed in the present work were found to be lower than those of some authors on borehole (tap) water (Edori and Kpee; Maqbul et al., 2021; Eboagu et al., 2023)

EC tells the extent of the electrical conducting power of water. The values of EC can be used to interpret the levels total dissolved solids (TDS), which is dependent on the ionic strength and the amount of current carrying species present in the water. Upsurge in dissolved solid content increases the ionic mobility and potencies of solution. High value of EC is an indication of acidic nature of water, which has dissolved a number of current carrying species or minerals into solution. The condition of elevated EC causes unusual taste and odor (WHO 2010). According to Navneet and Sinha (2010) ground water needed to be checked regularly and effectively for drinking quality and management. Generally, the observed low values of conductivity in the examined water samples is an indication of low levels of metals and other electrolytes in the water. However, the higher values observed during the wet season showed that there is increased presence of ionized species dissolved in the water due to rain water influence

Total dissolved solids (TDS)

The values of TDS in this research ranged from 34.2±13.3 to 65.2±31.4 mg/L in the dry season and 0.85±0.04 to 140.8±33.4 mg/L in the wet season. The observed values of TDS in all the stations and seasons were within the

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required standard values of 0–500 mg/L by WHO for domestic water use. The values of this work even though were within the range but were higher than the values of Eboagu et al. (2018) in borehole water for home use in parts of Anambra State, Nigeria. The values were within the same range as those of Edori et al. (2016) in private boreholes from Umuechem communities in Etche, Rivers State, Nigeria. Low values of TDS points to the fact that borehole waters from the selected areas are devoid of ion carrying species and that the water is a fresh water system. High levels of TDS in any water sample is a pointer to high level of solutes present in the water (Eboagu et al., 2018). The presence of elevated TDS values introduces taste to portable drinking water and abdominal irritation more especially when the observed values have exceeded the WHO limit of 500 mg/L (Selvakumar et al. 2014).

Turbidity

Turbidity values in the present work fall within a value range of 0.13±0.004 to 0.18±0.01 NTU in the dry season and 0.15±0.03 to 0.31±0.1 in the wet season. All the examined samples fall within the 5 NTU restrictions approved by WHO criteria. High turbidity is signposts to the presence of mineral particulate substances and non-soluble metal oxides. The value of turbidity in this work is lower than those of Terebo et al. (2019) in borehole water from selected coastline communities in Ondo State, Nigeria. However, these values fall within the range of values observed by Wokem and Lawson-Jack (2015) in borehole (tap) water from Abonnema, a well-known prominent town in Rivers State, Nigeria. The clear nature of the water is due to the absence of suspended particles on the water surface. The reason of low turbidity in the water may also be due to the nature and type of soil. High intake of turbid water is an invitation to gastrointestinal and abdominal pains, which can lead to serious health risk and also protect disease causing organisms from disinfectant effect (Singh et al. 2013) because the disinfectant adhere to the surface of the particles.

Table 1: Physical Characteristics of Tap Water from Water logged Areas of Selected Local Government Areas

Physical Parameters	Season	Location: Tai	Obio/Akpor	PHC	Oyigbo	Eleme
EC	Dry	0.87±0.005	0.91±0.0	0.90±0.06	0.97±0.0	0.90±0.0
	Wet	0.80±0.01	0.93±0.03	108.8±3.96	113±1.58	110.4±0.89
TDS	Dry	34.2±13.3	45.4±23.3	48.2±16.5	47.6±32.7	65.2±31.4
	Wet	138.8±13.9	140.8±33.4	127.2±5.9	224.6±20.7	0.85±0.04
Turbidity	Dry	0.14±0.02	0.13±0.01	0.15±0.02	0.13±0.004	0.18±0.01
	Wet	0.31±0.1	0.16±0.12	0.18±0.01	0.25±0.04	0.15±0.03

Chemical characteristics

Hardness

The observed values of total hardness in the seasons varied from 55.6±23.9 to 151.8±43.3 mg/L and 19.6±1.1 to 103.3±9.6 mg/L in dry and wet season respectively. Magnesium hardness values ranged from 6.52±0.87 to 10.8±1.30 mg/L and 1.92±0.08 to 7.86±0.22 mg/L for the respective dry and wet seasons. Hardness due to calcium in the water varied from 22.8±3.1 to 110.8±23.4 mg/L and 18.5±1.1 to 93.2±0.8 mg/L in dry and wet season respectively. The values of total hardness observed in this work is lower than the 200, 300 and 500 mg/L standards of WHO, India and NSDWQ values respectively. The values are lower than the values of Eboagu et al. (2018) and Abugu et al. (2022) in borehole water.

Hardness is one of the important water quality parameters utilized in the description of the effect posed by dissolved salts (minerals) of calcium and magnesium and serve a useful purpose in determining fitness of water for different uses. When the divalent metallic ions of Ca^{2+} and Mg^{2+} are largely present in water, then the water is bound to be hard. Elevated values of total hardness in water arises nature of the soil in contact with the water. If the source of the water comes from a soil laden with salts of calcium and magnesium or close to a dumpsite that metallic wastes are commonly dumped. The seepage of water through the aquifers can thus cause infiltration of hardness causing ions**.** High values of hardness leads to formation of washing and bathing and consumes a lot of soap before effective washing and bathing can take place. It also causes yellowing of textiles materials; takes longer time for vegetables to cook, forms scale deposits in pipes, radiators, furnaces and boilers. Chronic intake of hard water has the capacity to cause higher cases of some diseased condition such as; urolithiasis, anencephaly, prenatal death, some forms of cancer and cardiac disorders (Agrawal and Jagetia 1997).

Dissolved oxygen

The observed values of dissolved oxygen in the seasons varied from 6.18±0.03 to 6.46±0.02 mg/L and 6.21±0.01 to 6.29±0.07 mg/L in dry and wet season respectively. These values observed in the various boreholes (tap) water are within the WHO value of 6-10 mg/L for drinking water. The observed DO values in the present work is higher than the values of Maqbul et al. (2021) and Eboagu et al. (2023).

The concentration of DO in water reveals or gives true facts about the level of bacterial activity, photosynthesis, amount of nutrients present, stratification (Premlata, 2009). The low oxygen content of water is primarily due to elimination of free oxygen through bacterial respiration and decay of organic matter (Edori and Marcus, 2021; Edori et al., 2022). Water is the habitat of many living organisms. Therefore the disruption in this natural biotic and environmental system may possibly affect the health of it consumers. Another important factor which determines the amount of DO available in water is temperature. Elevated temperature reduces water oxygen content, while low temperature allows more oxygen in water. Temperature governs the solubility of gases in water and the reactivity of ionic species in water, microbial growth, activities and development (Kataria et al., 1996).

PH

The values of pH in the tap water varied from 6.80±1.10 to 7.60±0.89 in the dry season and 5.68±0.10 to 6.78±0.13 in the wet season. These values fall within the WHO range of 6.5 to 8.5 for water requirement. The values of the present work falls within the range of values observed in borehole water in parts of Abuja, Nigeria (Abugu et al., 2022) and also the values observed in water from boreholes within Anambra states (Eboagu et al., 2018). pH is considered an important parameter which is used to monitor the acid–alkali equilibrium of the water and helps to determine the nature and degree of pollution. Several factors are responsible for the level of pH in water. Such factors include; respirational activity, presence and amount of air, temperature, ionic species present, organic matter and sewage (Maqbul et al., 2021).

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The capacity of water to cause corrosion is a function of the pH, when the pH value is low, the corrosivity increases. High water pH indicates the presence of charge carriers (dissolved metals) in the water (Gupta et al., 2009). It is also a consequence of dissolved carbon dioxide and bicarbonates, which excludes dissolved oxygen from the water (Karanth, 1987) and leads to elevated temperature.

One area of pH importance is the role it plays in the toxicity of water pollutants. The rise and fall in pH values leads to either an increase or a decrease in toxicity potentials of poisons present in water bodies (Okonko et al., 2008). Extensive use of water with high acidic pH values has detrimental effects on the mucous tissue of cells (Nishtha et al., 2012), corrodes water pipe and cause damaged to the pipe and add taste to the water (Sabrina et al., 2013).

Table 2: Chemical Characteristics of Tap Water from Waterlogged Areas of Selected Local Government Areas

Chemical Parameters	Season	Location				
		Tai	Obio/Akpor	PHC	Oyigbo	Eleme
Total hardness	Dry	151.8±43.3	99.6±33.8	55.6±23.9	57.2±22.6	62±25.1
	Wet	103.3±9.6	94.6±9.2	43±5.0	19.6±1.1	44.2±2.9
Magnesium hardness	Dry	10±0.00	9.2±1.30	9.2±2.20	10.8±1.30	6.52±0.87
	Wet	3.74±0.42	7.8±0.23	1.92±0.08	7.86±0.22	3.82±0.22
Calcium hardness	Dry	110.8±23.4	95.6±11.5	62±14.2	22.8±3.1	44.4±12.4
	Wet	90.7±1.3	93.2±0.8	41.2±0.8	18.5±1.1	42.8±1.3
Dissolved oxygen	Dry	6.18±0.03	6.33±0.01	6.45±0.06	6.34±0.05	6.46±0.02
	Wet	6.28±0.02	6.23±0.04	6.29±0.07	6.28±0.07	6.21±0.01
pH	Dry	7.40±0.89	6.80±1.10	7.00±1.41	7.20±1.10	7.60±0.89
	Wet	6.24±0.26	5.68±0.10	6.78±0.13	6.18±0.13	6.62±0.13

Conclusion

The results from the examined samples from the different stations showed compliance with WHO requirement for drinking water. It is therefore concluded based on the parameters examined that water obtained from the selected stations from the boreholes are suitable for drinking and other purposes. However, since the fitness of water for consumption is based on other parameters as well, therefore further analysis should be conducted on these boreholes before a final conclusion is made.

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