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# AN ANALYSIS OF THE PHYSICO-CHEMICAL PROPERTIES OF TWO MAJOR DRINKING WATER SOURCES IN ADEYEMI FEDERAL UNIVERSITY OF EDUCATION, ONDO, NIGERIA

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## ABSTRACT

The research essentially focused on the analysis of two major sources of drinking water for quality. Water from two very strategic and major boreholes within Adeyemi Federal University of Education, Ondo in Ondo West Local Government Area of Ondo State, Nigeria were sampled and analyzed for physico-chemical properties. Some of the parameters analyzed were: Total hardness, calcium and magnesium hardness The total, calcium and magnesium hardness of the samples was done using complexometric titration using EDTA while the measurement of some other parameters of the water samples were done using titrimetry, pH, chloride hardness, conductivity, total solids, total suspended solids, total dissolve solids, acidity and alkalinity. Also heavy metals content (As, Cd, Cr, Cu, Fe, Ni, Pb, V, and Zn) were analyzed using a Perkin Elmer 3110 Atomic Absorption Spectrophotometer. in order to know if the water is safe for drinking. The result obtained from the analysis of the two water samples were compared with the Nigeria Industrial Standards (NIS) and World Health Organization (WHO) guidelines and safe limits for drinking water. The result shows that the two water sources are wholesome for human consumption.

**KEYWORDS:** Physico-chemical, heavy metals, complexometric, titimetry.

## INTRODUCTION

Water covers 75% of the earth's surface. On earth, 96.5% of the planet's water is found in seas and oceans, 1.7% in ground water, 1.7% in glaciers and the ice caps in Antarctica and Greenland and in the air as vapor, clouds. Water is a transparent fluid which forms the world's streams, lakes, oceans. Water is vital for all known forms of life. It is the major constituents of the fluids of organisms. Water helps keep the body well hydrated, which is essential because almost every cell in the body needs water to function properly (Oyebode, 2005). Further highlighting the importance and relationship between living matter and water, Seymour [1996] captures it thus: Water is the major constituent of living matter. Drinking water, also known as potable water is water safe enough for drinking and food preparation. In the U.S., approximately 42 million Americans [U.S. Geological Survey, 1995] get their water supplies from private water wells. Water is widely distributed through the world. It is liquid in nature, tasteless, odorless and colorless when pure and is capable of dissolving many substances (Dorsey, 1983). There are many sources of water but we are going to group them into three different sources which are the rain water, surface water and ground water. People use the different source of water every day for variety of purposes which include; domestic uses (drinking, cooking, washing, wetting etc.), also for recreational, agricultural and industrial activities.

There is need for caution in drinking water sources, encountering a low concentration of a toxic material a few times may not be dangerous, but having it in your drinking water day after day and year after year can be deadly. Rondeau et al (2000) in a study examined the relationship between aluminium in drinking water and the risk of Alzheimer's disease. The goal of standard setting is to identify maximum contaminant level (MCLs) which prevent adverse health effects (*Water Quality Association, 1995*). Public water suppliers are required to monitor the quality of the water they supply and consumers must be notified if a primary standard is exceeded.

Drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients. Globally, in 2012, 89% of people had access to water suitable for drinking. Nearly 4 trillion had access to tap water while another 2.3trillion had access to wells or public taps. 1.8 billion people still use an unsafe drinking water source which may have been contaminated by faeces. This can result in infectious diarrhea such as cholera and typhoid among others (Water fact sheet, 2014)

The amount of drinking water required is variable. It depends on physical activity, age, health issue, and environmental condition [Ukeje B.O (2012)]. It is estimated that an average human drinks about two litre of water a day [Grandjean A. C (2004).]. It is also essential that drinking water should be free of bacteria. Bacteria may be removed by filtration through beds of sands or destroyed by action of chlorine or bleaching powder (WHO, 2005). A number of quality parameters are used to determine the quality of water for different uses (Dorsey, 1990). According to (Weiser *et al* 1971), water can be obtained from either ground or surface water supplies. Typically in developed countries, tap water meets drinking water quality standards. It is noteworthy that and even rain water is not this clean in most places, because there is so much pollution in the air from automobiles and factories that when rain fall from cloud it will absorbs some of this pollutants on its way down (Weiser *et al* 1971).

Access to safe drinking water is indicated by safe water sources. This improved drinking water sources include household connection, public standpipe, borehole condition, protected dug well, protected spring, and rain water collection. Sources that do not encouraged improved drinking water to the same extent as mentioned include unprotected wells, unprotected springs, rivers or ponds, vendor provided water, and tanker trunk water. Access to sanitary water comes hand in hand with access to improved sanitation facilities for excreta, such as connection to public sewer, connection to septic system, or a pit latrine with a slab or water seal. Contaminated water can be defined as one that contains micro-organism, chemical, industrial waste which hinder its intended use (Frank, 1983).

According to Water Technology and Environmental Protection Agency (EPA, 2012) 68% of community water system users received their water from surface water sources, such as streams, rivers and lakes. Borehole water is "ground water". This source of water contains mineral salts which dissolve in it during its percolation through various layers of the soil, as Ground water sinks downward into the earth, (EPA, 2007). Minerals such as Ca, Mg, Se, Mo, Cr, F, I, Zn, Na, K, Cd, Si and other minerals may be present in drinking water since they are present in the soil and the bedrock (Rosborg, 2005). Water can pick up a large amount of minerals depending on the level of minerals present in the soil and bedrock containing such water (Bowman and Russel, 2006). Zinc may help in the proper functioning of the immune system, enzymes, taste and smell. It may also help in the healing process of body tissues (Iyengar, 2003) water systems, private water supplies are not subject to these standards.

Thomas, (1980) recommended that "the well supply should be tested for chemical and bacterial quality." The ultimate aim is to help reduce the exposure to any health hazards that could result from the consumption of water that is chemically and biologically unfit for drinking.

The authors considered the research justifiable given the fact that water from these two very strategic and major boreholes within Adeyemi Federal University of Education, Ondo constitutes major sources of drinking water to the college community and the town at large, AFUED Cooperative Water being a commercialized and popular sachet and bottled water source in service of Ondo town and state.

## MATERIALS AND METHODS

**Materials:** Sample wares, pipette, burette. measuring cylinder, retort stand, separating funnel, round bottom flask, analar grade KCl, 0.01M EDTA solution, 5% potassium chromate solution as indicator (the solution was prepared by dissolving 5g of potassium chromate in deionized water (used for blank titration) and diluted to 100ml). Buffer solution for water hardness determination - this was prepared by dissolving 40g of borax in 800ml distilled water. Then 10g of Na0H and 5g $Na_2S$ were dissolved in 100ml distilled water. Indicator solution was prepared by dissolving 0.5g Eriochrome Black T in a mixture of 3 parts triethanol-amine and 1 part of methylated spirit. Murexide /NaCl mixture indicator. Sodium cyanide. Methyl orange indicator (for alkalinity determination); Mixed indicator (0.1g thymol blue in 100ml of 50% ethanol and another solution containing 0.1g phenolphthalein in 100ml of 50% ethanol for acidity determination. 0.01M $AgN0_3$ solution, calcium carbonate powder, mercury-in-glass thermometer (0-100$^{oC}$). Whatman filter paper, conductivity meter, oven, desiccators, weighing balance a Metro pH meter, (Model E520), a Perkin Elmer 3110 Atomic Absorption Spectrophotometer..

**Methods:** Water samples for analysis were collected from two different sources (AFUED Cooperative water and Wande Hall (AFUED) water borehole) in Adeyemi Federal University of Education, Ondo. Two sets of samples of each water source were collected with well washed four, clean 1.5 litres plastic containers. The 1.5 litres plastic containers were rinsed with the water to be sampled before being filled and the samples were well labeled. The collected water samples were intended for physio-chemical analysis. However, test like temperature was done using a Metro pH meter, (Model E520), odour and colour were done on the field using the human sensory organs(nose and eyes). The collected samples were well labeled, placed in an ice box in which they were carried to the laboratory. Tests like conductivity, pH were done immediately on arrival in the laboratory after which the samples were stored in the refrigerator at 4$^{o}$C prior to analysis.

The measurement of temperature of the water samples was done using a mercury-in-glass thermometer (0 – 100$^{o}$C) while a The pH of each of the sample water was determined using Metro pH meter Model E520 on arrival at the laboratory. The conductivity of the samples was done at room temperature using a calibrated conductivity meter (calibrated with KCl). The total, calcium and magnesium hardness of the samples was done using complexometric titration using EDTA while the measurement of some other parameters of the water samples were done using titrimetry. The method used for the determination of total solids involves drying, cooling and weighing on the balance continued until a constant weight was obtained, Ademoroti (1996) The Mohr method as described by A0AC, 1984 (Association of Official Analytical Chemist) was used for the determination of chloride.

Mineral analysis. A Perkin Elmer 3110 Atomic Absorption Spectrophotometer was used for the mineral analysis. 200mls each of the samples used for heavy metals determination were put into an evaporating dish. 10% nitric acid was prepared. 1ml of the nitric acid prepared was added to the $H_2O$ sample in the evaporating dish. The sample was then evaporated to 50mls (concentration). The samples were filtered with Whatman filter paper and then run on the AAS. The mineral elements analyzed are: Arsenic (As), Calcium (Ca), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), and Zinc (Zn). Measurement of the mineral content of the water samples was done by Perkin Elmer 3110 Atomic Absorption Spectrophotometer using the hollow cathode lamps and standards of the elements of the elements to be determined. Potassium (K), Sodium (Na) were however determined using flame photometry.

## RESULTS AND DISCUSSION

**Table 1: Results from the analysis of Wande Hall Ace Coop water.**

| Parameters | Wande Hall | Ace Coop water | NIS standard |
|---|---|---|---|
| pH | 6.4-8.3 | 6.5 – 8.2 | 6.5-8.5 |
| Odour | Unobjectionable | Unobjectionable | Unobjectionable |
| Colour | Colourless | Colourless | Colourless |
| Taste | Unobjectionable | Unobjectionable | Unobjectionable |
| Conductivity | 1.45 | 1.30 | 1000 |
| Chloride | 68.06mg/L | 48.92mg/L | 250mg/L |
| Total Hardness | 38mg/L | 26mg/L | 150mg/L |
| Calcium Hardness | 15.5mg/L | 14.5mg/L | 150mg/L |
| $Mg^{2+}$ | 22.5mg/L | 11.5mg/L | 120mg/L |
| TDS | 74.03mg/L | 74.03mg/L | 500mg/L |
| Alkalinity | 44mg/L | 22mg/L | 600mg/L |
| Acidity | 50mg/L | 40mg/L | 200mg/L |

Tables 1 presents the results for the physico-chemical parameters like pH, conductivity, chloride, magnesium, calcium hardness, total dissolved solids, acidity and alkalinity. The obtained values are low and well below the safe and acceptable limits by NIS (Nigeria Industrial Standard).

The value of the results gotten from the organoleptic and physio-chemical analysis of the two water samples indicates that the water is good for consumption because the values obtained compare very well with the NIS values/ limits.

For the mineral contents of the water samples, Table 2 presents WHO standards while Table 3 compares the results.

**Table 2: W.H.O (2005) guidelines for drinking water quality for some parameters.**

| Parameters | Symbols | Limits |
|---|---|---|
| Aluminium | Al | 0.2mg/l |
| Arsenic | As | 0.05mg/l |
| Cadmium | Cd | 5.0ug/l |
| Calcium | Ca | 200.0mg/l |
| Chromium | Cr | 0.05mg/l |
| Copper | Cu | 1.0mg/l |
| Iron total | Fe | 0.3mg/l |
| Lead | Pb | 0.1mg/l |
| Magnesium | Mg | 150.0mg/l |
| Mercury | Hg | 1.0ug/l |
| Nickel | Ni | - |
| Potassium | K | - |
| Selenium | Se | 0.01mg/l |
| Sodium | Na | 200.0mg/l |
| Tin | Sn | - |

ug/L = microgram or ppb, mg/L = milligram or ppm

**Table 3: Water samples compared with W.H.O limits/standards.**

| Minerals analyzed | Sample A (ACE Coop.) | Sample B (Wande Hall water) | W.H.O Standards |
|---|---|---|---|
| As | 0.00 | 0.00 | 0.05 |
| Ca | 14.90 | 10.51 | 200.00 |
| Cd | 0.00 | 0.00 | 5.00 |
| Cu | 0.04 | 0.02 | 1.00 |

| | | | |
|---|---|---|---|
| Cr | 0.00 | 0.00 | 0.05 |
| Fe | 0.09 | 0.07 | 0.30 |
| K | 29.10 | 19.00 | - |
| Mg | 21.05 | 30.50 | 150.00 |
| Na | 15.16 | 18.30 | 200.00 |
| Pb | 0.00 | 0.01 | 0.10 |
| Zn | 0.03 | 0.05 | 5.00 |

From the results in Table 3 there is no trace of arsenic, chromium, and cadmium but calcium, potassium sodium, lead, magnesium, iron, zinc and copper are present in the two water samples in values which are lower than the W.H.O. acceptable standard.

The result also shows that lead is not present in sample A but has a very low value of 0.01m/L in sample B at a value ten times lower than WHO limit. The results obtained for most of the mineral elements are very good when compared to the desirable W.H.O standard for the mineral elements.

Therefore, from the W.H.O.'s guideline compared with the values obtained from the analysis of the two water samples made one can safely deduce that the water sources are quite good for consumption.

## CONCLUSION

The consumption of impure water has led to so many health challenges and untimely deaths globally. Water potability and safety was the reason for this study. The focus was to sample, analyse and compare results with NIS/WHO standards. Various research works had been carried out on water before now and it has been discovered that water may not be 100% pure. This has underscored the need for water purification in other to make it potable and useful for different purposes. However, after comparing the obtained results with W.H.O. guidelines, one can safely conclude that as far as physic-chemical parameter of the water sources are concerned, they are both safe and wholesome for drinking. Because his study has not done any bacteria (germs) analysis on the two water samples more research should be done in that regard in addition to the parameters checked in this study.

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