Original Research Article

Assessment of Water Quality of Major Water Sources for Domestic Use in Shelleng Town, Shelleng LGA Adamawa State, Nigeria

Abstract

This paper presents the empirical assessment of major water sources used for domestic purposes in Shelleng town. Shelleng LGA Adamawa State, Nigeria located at Latitude 9^0 53' 5" N and Longitude 12^0 0' 32" E. Portable domestic water supply is requisite for good health, but access to a safe and sustainable water supply has been a challenge in many developing countries for several decades. Water free from pathogenic agents, harmful chemical substances, and pleasant to taste is good for healthy living. For many centuries, farming, fishing, and rearing of animals have been the major occupation of the people of the land. Aside from the naturally dissolved minerals in groundwater, the physicochemical properties of water will be changed due to contaminants such as pesticides, herbicides, and fertilizer in addition to the use of farm tools for both commercial and subsistence farming. The objective of the research is to examine the physicochemical properties of the water samples in shelleng for domestics' usage; where about 90% of humans and animals patronize the same water source in the area. In many cases such activities and the habit of open defecation, dumping of domestic and automobile waste such as battery and fuel along undesignated areas makes the water bodies both surfaces and groundwater susceptible to contamination. This suggests that a water treatment plant must be installed within Shelleng municipal to ensure safe and potable water for domestic uses.

Keywords: Assessment, Water quality, Safe domestic water, Major water source, Shelleng.

1.0 Introduction

The current technological advancement to improve the quality of life and reduced mortality due to avoidable sickness will be long overdue without access to quality water for domestic use. Water exists naturally in many forms but not limited to ocean, river, lake, cloud, rain, snow, fog. In biological, social, and economic systems the survival of humans, animals, and plants largely depends on it. Ingestion of contaminated water or food has been one of the major sources of many diseases, even the groundwater which is not exposed and has passed through the layers of sand was found to contain some quantity of heavy metals such as Cd and Pb concentration above the permissible level [1]. According to the World Health Organization (WHO), about 9.1% of the global burden of disease and 6.3% of all deaths are due to unsafe water, inadequate sanitation, and poor hygiene. In practice, contaminated water and poor sanitation are linked to the transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, and polio [2-3]. Furthermore, the absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks.

Over time many researchers have done different analysis on water quality from various sources to decide its suitability for drinking and agricultural uses. To determine the physical, chemical, ionic, and biological properties, [4] reported the water quality is within the permissible limit as mentioned with ISI but not without the presence of some external element. The water quality of Triveni lake was studied and analyzed for one year [5], and the report of the studies shows that the water is suitable for drinking only in the winter and summer seasons. Properties of treated and untreated water were studied and compared [6], and the result showed that the values changed after the treatment of the water. In Adamawa State, Nigeria, investigation of the occurrence and level of some heavy metal in Spring Water from Bazza, Pella, and Yadim were reported [7], from the empirical results on Iron (Fe) which is above the acceptable limit, other heavy metals present can pose threat to the inhabitant of the communities only as a result of bioaccumulation. Over the decades, there have been tremendous efforts to assess the quality and physicochemical properties of water for domestic use with regards to the source and location [8-13]. Interestingly, such reports have contributed to the field of water analysis and have greatly educated the community dwellers on the health status of domestic water, however, such study is lacking in Shelleng town where the sources of water for domestic uses have been a societal challenge. Shelleng town in Shelleng Local Government Area of Adamawa State, Nigeria is located at Latitude 9^0 53' 5" N and Longitude 12^0 0' 32" E. For many centuries, farming, fishing, and rearing of animals have been the major occupation of the people of the land.

Furthermore, aside from the naturally dissolved minerals in groundwater, the physicochemical properties of water could be attributed to the use of pesticides, herbicides, and fertilizer in addition to the use of farm tools for both commercial and subsistence farming. In Area like Shelleng LGA, about 90% of humans and animals patronize the same water source in the area, in many cases such activities and the habit of open defecation, dumping of domestic and automobile waste such as battery and fuel along undesignated areas makes the water bodies both surfaces and groundwater susceptible to contamination. To that, we consider it necessary to report the empirical assessment of major water sources that are used for domestic purposes in Shelleng Town, Shelleng LGA, Adamawa State, Nigeria.

2.0 Materials and Method

2.1 Sample and Sampling Techniques

Samples were taken from Shelleng town in Shelleng Local Government in five specific water sources: Stable (ST), Gundu Gundum (GD), Kambari (KB), Donge (DG), and GSSjumbul (GJ). One liter of water sample was taken in the morning, afternoon, and evening from all the water sources, making three (3) liters of sample from each source. The sampling method carried out is similar to that described by [14]. Sampling involves the selection from the total population of a subset of individuals upon which measurement will be made. Furthermore, it's a method of obtaining a fraction of bulk material that represents the whole material under analysis [15].

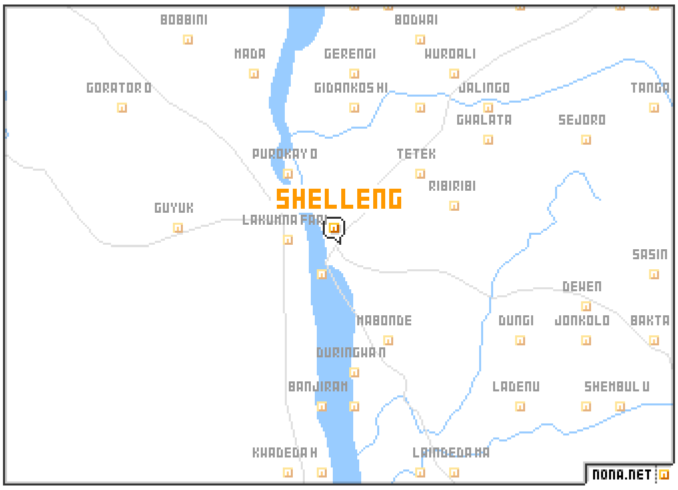

Figure 1 Map of shelleng.

2.2 Determination of Heavy Metals:

100ml of the water sample was transferred in to volumetric flask and 2ml of concentrated nitric acid was added, mixed well and filtered using Watchman no:1 filter paper. The filtrate was taken for AAS (Buck 230, Buck scientific Las Vegas USA). A lamp of each metal of interest was installed into the instrument and a wavelength characteristics of each heavy metal set for determination using air acetylene integrated flame mode (for all heavy metals). Standards of each metal in the sample were run with corresponding lamps and the concentration of each metal was sbtained by extraploitation from the calibration curve of standard. AOAC (2015).

2.3 Storage and Preservation

Water samples were analyzed immediately after collection and digestion. Where analysis couldn't commence immediately, the samples were stored at 4°C [7].

2.4 Analytical Techniques

For this study, we employed the use of both classical and instrumental techniques of analysis. Specifically, the classical method was used for the determination of the percentage of hydrogen (pH), total dissolved solids (TDS), electrical conductivity (EC), chloride (Cl^-), total hardness (TH), total alkalinity $CaCO_3$ (TA), Calcium (Ca^{2+}), Silica (SiO_2) and free residual Chlorine (FRC). Furthermore, atomic absorption spectrophotometer (AAS) was employed for the determination of essential and heavy metals including Pb, Cd, As, Mn, Fe, and Cu, in water samples. Analysis by AAS is based on the absorption of electromagnetic radiation by atoms. The absorption of the radiation is proportional to the number of atoms or concentration of the element of interest in the sample [15]. This follows Beer-Lambert Law.

$A = \text{Log } I_0/It = abc$

Where;

A = absorbance of radiation by atom.

I_0 = intensity of incidence radiation

I_t = intensity of transmitted radiation

a = absorptivity constant in $Lmol^{-1}$ cm^{-1}.

b = path length in cm

c = concentration of atomic species of interest of the sample in mol L^{-1}

Absorbance (A) readings for various standard concentrations were obtained using the same instrument. Various standards were prepared and their absorption was used to plot the calibration curve for each metal element. The absorbance (A) of the sample element of interest was obtained and the concentration (c) was traced on the standard calibration curve. The results obtained from the calibration curve have a concentration (c) in mg/L and sample Mean and Standard deviation were calculated.

3.0 Results and Discussion

According to WHO (2008), there is no health-based limit for TDS in drinking water as TDS occurs in drinking water at concentrations well below toxic effects. But the palatability of drinking water with a TDS level of 50-500mg/L is generally considered. Drinking water becomes significantly and increasingly unpalatable at TDS levels greater than 1000mg/L. From our results, as shown in Table 1 all samples are within the range except that of Donge which has the value (15.5mg/L) below the range, while we cannot say it contains little dissolved toxic minerals, neither devoid of some essential minerals, however, further analysis is required to make a valid inference. The pH value of 6.5-8.5 is acceptable for drinking water [17]. The natural acid-base balance of the water body can be affected by industrial effluents and atmospheric deposition of acid-forming substances. The pH values obtained from our analysis show that all water samples are within the permissible limit except that of GSS Jumbul and Donge which are 6.35 and 6.20 respectively which are acidic and below the standard range of 6.5 – 8.5, the occurrence of such may be attributed to the seasonal fluctuation of dissolved minerals in groundwater. The Electric Conductivity (EC) which is a measure of water ability to conduct an electric current is related to the number of dissolved minerals in the water, ions in water facilitate the breakdown of food items and enable easy intake by the cells and organs of the body, it does not indicate specific ions of element contribution but higher values of EC is a good indicator of the presence of minerals such as Sodium, Potassium, Chloride or Sulphate. From the results of our analysis, the only sample from Donge has a value (32.0µs/cm) slightly below the required limit, but the remaining results are all within the guideline limit of 34-750µs/cm as shown in table 2. The results of our analysis for total hardness**,** calcium, alkalinity, and silica shows that all samples are within the guideline limit of drinking water quality, except sample collected from Donge with a low alkalinity value below standard and free residual chlorine content were below the limit as suggested by the WHO which has no guarantee to lower microbial activities. This reassured the confidence that water from such locations poses no threat to humans, plants, and animals.

Table 1: Results of physicochemical analysis of water sample obtained from different locations in Shelleng.

Source/ Physicochemical Properties	ST	GD	GJ	KB	DG	WHO GUIDELINE LIMIT
PH	6.82±0.37	6.98±0.30	6.35±0.27	7.24±0.25	6.20±0.23	6.5 – 8.5
TDS (mg/L)	110±0.01	139±0.00	351±0.5	140±0.02	15.5±0.00	50 – 500
EC (µs/cm)	220±0.30	279±0.10	700±0.01	281±0.00	32.0±0.20	34-750
Chloride (mg/L)	24±0.00	24±0.02	34±0.70	16±0.11	16±0.71	<100
T. H mg/L	36±0.23	100±0.80	160±0.10	148±0.05	20±0.47	<200
Total Alkalinity (mg/L)	100±0.13	128±0.37	380±0.50	140±0.29	12±0.17	30-400
Calcium (mg/L)	14.3±0.02	25.2±0.33	51.3±0.21	32.8±0.13	1.7±0.10	<100
Silica (mg/L)	10±0.2	20±0.41	7±0.38	10±0.09	5±0.10	5 – 25
Free Residual Chloride (mg/L)	0.05±0.01	0.02±0.00	0.05±0.10	0.04±0.90	0.01±0.00	0.2 – 0.5

Key: ST=Stable, GU Gundu-gudum, GJ=GSS Jumbul, KB=Kambari, DG=Donge,

Table 2: Heavy metals composition of water samples (mg/L).

Sample water	Pb (mg/L).	Cd (mg/L).	As (mg/L).	Mn (mg/L).	Fe (mg/L).	Cu (mg/L).

ST	0.012±0.003	0.023±0.005	0.000±0.00	18.22±0.004	2.12±0.01	0.146±0.002
GD	0.038±0.001	0.042±0.003	0.000±0.00	27.12±0.05	13.16±0.005	0.411±0.02
GJ	0.025±0.001	0.037±0.003	0.000±0.00	26.89±0.005	6.33±0.2	0.345±0.001
KB	0.012±0.0004	0.024±0.003	0.000±0.00	17.15±0.004	12.35±0.003	0.242±0.002
DG	0.025±0.0002	0.034±0.005	0.000±0.00	12.06±0.000 01	2.40±0.02	0.166±0.005

Key: ST=Stable, GU Gundu-gudum, GJ=GSS Jumbul, KB=Kambari, DG=Donge,

Table 3: Permissible limits of heavy metals in water

Heavy Metals (mg/L).	WHO (mg/L).	SON (mg/L).	NAFDAC (mg/L).
Pb	0.01	0.01	0.01
Cd	0.003	0.003	0.003
As	0.010	0.010	0.010
Mn	0.4	0.2	2.0
Fe	-	0.3	0.3
Cu	2.0	1.0	1.0

WHO – World Health Organization (2011)
SON – Standard Organization of Nigeria (2007)
NAFDAC – National Agency for Food and Drugs Administration and Control (2001)

According to the WHO guidelines for drinking water quality, lead has a guideline limit of 0.01mg/L. From the result shown in table 2 the level of lead found shows that only water sample from stable has the value of 0.012±0.003mg/L which is within the permissible limit, while the rest are above the limit. Lead is the most significant of all heavy metals because it's toxic, very common, and harmful even in small amounts. Lead enters the water body in many ways. It could be dissolved from dust, underground minerals, and inappropriate discharge of lead containing materials such as car batteries, lead paints, or waste gases from leaded gasoline. It is found in food in trace amounts, notably in fish, which are subjected to industrial Pollution. Some old homes may have lead water pipes, which if we take are removed from our bodies in urines, however as exposure to lead is cumulative over time there is still the risk of buildup. The highest level of lead found during the analysis is 0.038mg/L from the sample of Gundugundum water. Cadmium concentration in all the samples was above the permissible limit of 0.003mg/L, Cadmium could be released in water through various ways such as pollution caused by contamination from fertilizer and local air pollution. Contamination in drinking water may also be caused by impurities in the Zinc of galvanized Pipes and solder and some metal fittings.

The presence of manganese in drinking water, like that of Iron, has no health concern, however, it may lead to the accumulation of deposits in the distribution system and a permissible value of 0.4mg/L may be considered suitable. Manganese at levels exceeding 0.1 mg/L begins to cause an undesirable taste in beverages and stains sanitary ware and laundry. The high level of Manganese could be attributed to it as the most abundant metals in the Earth's crust, usually occurring with iron and steel used prenatally in the manufacture of iron and steel alloys as an oxidant for cleaning, bleaching, and disinfectant (as Potassium Permanganate) and as an ingredient in various products. For manganese, all the samples exceeded the normal range. Iron is the fourth most abundant element by mass in the earth's crust in water, it occurs mainly in ferrous or ferric states (Ghlman et al; 2008). Iron in surface water generally presents in a ferric state. It is an essential and non-conservative trace element found in significant concentration in drinking water because of its abundance in the earth crust, shortage of iron causes a disease called anemia and prolonged consumption of drinking water with a high concentration of iron may lead to a liver disease called hemosiderosis. During this analysis water samples from Gundugundum show the iron concentration of 13.15mg/L and S.D of 13.16 ±0.005. While sample from stable shows the iron concentration of 2.15mg/L which is the least with S.D 2.12 ± 0.01. This shows that all the samples are above the world health organization WHO (2011) guidelines for drinking water quality (GDWQ). Copper is both an essential nutrient and a drinking water contaminant. It is used to make pipes, values and is present in alloys and coatings. Copper sulfate pentahydrate is sometimes added to surface water for the control of algae. Copper concentration in drinking water vary widely, with the primary source most often being the corrosion of interior copper plumbing levels in the running of fully flushed water tend to be low, whereas those in standing or partially flushed water sample are more variable and can be substantially higher above

1.0mg/L, food and water are the primary sources of copper. The guideline for drinking water quality for copper is 2.0mg/L according to WHO (2011), all the samples collected and analyzed for copper are within the acceptable guidelines [16-18].

4.0 Summary and Conclusion

The good quality of water resources depends on a large number of physicochemical and biological characteristics [19]. Most floating water sources have various types of floating, dissolved, suspended, and microbiological substances, however for groundwater; the contamination may come as a result of dissolved unwanted minerals such as heavy metal containing ores. Sometimes even the essential minerals such as calcium and iron may dissolve in a level that is harmful to man. In conclusion, some physical analysis such as P^H, Temperature, and Total Dissolved Solids (TDS), has been carried out to ascertain the physicochemical parameters while a chemical test was done to determine the hardness, Electrical conductivity, Chloride concentration, and other properties. More quality and healthy water should be tested to reveal the heavy metal content. Water properties should remain at their acceptable limits for the existence and health of the inhabitants of the environment.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

Reference

[1] M.A. Momoduh, C.A. Anyakora. Heavy metal contamination of groundwater: The surulere case study. Research Journal Environmental and Earth Sciences.2010; 2 (1):39-43

[2] Pruss-Ustun A, Bos R, Gore F, Bartram J (2008) Safer water, better health: costs, benefits and sustainability of interventions to protect and promotehealth. World Health Organization, Geneva.

[3] https://www.who.int/news-room/fact-sheets/detail/drinking-water

[4] V.B.Y.Sheihk, P.R Bhosale, B.N. Nagzari.Dam of Maharashtra. "Journal of Applied Technology in Environmental Sanitation, Volume 3, Number 3:11-116. October 2013.

[5] R.M.Khan, M.J.Jadhav, I.R.Ustad-"Physicochemical Analysis of Triveni Lake Water of Amravati District in (M.S) India. Bioscience Discovery. 3(1):64-66, Jan.2012.

[6] S.Hussaina, V.Maneb, S.Takdea, A.Pathane, M.Farooqui-"Comparison between Treated and Untreated Waters as to study Water treatment plant of Ahmadpur Dist. Latur, "International Journal of Modern Engineering Research (IJMER) www.ijmer.com,vol.1,issue 2, pp-564-569, ISSN: 2249-6645.

[7] P.I. Amos and I.A. Joseph. Investigation of the Occurrence and Level of some Heavy Meatals in spring Water from Bazza, Pella and Yadim Areas of Adamawa State: chemical science international journal 17(4): 1-6, 2016.

[8] S.N. Thitame and G.M. Pondhe-"Assessment of seasonal variation in physico-chemical characteristics and quality of pravara River Water for irrigation use in sangammer, Dist. Ahmednagar,Maharashtra,"Journal of Chemical and Pharmaceutical Research, J.Chem.Pharm.Res., 2(2): 316-320, 2010.

[9] T.M. Heidtke, A.M. Asce and W.C. Sonzogni-"Water Quality Management for the Great Lakes", J.WaterResour. Plann. Manage. 112: 48-63, 1986

[10] Z. Demirel (2007). Monitoring of heavy metal pollution of groundwater in a phreatic aquifer in Mersin-Turkey. Environ. Monit. Assess. 132 (-3): 15-23.

[11] R.N. Subba (2006). Season variation of groundwater quality in a part of Guntur district, Andhra Pradesh, India. Environ. Geol. 49: 413-429.

[12] U. Mendie. The Nature of water. In: The theory and practice of clean water production for domestic and industrial use. Lagosi: Lacto-medals publishers. 2005; 1-21

[13] P.U. Verma, D.K. Chandawat and H.A. Solanki, seasonal variation in physic-chemical and phytoplankton Analysis of Kankaria Lake, 842-854, 2011

[14] Taylor and Francis group. LLC. Soil sampling and methods of analysis 2nd edition; 2006.

[15] Joseph, I., M. Maina, H., Amos Isah, P., & E. Eneche, J. (2017). Comparative Analysis of Some Digestion Methods Used in the Determination of Metals in Soil and Sediments. *Chemical Science International Journal*, *19*(4), 1-4. https://doi.org/10.9734/CSJI/2017/34652

[16] WHO. World health organization, guidelines for drinking -water quality. Fourth Edition. Appendix; 2011.

[17] NAFDAC. National agency for food and drug administration and control in Nigeria. Drinking water regulations. In NAFDAC Consumer Bulletin Oct-Dec. 2001; 1-9.

[18] SON. Standard organization of Nigeria, Nigerian standard for drinking water quality. 2007;16-17.

[19] K. Vankatesharaju, P. Ravikumar, P.K. Somashekar, and K.L. Prakash. 2010. Physico-chemical and Bacteriological Investigation on the river Cauvery of Kollegal stretch in Kamataka. Journal of Science Engineering and Technology, 6:50-59.