Available Online at http://www.journalajst.com

ISSN: 0976-3376

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

*Asian Journal of Science and Technology*
*Vol. 11, Issue, 02, pp.10751-10756, February, 2020*

# RESEARCH ARTICLE

# ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS AND SOME SELECTED HEAVY METALS; CADMIUM, CHROMIUM, IRON AND LEAD IN BOREHOLE WATER AND HAND DUG WELL WATER: A CASE STUDY OF JIWA VILLAGE IN THE OUTSKIRT OF ABUJA, NIGERIA

***Maimuna Buba and Mustapha Maina**

Department of Industrial Chemistry, Nile University of Nigeria Cadastral Zone Plot: 681 F.C.T, Abuja

## ARTICLE INFO

***Article History:***
Received 25th November, 2019
Received in revised form
19th December, 2019
Accepted 07th January, 2020
Published online 28th February, 2020

***Key words:***

Water, Heavy Metals,
Concentration,
Analysis,
Abuja, Nigeria.

## ABSTRACT

Groundwater contamination is responsible for water related and water borne diseases in rural communities and some parts of the cities of Nigeria. This work was carried out to determine the water quality and some selected heavy metals of well water and borehole water samples from jiwa village, Abuja. Quantitative method was used to determine the metals in the sample by using Atomic absorption spectroscopy (AAS). From the analysis that were conducted, the results obtained revealed that the values of conductivity, total hardness, total alkalinity, total dissolved solids, dissolved oxygen in the well and borehole (BH) water samples were low when compared with WHO standards for potable water. The results of the heavy metals analyzed in all the water samples showed that Iron, Cadmium, Lead and Chromium in all water samples were found to be far above the WHO limit of drinking quality water. However, the concentrations of Cd and Pb exceeded the WHO limit in all borehole samples, the concentration of Fe in BH1 and BH5 were below the limit set by WHO while the concentration in BH2, BH3 and BH4 were above the WHO limit. The concentrations of chromium in all the borehole samples were found to be below WHO limit except BH1.

**Citation:** ***Maimuna Buba and Mustapha Maina*, 2020.** "Assessment of physicochemical parameters and some selected heavy metals; cadmium, chromium, iron and lead in borehole water and hand dug well water: a case study of jiwa village in the outskirt of Abuja, Nigeria.", *Asian Journal of Science and Technology*, 11, (02), 10751-10756.

***Copyright © 2020, Maimuna Buba and Mustapha Maina.*** *This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.*

## INTRODUCTION

Over a billion people lack access to safe potable water supply globally and out of this number, more than 300 million people living in rural area of sub-Saharan Africa are being affected (Bresine, 2007). Rural settlements in Nigeria are characterized by lack of portable water supply. This situation makes dwellers depend on stream, lakes, shadow dug wells etc. However, it is known that water resources in rural areas of Nigeria are prone to pollution either by low level of hygiene manifested by the inhabitants or by agricultural and local industrial activities of the inhabitants (Ikem et al, 2002; Adeleye and Adebeyi, 2003; Adekunle *et al* 2007).These rural areas are most often neglected by government as they lack basic infrastructure like potable water, health facilities, access roads sanitation facilities and even electricity. The near absence of these facilities exposes the dwellers to a variety of health-related risks. Contamination of water resources unarguably stands prominent among the many ills plaguing the rural settlements in developing countries.

***Corresponding author:*** **Maimuna Buba,**
Department of Industrial Chemistry, Nile University of Nigeria Cadastral Zone Plot: 681 F.C.T, Abuja.

Water is one of the essentials that supports all forms of plant and animal life (Vanloon and Duffy, 2005) and it is generally obtained from two principal natural sources; Surface water such as fresh water lakes, rivers, streams, etc. and Ground water such as borehole water and well water (McMurry and Fay, 2004; Mendie, 2005). Water has unique chemical properties due to its polarity and hydrogen bond which means it can dissolve, absorb, adsorb or suspend many different compounds (WHO, 2007). Ground water constitutes 20% of water present as freshwater. The value of groundwater lies not only in its wide spread occurrence and availability but also in its consistent good quality, which makes it an ideal supply for drinking water (UNESCO, 2000). However, ground water resources are under a serious threat due to growing interest in mechanized agricultural practices, increasing population density and rapid urbanization as well as domestic and industrial usage. Ground water provisions are sometimes unsustainable because of poor water productivity of wells, drying of wells after prolonged drought and sometimes due to poor water quality (Kortatsi, 1994; Xu and Usher, 2006). Pure water is one of the most essential elements of life on Earth, in its purest form, it's colorless, odorless and tasteless with boiling and freezing point of 100 and 0 respectively.

At atmospheric pressure it has a maximum density of 1g/cm3 at 4cf or human consumption without any fear of adverse effect it should be neutral, that is, at pH7 and must have certified all the above physical properties. (Bonhardt and Waltin, 1971) due to human and animal activities, it is usually contaminated with solid and human waste, effluents from chemical industries and dissolved gases. The acid rain is another major water contaminant in addition; water contains some amounts of minerals constituents such as iron (FE), vanadium (V), magnesium (Mg), lithium (Li), chromium (Cr), selenium (Se), lead (Pb) and so many others the presence of these toxic metals in excess concentration in the environment has been a source of worry to the environmentalists, government agencies and health practitioners. This is mainly due to their health implications when in higher concentrations, and some of them are non-essential metals of little or no benefit to humans. The total replenish able water resource in Nigeria is estimated at 319 billion cubic meters, while the groundwater component is estimated at 52 billion cubic meters, an indication that Nigeria has adequate groundwater resources to meet its current water demands. However, with all the efforts put by various Governments and agencies to improve access to potable water supply to all Nigerians, it is estimated that only 58% of the inhabitants of the urban and semi-urban areas and 39% of rural areas have access to potable water supply.

## GROUND WATER

Boreholes and hand dug wells are groundwater types that form an integral part of water supply system in urban and rural communities of Nigeria, and so can be described as indispensable because of inadequate public water supply systems in most communities in Nigeria. According to Egwari and Aboaba (2002) natural processes and anthropogenic activities of man can contaminate ground water, and such activities could be domestic, agricultural or industrial in nature. Uncontrolled discharge of toxic effluents to the soil, streams and rivers by industries and indiscriminate dumping of garbage and farces have been reported to heavily contaminate groundwater in Nigeria. There are reports that residential wells and boreholes water are contaminated by sewage from numerous septic tanks, latrines, and soak away pits often sited near them. Most people drink water from these groundwater sources without any form of treatment. Indiscriminate dumping of materials laden with lead and other toxic metals on land and use of gasoline had been shown to contribute to the lead load of groundwater sources of many Nigerian cities. Groundwater (water from wells and borehole) provides potable water to an estimated 1.5 billion people worldwide daily and has proved to be the most reliable resources for meeting rural water demand in sub-Saharan Africa. The pollution of groundwater has become a major environmental issue, particularly where groundwater represents the main source of drinking water. This situation is so common in many less developed countries like Nigeria that the security of drinking water supply has been chosen as one of the ten Millennium development goals.

**HEAVY METALS:** The term heavy metal refers to any metallic chemical element that has relatively high density and is toxic or poisonous at low concentrations. They are defined by the United Nations Economic Commission for Europe (UNECE) as "those metals or, in some cases, metalloids which are stable and have a density greater than 4.5 g/cm3 and their compounds" (UNECE 1998). Example of heavy metals include; mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), thallium (TI), Lead (Pb) etc. Heavy metals are natural component of the earth's crust. They cannot be degraded or destroyed. "Heavy metal" is a collective term, which applies to the group of metals and metalloids with atomic density greater than 4g/cm3, or 5 times or more, greater than water. They occur as natural constituent of the earth crust, and are persistent environmental pollutants since they cannot be degraded or destroyed hence, toxic at very high concentrations to organisms and even the environment where they exist thus the great concern in their handling and release into the environment to a small extend they enter the body, food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes). Heavy metals can cause serious health effects with varied symptoms depending on the nature and quantity of the metal ingested (Adepoju-Bello and Alabi, 2005). They produce their toxicity by forming complexes with proteins, in which carboxylic acid (-COOH), amine (-NH2) and thiol (-SH) groups are involved. These modified biological molecules lose their ability to function properly and result in the malfunction or death of the cells. When metals bind to these groups, they inactivate the important enzyme systems or affects protein structure, which is linked to the catalytic properties of enzymes. This type of toxins may also cause the formation of radicals which are dangerous chemicals that cause the oxidation of biological molecules.

**The Toxic Effects of Heavy Metals to the Human Body:** The toxicity of a metal is usually defined in terms of the concentration required to cause an acute response (usually death) or a sub-lethal response (Smith, 1986). Predicting the consequences of metal exposure on living organisms is complicated because metals may be essential or non-essential. Very low concentrations of essential metals can be as harmful as high concentrations (Figure 1, upper panel). Non-essential metals display more conventional toxicity curves, showing a sigmoidal increase in proportion of exposed individuals dying with an increase in metal concentration (Figure 1, lower panel) (Newman and Clements, 2008).

**Statement of problem:** Groundwater (boreholes and hand dug wells) contamination is responsible for water related and water borne diseases in in rural communities and some parts of the cities of Nigeria, evaluation of groundwater quality for human consumption is essential to human existence. The source of ground water contamination could be natural through ground water-rock interaction or through anthropogenic which involve human activities that can affect ground water. Heavy metal contamination of groundwater is a worldwide environmental problem affecting water resources because of their strong toxicity even at low concentrations, hence the need to assess the quality of the water for the safety of the health of the commuters.

**Justification of the work:** Groundwater sources are being increasingly used as drinking water yet, testing to see whether the water is of good quality is almost non-existent.

The presence of Heavy metals and physicochemical characteristics in human body can affect health for long period of time. Therefore, it is important to know the concentration of heavy metals and the level of physicochemical characteristics in borehole water and hand dug wells because these are the main source of water consumed by the people of jiwa village

**Aims and objectives:** To assess and evaluate the level of some selected heavy metals and physicochemical characteristics in boreholes and hand dug wells of jiwa village located in the outskirt of Abuja, FCT. The objective of this study is carrying out water quality analysis on water samples obtained from randomly selected hand dug wells and boreholes in Jiwa village in order to ascertain;

- The level of some physical, chemical parameters presents in the sample,
- The level of some heavy metals and compare to WHO standards for drinking water quality.

**Scope and limitation**

- The scope of this research work covers water quality and heavy metals analysis of water samples obtained from ten randomly selected hand dug wells and boreholes from jiwa village
- This study is limited to some selected heavy metals cadmium, lead, chromium and iron and some physical and chemical parameters
- This is limited to water samples of wells and boreholes from jiwa village only.

**Research methodology**

**Sampling location:** This research was conducted in jiwa village, a community 8 kilometers away from the federal capital territory, Abuja

**Sample collection:** Ten water samples were collected for this research from jiwa village. Five from boreholes and five from hand dug wells. All the samples were collected in plastic bottles that were washed with ion free detergents and dried. Water samples, in the hand-dug wells were obtained from different households using same material that is used to fetch water from each well. This is usually a rubber container made from motorbike or car wheel tube, attached to a long chord. Before the collection of water samples, the boreholes were allowed to pump for 5 minutes so that water with a constant temperature and pH, representing that from the aquifer was collected. The samples were then taken to laboratory for physic-chemical tests.

**Physicochemical analysis:** The physical and chemical parameters analyzed were;

**Temperature:** The temperature was recorded in Celsius (0C) with the help of mercury thermometer.

**Conductivity:** The conductivity of water was determined with the help of Conductivity meter (Model Inolab Cond 720) and expressed in terms of µS/cm.

**Total dissolved solids (TDS):** The total dissolved solid was determined using a Conductivity meter, the programme menu of the Conductivity meter was switched to total dissolved solid, 50cm$^3$ of the sample was measured into the beaker and the electrode was introduced into the sample. The results of total dissolved solid were displayed and recorded in mg/l.

**PH:** pH of the water was determined with the help of pH meter (Model) Digital pH meter 335).

**Procedure:**

**Determination of Total Hardness:** The EDTA titration method was used in determining the total hardness of the samples. The sample was shaken thoroughly. 25cm3 of the sample was taken and diluted with 50cm3 of distilled water and transferred quantitatively into a clean 250cm3 Erlenmeyer flask. 2cm3 of buffer solution (NH4CL – NH4OH) was added, followed by two drops of Erichrome Black indicator and the sample titrated with standard EDTA solution that has been standardized using the standard calcium solution. The formation of blue color indicated the end point, titre value was recorded. (US-EPA, 1983; APHA-AWWA-WPCF, 1985; Trivedy and Goel, 1986; NWRI, 2001)

**Calculation**

Hardness (EDTA) as mg CaCO3
= AxBx100/ml of sample
Where A = Titre for sample (ml) and B = mg CaCO3 equivalent to 1.00ml EDTA titrant

**Alkalinity Determination**: A 50 ml sample was measured into a conical flask. Two drops of methyl orange indicator was added and the resulting mixture titrated against the standard 0.2M HCL solution to the first permanent pink colour at pH 4.5.

Alkalinity mg (CaCO3)/L =AxNx1, 000 ml /1ml of sample

Where A=ml of acid used, N= Normality of standard acid used

**Heavy metals determination:** Determination of heavy metals from the water samples was carried out by pre-treating the water samples (wet digestion) before taking the samples to atomic absorption spectroscopy machine for elemental analysis.

**Wet digestion method:** 20mL of each water sample was measured into a beaker and 5ml of concentrated HNO3 was added. The solution was evaporated to near dryness on a hot plate, making sure that the sample does not boil. The beaker containing the residue was cooled. 5mL of conc. HNO3 was further added and returned to the hot plate until digestion was completed (Ahn et al., 1996). 2 ml of conc. HNO3 was added and the beaker warmed slightly to dissolve the residue. The digested sample was filtered, and the filtrate made up to 50 ml mark with deionized water. The solutions were stored in a refrigerator prior to metal analysis using atomic absorption. Blanks were also prepared using the same procedure of digestion of the samples. Cadmium, chromium, iron and Lead standards of various concentrations were prepared and used for the calibration of the AAS. The digested samples were then taken to the atomic absorption spectroscopy for metals analysis

**Atomic Absorption Spectroscopy (AAS):** Atomic absorption spectroscopy (AAS) is a spectro-analytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state. In analytical chemistry the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution or directly in solid samples used in pharmacology, biophysics and toxicology research. Atomic absorption spectroscopy was first used as an analytical technique, and the underlying principles were established in the second half of the 19th century by Robert Wilhelm Bunsen and Gustav Robert Kirchhoff, both professors at the University of Heidelberg, German

## RESULT AND DISCUSSION

**Water quality analysis results:** The result of the water quality analysis carried out on the water samples from boreholes and hand dug wells from different locations are presented in Tables below

**Discussion of Results for the Physical and Chemical Parameters**

**Temperature:** In this study, the temperature ranged from 29.6-30.5 for hand dug well samples and 29.1-29.3 for borehole water samples. Temperature of drinking water is often not a major concern for consumers especially in terms of drinking water quality. There are no set guidelines for drinking water temperature.

**Conductivity:** Electrical conductivity is a measure of water's ability to conduct an electric current and it is related to the amount of dissolved minerals in the water, but it does not give an indication of which element is present but higher value of conductivity is a good indicator of the presence of contaminants such as sodium, potassium, chloride or sulphate (Orebiyi *et al.,* 2010). Conductivity is a good and rapid method to measure the total dissolved ions and is directly related to the total solids in the water sample (Singh *et al.,* 2010). The higher the value of dissolved solids, the greater the number of ions in water. (Bhatt *et al.,* 1999). The range of conductivity of the samples was from 257.8µS/cm to 262.1µS/cm in the well samples and from 111.71µS/cm -250.1µS/cm in the borehole samples. Analysis of the results show that all the samples have conductivity values below 1000 µS/cm which is the WHO standard (2008).

**pH:** pH is the standard measure of how acidic or alkaline a solution is. It is measured on a scale from 0-14. pH of 7 is neutral, pH less than 7 is acidic and pH greater than 7 is basic. The pH values of the borehole water samples ranges from 8.27- 8.57and that of well ranges from 8.05 to 8.31 with borehole 1 having the highest pH and well 5 having the lowest pH value. By comparing to the NSDWQ (National standard for drinking water quality) and WHO standard of 6.5-8.5, it shows that the pH of all the waters is acceptable and suitable for consumption and other uses except BH1 and BH4 whose pH were 8.57 and 8.67 respectively exceeded the WHO standard.

**Total Hardness:** Hardness is mostly due to the presence of carbonates and bicarbonates, chlorides, nitrates and sulphates of Ca and Mg. Tables 1-2 give total hardness values for the well water and borehole water samples from the study area. According to WHO (2004) water hardness classification, water can be classified as; soft (0 – 50mg/L CaCO3.), moderately soft (50 – 100 mg/L CaCO3), slightly hard (100 – 150 mg/L CaCO3), moderately hard (150– 200mg/L CaCO3), hard (200 – 300mg/L CaCO3) and very hard (over 300mg/L CaCO3). Using the above water hardness classification by WHO, wells in Table 1 are all within the range of (200-300Mg/l) which means they are hard. Boreholes in Table 2 shows that BH1 is moderately hard, BH2>BH3 are hard and BH5>BH4 are very hard. Hard water has a number of advantages; it tastes better than soft water because of the dissolved minerals salts in it, helps animals to build strong teeth and bones and can be supplied in pipes made of lead as it does not dissolve lead, which is the case with soft water (Thriodore, 2004). Hard water, if not in excess of 500mg/L does not constitute a health problem. It only leads to chronic diseases, especially cardiovascular diseases at levels higher than WHO maximum permissible limit of 500mg/L. From the measured values for the study area with respect to total hardness, only BH1 is moderately hard in Table 2, the entire wells in Table1 are hard and the rest are very hard.

**Alkalinity:** Alkalinity values for the wells and boreholes are shown in Tables1- 2. Alkalinity is not a pollutant but is a total measure of the substances in water that have acid-neutralizing ability or quantitative capacity to react with hydrogen ions. Alkalinity of all the wells and BH3, BH4, B5 is below the limit set by W.H.O while BH1 and BH2 exceeded the limit set by W.H.O and NSDWQ of 500Mg/l.

**Results for heavy metals analysis**

The results obtained for the concentrations of metals ions (Cd, Cr Fe, and Pb) in the water samples collected from different hand-dug wells and boreholes, was compared with the W.H.O maximum permissible limit. The results are presented in the tables below.

**Iron (Fe):** Most groundwater contains some iron because it is common in many aquifers and it is found in trace amounts in practically all sediments and rock formations. The minimum and maximum concentrations of iron obtained from the hand-dug wells and borehole waters are BH5 (0.0587mg/l) and W5(0.4279) respectively. The maximum permissible limit by WHO is 0.3mg/L for iron, all the samples except W1 and W5 were found to be below maximum permissible limit set by WHO for drinking water quality. This indicates that the local mineral deposit in the studied area of W1 may have high levels of iron.

**Cadmium:** the minimum and maximum concentrations of cadmium metal ions obtained from the hand-dug wells and borehole water samples were BH4 (0.9480) and W1 (2.1074) respectively. The maximum tolerance limit by WHO is (0.003 mg/L). Cadmium metal ion in all the samples were found to be far above the maximum permissible limit set by World Health Organization (WHO) for drinking water.

**Lead:** Lead is the most significant of all the heavy metals because it is toxic, very common (Gregoriadou *et al.,* 2001) and harmful even in small amounts. High concentration of lead in the body can cause death or permanent damage to the

**Table 1.** Variation of the parameters of Well water 1 to 5 with WHO maximum permissible limit

| Parameters | Unit | Well1 (W1) | Well2 (W2) | Well 3 (W3) | Well 4 (W4) | Well 5 (W5) | WHO Limit |
|---|---|---|---|---|---|---|---|
| Temperature | ⁰C | 30.5 | 30 | 29.7 | 29.3 | 29.6 | |
| Conductivity | μS/cm | 257.8 | 260.6 | 260.4 | 262.1 | 261.7 | 1000 |
| pH | | 8.16 | 8.31 | 8.26 | 8.10 | 8.05 | 6.5-8.5 |
| Total Hardness | mg/L | 284 | 253.4 | 276 | 254 | 230 | 500mg/L |
| Alkalinity | mg/L | 180 | 200 | 170 | 160 | 190 | |

**Table 2.** Variation of the parameters of Borehole water 1 to 5 with WHO maximum permissible limit

| Parameters | Unit | Borehole 1 (BH1) | Borehole 2 (BH2) | Borehole 3 (BH3) | Borehole 4 (BH4) | Borehole 5 (BH5) | WHO |
|---|---|---|---|---|---|---|---|
| Temperature | ⁰C | 29.2 | 29.2 | 29.3 | 29.3 | 29.1 | |
| Conductivity | μS/cm | 250.1 | 249.3 | 124.74 | 243.3 | 111.7 | 1000 |
| PH | | 8.57 | 8.44 | 8.46 | 8.67 | 8.27 | 6.5-8.5 |
| Total Hardness | mg/L | 194 | 220 | 202 | 360 | 380 | 500mg/L |
| Alkalinity | mg/L | 600 | 700 | 320 | 270 | 220 | |

**Table 3.** Comparison of average of heavy metals concentration in well 1 to 5 of Jiwa village with WHO maximum permissible limit

| Metal | W1 | W2 | W3 | W4 | W5 | WHO Limit |
|---|---|---|---|---|---|---|
| Fe | 0.4118 | 0.2192 | 0.3476 | 0.2995 | 0.4279 | 0.1 |
| Cd | 2.1070 | 1.7410 | 1.5580 | 1.0090 | 1.8630 | 0.003mg/l |
| Pb | 0.0457 | 0.1147 | 0.2298 | 0.1377 | 0.2528 | 0.01mg/l |
| Cr | 0.3243 | 0.2154 | 0.2373 | 0.1936 | 0.1936 | 0.05 mg/l |

**Table 4.** Comparison of average of heavy metals concentration in Borehole 1 to 5 of Jiwa village with WHO maximum permissible limit.

| Metal | BH1 | BH2 | BH3 | BH4 | BH5 | WHO Limit |
|---|---|---|---|---|---|---|
| Fe | 0.0747 | 0.2192 | 0.2674 | 0.2032 | 0.0587 | 0.1mg/l |
| Cd | 1.070 | 1.5580 | 1.1310 | 0.9480 | 1.1310 | 0.003mg/l |
| Pb | 0.2528 | 0.2528 | 0.3909 | 0.3219 | 0.3679 | 0.01mg/l |
| Cr | 0.1718 | 0.1064 | 0.0193 | 0.0193 | 0.0679 | 0.05 mg/l |

central nervous system, the brain, and kidneys (Hanaa *et al.*, 2000). In this study maximum level of lead concentration (0.3909) was found in sample borehole 3 and the minimum concentration (0.0457) was found in well water sample 1. All the samples in this study except water sample Well 1 (0.0457) were far above the standard limit set by WHO of drinking water quality.

**Chromium:** The minimum and maximum concentration of chromium metal ions obtained from the hand-dug wells and borehole waters samples range from (0.0193- 0.3243mg/l). The maximum permissible limit by WHO is 0.05 mg/l. All the samples except BH3 and BH4 (0.0193) were observed to be far above the maximum permissible limit set by world health organization (WHO) for drinking water.

## Conclusion

Water is very vital for nature and can be a limiting resource to man and other living things. Without a well-functioning water supply, it is difficult to imagine productive human, livestock and agricultural activities. The quality of water is of utmost importance to quantity in any water supply planning. Due to the excellent solvent properties of water, it is rarely in pure nature. Water contamination has over the years been a major threat to man's health and that of animals, as well as, vegetation. It is a medium through which disease such as dysentery, cholera, typhoid, fever, skin infections and haemosidorosis among others are contracted. This has also caused death especially in Nigeria and other developing countries.

The results obtained from the analyses that were conducted in jiwa village Abuja, revealed that well and borehole water samples from the study area were basic during the period of investigation. Generally, the values of conductivity, total hardness, total alkalinity, total dissolved solids, dissolved oxygen in the well and borehole water samples investigated were low when compared with WHO standards for potable water.

The results of the heavy metals analyzed in all the water samples showed that Iron, Cadmium, Lead and Chromium in all water samples were found to be far above the WHO limit of drinking water quality. However, the concentrations of Cd and Pb exceeded the WHO limit in all borehole samples, the concentration of Fe in BH1 and BH5 were below the limit set by WHO while the concentration in BH2, BH3 and BH4 were above the WHO limit. The concentrations of chromium in all the borehole samples were found to be below WHO limit except BH1.

## Recommendation

From the findings from this research work, the following recommendations will help improve the quality of the water of Jiwa village.

- It is recommended that the water quality analysis be carried out on all the boreholes and hand dug wells in the community at least every two years. This will ensure incidences of contamination are noticed earlier for remedial action to be taken.

- The populace should be educated on the siting of wells away from liable sources of contamination
- To safeguard the health of people and to reduce to the barest minimum of ugly experiences of drinking and/or using of low-quality waters, it is necessary that the quality of water should be monitored with the view to finding lasting solution to health problems associated with the use and drinking of low quality waters.
- Continuous monitoring of pollution in water bodies and measures for treatment should be taken.
- Hygienically approved methods for waste disposal should be explored and adopted to check the possibilities of indiscriminate land-dumping of potentially hazardous waste materials.

## REFERENCES

Adekunle, IM, Adetunji, MT, Gbadebo, AM, Banjoko, OB 2007. Assessment of groundwater quality in a typical rural settlement in southwest, Nigeria. *Int. J. Environ. PublicHealth, 4(4)*: 307-318

Adeleye, I.A and Adebiyi, A.A 2003. Physiochochemical and microbiological assessment of Oko-Oba: A Nigerian Abattoir effluent discharge. *Int. Journal of Environ. Biol*,24 309-313.

Adepoju-Bello, A.A. and Alabi, O.M. 2005. Heavy metals: A review. The Nig. *J. Pharm., 37:* 41-45.

Ahn, K., Angulo, A., Ghazal, P., Peterson, P.A., Yang, Y., and Fru, K. 1996. *Human cytomegalovirus inhibits antigen presentation by a sequential multistep process*. Proc. Natl. Acad. Sci. USA 93, 10990–10995.

American Public Health Association (APHA), American Water Works Association (AWWA) and Water Pollution Federation (WPCF) 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition. Washington, D. C., PP. 1260 – 1268.

Bhatt,L.R, Lacoul, P., Lekhak, H.D and Jha, P.K. 1999. Physicochemical characteristics and phytoplankton of Taudaha Lake, Kathmandu.Poll.Res.18(14):353-358.

Borchardt JA, and Walton G. 1971. *Water quality and treatment*: a handbook of public water supply. American Water Works Association, 1-52

Bresine E. 2007. Sustainable water supply in developing countries. geol. soc. Amer. paper no 194-201.

Egwari, L. O.& Aboaba, O.O. 2002. Environmental impact on the bacteriological quality of domestic water supplies in Lagos, Nigeria. *Rev SaúdePública*; 36(4):513-20

Gregoriadou, A., Delidou, K., Dermosonoglou, D., Tsoumparis, P., Edipidi, C & Katsougiannopoulos, B. 2001. Heavy metals in drinking water in Thessaloniki area, *Greece. Proceedings of the 7th International Conference on Environmental Science and technology*, Aristotle University, Ermoupolis.

Hanaa, M., Eweida, A & Farag, A. 2000. Heavy metals in drinking water and their environmental impact on human health. *International Conference on Environmental Hazards Mitigation,* Cairo University, Egypt, pp. 542-556.

Ikem, A.; Osibanjo, O.; Sridhar, M. K. C. and Sobande, A. 2002. Evaluation of groundwater quality characteristics near two waste sites in Ibadan and Lagos, Nigeria.Water, Air and Soil Pollution, 140 (1-4), 307-333

Kortatsi, B.K. 1994. Future groundwater resources at risk. IAHS Publication No. 222, IAHS, Helsinki.

McMurry, J. and Fay, R. 2004. Hydrogen, Oxygen and Water. In: McMurry Fay Chemistry. K.P. Hamann, (Ed.). 4th Edn. New Jersey: Pearson Education, 575-599. Mendie, U. 2005. The Nature of Water. In: The Theory and Practice of Clean Water Production for Domestic and Industrial Use. Lagos: Lacto-Medals Publishers, 1-21.

Newman M. C and Clements W. H. 2008. Ecotoxicology: A comprehensive treatment: integrated environmental society assessment and management. Retrieved from https://doi.org/10.1002/ieam.5630040423

Orebiyi, EO, Awomeso, AJ, Martins, O, Idowu, AO, Oguntoke, O and Taiwo, AM. 2010. Assessment of Pollution Hazards of Shallow Well Water in Abeokuta and Environs. Am. J. Environ. Sc. 6 (1): 50-56.

Singh A., Sharma R. K., Agrawal M. and Marshall F. M. 2010. Risk assessment of heavy Metal toxicity through contaminated vegetables from wastewater irrigated areas in Varanasi, India. Tropical Ecologhcal Issue 51. 2: 375–387

Singh M. R, Gupta, Asha, Beeteswari, K.H. 2010. Physico-chemical Properties of Water Samples from Manipur River System, India. *J. Appl. Sci. Environ. Vol. 14* (4) 85 – 89.

Smith N.J, Topping M.D, and Stewart J.D, 1986. Occupational cadmium exposure in jig solderers. Br J Ind Med; 43:663–666.

Thriodore, B. S. 2004. Interpreting Drinking Water Quality. Cook College, Rutgers University, New Brunswick.

Trivedy R.K. and Goel P.K. 1986. Chemical and Biological methods for water pollution studies, Environmental publication, Karad.

Vanloon. G., and Duffy. S. 2005. The Hydrosphere. In: Environmental Chemistry: A Global Perspective. 2nd Edn. New York: Oxford University Press, pp: 197-211

World Health Organization (WHO) 1985. Guidelines for Drinking Water Quality, PP. 1-2

World Health Organization (WHO) 2004. WHO Guidelines for Drinking Water Quality, 3rd Edition, Vol. 1, Geneva, Switzerland, PP, .89, 112, 143-168

Xu, Y. and Usher, B. H. 2006. Issues of groundwater pollution in Africa. In Y, Xu, and B. H., Usher, (Eds.). Groundwater Pollution in Africa, (pp.3-9). Leiden: Taylor and Francis Balkema.

*******