Chemistry Research Journal, 2020, 5(4):211-218

Available online www.chemrj.org

Research Article

ISSN: 2455-8990
CODEN(USA): CRJHA5

A Comparative Study between Stream Water and Borehole Water in Ganuwa Village of Charanci Local Government Area, Katsina State

Khalid Haliru*, Muhammad Sulaiman Rahama

Department of Pure and Industrial Chemistry, Faculty of Natural and Applied Science, Umaru Musa Yar'adua University PMB 2218 Dutsin-ma Road Katsina
*Corresponding Author E-Mail; Khalid.haliru@umyu.edu.ng

Abstract A comparative analysis of water was carried out on stream and borehole water from Ganuwa village in Charanci Local Government of Katsina state Nigeria. The aimed of the study is to determine the Physiochemical water quality parameters of the stream water and borehole water which serve as the two major sources of water to the community. The parameters analyzed were; temperature, pH, Electrical conductivity, DO, TDS, TSS, BOD, total hardness, total alkalinity and some heavy metals such as Pb, Zn, Cr, Fe, Cu, Fe and Co. The result showed that the stream and borehole water samples have all the physicochemical parameters analyzed within the recommended tolerable limit with turbidity, hardness and total suspended slightly higher than the recommended safe limit set up World Health Organization. With respect to the concentrations of the heavy metals, all the samples were found to have lead, chromium and zinc concentrations higher than the recommended values set by the world health organization. Iron was found to be higher and above the tolerable limit in stream water sample while borehole water sample was found to be below the safe limit as recommended. Cobalt and copper concentrations in both the stream and borehole water samples were all found to be within the permissible limit recommended by world health organization.

Keywords Stream water, borehole water, alkalinity, turbidity, total hardness

Introduction

Although, water is vital for life, it also serves as the commonest route of transmission of a number of infectious diseases. The majority of the population in developing countries is not adequately supplied with potable water and this obliged to use unsafe water for domestic and drinking purposes [1]. Safe water is defined as water with microbial, chemical and physical characteristics that meet the WHO guidelines of natural standards on drinking water quality [2]. Water plays a significant role in maintaining the human health and welfare. Safe drinking water is therefore recognized as a fundamental right of human being. Statistically, around 780 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation as a result, around 6-8 million people die each year due to water related diseases and disasters (UN-2013). Therefore, water quality control is a top priority policy agenda in many parts of the world [3]. Water quality and suitability for use are determined by its taste, odor, color and concentration of organic matters [4].

The quality of water depends on various chemical constituents and their concentration, which are mostly derived from the natural and anthropogenic activities taking place in the particular region. Industrial wastes and municipal solid wastes have emerged as the leading causes of pollution of surface and ground water [5]. In many parts of Nigeria, available water is rendered non-potable because of the presence of excess heavy metals. It is now universally acknowledged by water and medical experts that the greatest risk associated with the ingestion of water is microbial risk due to water contamination by human and/or animal faeces [6]. In 2000, lack of access to safe water remained a problem for over a billion people worldwide and inadequate sanitation services affected at least 2.5 billion people [7]. Poor water quality, sanitation and hygiene account for some 1.7 million deaths a year worldwide mainly through infectious diarrhea [6]

In the portability study of ground water in Enugu town, South Eastern Nigeria, 88 ground water samples were analyzed in order to evaluate their portability. The result showed that about 22% of the samples had concentrations of NO_3 higher than the World Health Organization (WHO) standard, while 8 out of the samples analyzed for bacteriological quality showed evidence of sewage contamination. [8]. Studies carried out on selected water sources including underground water in Calabar indicated that the physicochemical parameters, biological oxygen demand (BOD), silica and pH were positively correlated with indicator bacteria with counts reaching a maximum of 520 faecal coliforms per 100 ml., the quality of the water samples therefore did not conform to the approved WHO standard for drinking water [9]. In the analytical study of borehole water quality in both sedimentary terrain and basement by Fasunwon, it was discovered that the composition of the terrains had influence on the water quality. It was observed that the pH ranged from 5.30 to 7.60. Iron, nitrite, nitrate and manganese contents had maximum values of 2.70, 2.00, 7.30 and 0.10mg/l respectively. Total alkalinity ranged from 21.00 to 275 mg/l, salinity ranged from 15.00 to 566mg/l, chloride ranged from 5.50 to 70.00 mg/l, but sulphate was absent in all the water samples. The results obtained showed how elemental compositions vary with lithogy [10].

Aim of the Study

The aim of the study is to compare the levels of some selected physicochemical and heavy metal parameters in borehole and stream water from Ganuwa village in Charanci Local Government, Katsina State.

Figure 1: Map showing the study location [11]

Justification of the study

The issue of accessibility to clean water is of global magnitude. The global environmental outlook report indicates that about 30% of the world's population lack access to safe drinking water and 6-8 million people die each year due to water related disease.

The consumption of water worldwide increased yearly, while most of the world's water resources continue to be polluted due to improper environmental management practices. Globally, more than 25,000 die daily as a result of water related diseases [3].

Selection of the study area

The study area selected is stream and a borehole situated at Ganuwa village in Charanchi local government area of Katsina state. It is so selected because a significant percentage of the population of the village depends on these two water points as their sources of drinking water.

Materials and methods

Sample collection

The samples were both collected in a thoroughly washed PVC bottles and transported to Umaru Musa Yaradua University, Katsina chemistry laboratory. The samples temperatures were immediately measured at the site of the collection.

Sample treatment

All the collected samples were kept under ambient temperature so as to deactivate the microbial activities of microorganisms.

Methods of Analysis

Analysis of the water samples was carried out to identify the physiochemical properties of the two different water samples collected from the study area for the research project. Parameters determined include the following:

i. Temperature
ii. pH Level
iii. Electrical Conductivity
iv. Total Suspended Solid
v. Total Dissolved Solid
vi. Total Dissolved Oxygen
vii. Biological Oxygen Demand
viii. Turbidity
ix. Chloride Content
x. Total Hardness
xi. Total Alkalinity
xii. Lead Content
xiii. Zinc Content
xiv. Chromium Content
xv. Cupper Content
xvi. Iron Content
xvii. Cobalt Content

Determination of temperature

A portion of each of the water sample was taken into a beaker and thermometer was immersed into the beaker and readings were recorded in degree centigrade.

Determination of pH

pH was measured using pH meter. It was first calibrated with a standard buffer solution. The glass electrode was washed with distilled water. Then glass electrode was dipped in the beaker containing water sample till when the reading stabilized at a certain point. The pH readings were noted down.

Determination of Electrical conductivity

Conductivity meter was used. The meter was first calibrated with standard potassium chloride solution of 0.01M. The electrode was dipped in each portion of the samples and the readings were recorded.

Determination of Total Suspended Solids

A well-mixed sample was filtered through a weighed standard fiber filter paper. 100ml was filtered and the residue retained on the filter was dried at 103-105℃. The filter paper was then reweighed again and an increase in the filter paper weight was calculated

Determination of Total Dissolved Solids

50 ml of well mixed sample was evaporated in a pre-weighed evaporating dish in an oven at 103-105℃. The evaporating dish was weighed and the difference between the first and second weight of the dish was calculated.

$$TDS = \frac{(W_2 - W_1) * 1000}{\text{Sample volume}}$$

Determination of Dissolved Oxygen

A portion of each of the samples was collected in a beaker. A dissolved oxygen meter was inserted into the beaker and readings were recorded.

Determination of Biological Oxygen Demand

D.O values of the samples were taken the first day. The samples from that moment were tightly closed and then incubated in a light-absent condition at 20℃ for five days. On the 5^{th} day, the D.O values were then taken again. The difference between the two values gives the BOD value.

$BOD = DO_1 - DO_2$

Determination of Turbidity

Turbidity was determined using nephelometer. The meter was calibrated using distilled water and a standard turbidity suspension of 40NTU. The meter was dipped in the sample and readings were recorded.

Determination of Chlorides

Chloride was measured using titration methods. 50 ml of sample was measured into a conical flask. 2 ml of potassium chromate was added to the sample. It was then titrated against 0.02 N silver nitrate until a persistent brick red color appeared which the end point was. A blank was prepared and titrated by placing 50 ml of chloride.

Determination of Total Hardness

Total hardness was determined by EDTA titrimetric method. This was done by titrating 100ml of the sample in a conical flask and adding 1ml of buffer solution with Erichrome black-T indicator. The solution changed from wine to blue at the end point. The results were then tabulated and the total hardness was calculated using the standard methods.

Determination of Total Alkalinity

Alkalinity in terms of calcium carbonates was determined using titrimetric method. 100 ml of the sample in a conical flask with addition of 2-3 drops of methyl orange was titrated against 0.02N H_2SO_4. At the end point, yellow color changed to pink color. The result was then tabulated and the alkalinity was then calculated.

Procedure for Digestion

50 cm^3 of sample was transferred into a beaker and 5 ml of concentrated HNO_3 was added into the beaker. It was boiled slowly on a hot plate. About 20 cm^3 was evaporated and then further 5 cm^3 of concentrated $HNO_3$was added and covered with watch glass and heated until the solution appears light colored and cleared. Filtrate solution was transferred into a 50 cm^3 volumetric flask and allowed to cool and was then made up to the mark with distilled water.

Results and Discussion

Results

Table 1: Result of the physicochemical analysis of stream water and borehole water

S/NO	Parameter	Measured Value (Stream water)	Measured Value (Borehole water)	WHO Standard
1	Temperature (ºC)	26.4 ±0.36	26.3 ±0.1	30-32
2	Conductivity (µS/cm)	117.56 ±0.51	128 ±0.1	500
3	Ph	7.11 ±0.105	6.67 ±0.109	6.5-8.5
4	TSS(mg/l)	100 ±1.0	16 ±0.25	50
5	D.O (mg/l)	1.35 ±0.25	4.16 ±0.025	7.5
6	BOD (mg/l)	0.57 ±0.25	0.30 ±0.015	NS
7	Turbidity (mg/l)	18.33 ±0.70	3.0 ±0.158	5
8	Alkalinity (mg/l)	18.15 ±0.15	14.65 ±0.05	120
9	Chlorides (mg/l)	133.3 ±0.447	132.1 ±0.6	250
10	TDS(mg/l)	0.999 ±0.0014	133.1 ±0.47	1000
11	Hardness (mg/l)	3.36 ±0.61	106.2 ±0.6	200

Table 2: Result of the heavy metal analysis of stream water and borehole water

S/NO	Metal	Concentration (mg/l) Stream water	Concentration(mg/l) Borehole water
1	Lead	0.333 ±0.05	0.167 ±0.001
2	Zinc	0.647 ±0.002	0.118 ±0.005
3	Chromium	0.429 ±0.01	0.143 ±0.003
4	Copper	0.061 ±0.004	0.044 ±0.05
5	Iron	1.444 ±0.03	0.222 ±0.08
6	Cobalt	0.024 ±0.002	0.016 ±0.002

Discussions

Temperature

The mean values of temperature measured along the stream and borehole water in Ganuwa village were 26.4°C and 26.3°C respectively. All the measured samples were found to be within the range of limit set up by world Health Organization.

pH

The water samples collected from the stream at Ganuwa village showed an acidic pH with mean pH values of 7.11 while the mean pH value of the water sample collected from the borehole is 6.67 which showed that it is basic. All the water samples from both the stream and the borehole are within the safe limit of 6.5-8.5 put by World Health Organization

Electrical conductivity

The values of electrical conductivity obtained from the borehole and stream water samples collected from Ganuwa village are 128 µs/cm and 117.56 µs/cm respectively. The borehole water showed a higher electrical conductivity than the value obtained in the stream water samples. All values were below the recommended WHO standard of 1000 µs/cm and were better health wise.

Dissolved oxygen

The D.O values of the stream and borehole water samples collected from Ganuwa village are 1.35 mg/l and 4.16 mg/l respectively. The borehole water sample showed a higher concentration of the dissolved oxygen than the stream water sample though all the samples analyzed are within the tolerable limit of 5 mg/l put by world Health organization.

Biological Oxygen Demand

The Biochemical Oxygen Demand (BOD) mean of 0.30mg/l was recorded for borehole water samples, while 0.57mg/l was recorded for the stream water and were quite lower than the WHO recommended standard of 10 mg/l, but acceptable. The stream was reported to have higher value than the borehole water sample.

Chloride content

The measured concentration of chloride in the borehole water samples was 132.1 mg/l while that of the stream water sample was 133.3 mg/l which showed a slight variation in the two water sources analyzed. The chloride content is almost equal in the samples tested. All the samples were within the WHO recommended standards of 250 mg/l.

Total Alkalinity

The mean alkalinity values of 18.15 and 14.65 mg/l were recorded for the stream and borehole water samples in the study area respectively. The stream water sample has the highest alkalinity value than the borehole water sample. These values for both the two water samples were below the highest desirable level of 200 mg/l recommended by the WHO and were accepted.

Turbidity

Turbidity is the expression of optical property. It is the cloudiness of water caused by certain variety of particles. It is also related to the content of disease causing organisms in water which may come from soil run off. High level of has been recorded in the stream water samples than the borehole water samples in this study. The mean values of turbidity were 18.33NTU and 3.0NTU for the stream and borehole water samples. The borehole water sample was below the recommended WHO value of 5NTU while the stream water sample is above the recommended value and therefore not safe for direct drinking. The higher value obtained in the stream water sample was due to washing off of agricultural and farm particles. . High turbidity can cause temperature and dissolved oxygen stratification in water bodies [12].

Total Hardness

Magnesium and calcium salts are largely responsible for the total hardness (TH) of water [13]. The principal hardness causing ions are Ca^{2+} and Mg^{2+} and the acceptable limit can be up to 500 mg [8]. Hardness can classified into four; soft (0-60 mg/l), moderate (60-120 mg/l), hard (121-180 mg/l) and very hard (180 mg/l and above)[14]. Similarly, the World Health Organization standard for drinking water classified water with a total hardness of $CaCO_3$ less than 50 mg/l as soft water, 50-150 mg/l as moderately hard and water hardness above 150mg/l as hard water. The mean total hardness values of the stream and borehole water samples were 336.6 mg/l and 106.2 mg/l respectively. Based on the above classification, the stream water sample was found to be far above the WHO recommended value while that of the borehole was below the WHO permissible limit. In addition to the other former classification, the borehole water sample can be classified as moderately hard while the stream water sample can be classified as hard water and not suitable for drinking.

Total Suspended Solids (TSS)

The maximum recommended limit of total suspended solids set by the world health organization is 50 mg/l. The TSS values were 100 mg/l and 48mg/l in the stream and borehole water samples respectively. Higher concentration of suspended solids is reported in the stream water. The borehole water sample unlike the stream water sample has concentration below the permissible limit of 50mg/l put on World Health Organization. This showed that the stream water contains a considerable amount of suspended particles originated from the farming and domestic activities which might have been washed away into the stream by rain. High TSS levels in surface water absorb heat from sunlight, which increases water temperature and decreases levels of dissolved oxygen [15]

Total Dissolved Solids (TDS)

Total dissolved solids are the inorganic and small amount of organic matters which are present as solutions in water. TDS indicates the salinity behavior and the amount of other substances in dissolved in water. These substances affect the sunlight reaching to submerged aquatic plants and consequently photosynthesis and decrease the amount of dissolved oxygen released by aquatic plants. The mean TDS values in the stream and borehole water samples were 0.999 mg/l and 133.1 mg/l respectively. The borehole water sample was found to have the highest TDS value than the stream water sample. This can be attributed to the amount of particles found dissolved in it. All the samples were to be below the permissible limit of 1000mg/l set up by the world health organization. TDS value is formed due to the ability of water to dissolves salts and minerals and these minerals produced unwanted taste in water [16].

Copper concentration

The value of copper concentration of the borehole water samples was 0.044 mg/l while that of the stream water sample was 0.061 mg/l. Higher copper concentration was recorded in the stream water sample. The borehole water sample was found to have lower than that of the stream water sample. But all the samples were found to be within the permissible limit of 1.00 mg/l as recommended by the world health organization.

Zinc Concentration

The mean values of zinc in the stream and borehole water samples were 0.647 and 0.118 mg/l respectively. All the values obtained in all the analyzed samples were far above the WHO standard of 0.1mg/l. The stream water sample was found to be higher than the borehole water sample.

Iron concentration

In this study, the mean Iron levels in the borehole and stream water samples were 0.222 mg/l and 1.444 mg/l respectively. The stream water sample was found to be higher than the borehole water sample. The borehole water sample was found to be below the recommended safe limit of 0.3mg/l while the stream water sample was found to have exceeded the safe limit of iron in drinking water.

Lead Concentration

The mean lead concentrations in the stream and borehole water samples were 0.333 mg/l and 0.167 mg/l respectively. The mean concentration of lead in the stream water sample was higher than that of the borehole water and all were above the allowable limit of 0.05mg/l and 0.01mg/l set by world Health organization and Nigerian standards for drinking water quality (NSDWQ).

Chromium concentration

The mean concentrations of chromium as determined in the water samples under this study were 0.428 mg/l and 0.143 mg/l for steam and borehole respectively. All the samples were found to be far above the safe limit of 0.05 mg/l. The stream water sample was higher in chromium concentration than the borehole water sample and therefore less safe for drinking as the later sample. High level of chromium in drinking water is found to cause cancer and lethal to healthy well-being of humans especially at a concentration above 1.0 mg/l

Cobalt concentration

In this study, the stream water sample was found to have the mean cobalt concentration of 0.024 mg/l while the borehole water sample was found to be 0.016 mg/l. Higher cobalt concentration was reported in stream water sample. All the analyzed samples were both below the recommended permissible limit of 0.05 mg/l

Conclusion

The study of the physicochemical and heavy metals parameters of a stream and borehole water in Ganuwa village of Charanci Local Government, Katsina state which serve as the two major sources of water to the community shares significant importance in improving living standard and quality of life in the area. Therefore the periodic examination of water source for both domestic and commercial activities should be an important component for the protection strategy in this area. Understanding of pathogenic bacteria genera in water sources is useful and to arrive at measures they may act as indicators of water quality and pollution. In this study, the physicochemical and heavy metals status of these two water sources were study.

With respect to the concentrations of the heavy metals, all the samples were found to have lead, chromium and zinc concentrations higher than the recommended values set aside by the world health organization. Iron was found to be higher and above the tolerable limit in stream water sample while borehole water sample was found to be below the safe limit as recommended. Cobalt and copper concentrations in both the stream and borehole water samples were all found to be within the permissible limit recommended by world health organization.

On the other side, the borehole and stream water samples have all the physicochemical parameters analyzed within the recommended tolerable limit with turbidity, hardness and total suspended slightly high than the recommended safe limit set up world health organization

References

[1]. Itah, A. Y. and Akpan, C. E. (2005) Portability of Drinking Water in an Oil Impacted Community in Southern Nigeria. *Journal of Applied Science and Environmental Management,* 91(1):35-74.

[2]. WHO (2007). Guideline for drinking water quality, WHO press, Geneva, Switzerland, 6th edition, 2012

[3]. WHO (2011). Guideline for drinking water quality, www.who.int/water-sanitation health/publications/2011/dwq-chapters/en/

[4]. Dissmeyer, G.E. (2000) Effects Drinking water from forests and Grasslands South Research station, USDA forest service, Ashville, NC, USA.

[5]. WHO (2004). Guideline for drinking water quality, WHO press, Geneva, Switzerland, 4th edition.

[6]. Asbbolt, N.J. (2004). Microbial contamination of drinking water and disease outcomes in developing regions Toxicology 198: 229-238 http://dx.doi.org/101016.

[7]. Mintz, E., Bartram J., Lochery, P. And Wegelin, M. (2011) Not just a drop in the bucket, Expanding access to point-of-use water treatment systems, *American Journal of public Health* 91(10): 1565-1570.

[8]. Onwuka, K. O., Uma, K. O. and Ezeigbo, H. I. (2004) Possibility of Shallow Groundwater in Enugu Town, South Eastern Nigeria. *Global Journal of Environmental Sciences 182*(3): 33-39.

[9]. Afbede, O. A. and Oladejo, O. S. (2003) Study of Water Quality at Oil Depots in South Western Nigeria *Journal of Environmental Issues* Vol. 1, no. 1 pp. 160-165.

[10]. Olusola O.F., Ayeni A., A.O. Lawal (2010). A Comparative Study of Borehole Water Quality from Sedimentary Terrain and Basement Complex in South-Western, Nigeria, *Research Journal of Environmental Sciences* 4(3): 327-335.

[11]. www.google.com/maps/ accessed date; 16-09-2020.

[12]. Tessema, A., and Muhammad, B.T. (2014). Assessment of physicochemical water quality ofBira Dam, Batiwereda. *Journal of Aquatic Research and Development*, 5(6) 1-4.

[13]. Anhwange, B.A., Agbaji, E.B, and Gimba, E.C. (2012). The Impacts of assessing human activities and seasonal variation on River Benue, within Makurdi metropolis. *International Journal of science and Technology*, 2(5), 248-254.

[14]. Tsoumbaris, P., Papadakis, N., Sargiotis, G., Georgianos, P., and Mikolaou, K. (2009).Determination of heavy metals in drinking water of the Evrosprefecture, Greece. *Journal of Environmental protection and Ecology*. 10: 359-364.

[15]. Igbal, J. Mumtaz, M., Mukhtar, H., Igbal, T., Mahmood, S. and Razaq, A. (2010) Particle size distribution Analysis and physicochemical characterization of Chenab River water at Marala Headwork, *Pakistan Journal of Botany*, 42 (2), 1153-1161.

[16]. Muhammad M., Samira S., Faryl A., & F. Jamal (2013); Assessment of Drinking water and its impact on residents health in Bahawalpur city, *International Journal of Humanities and Social Sciences*, vol 3 pg 114-128.