http://www.inosr.net/inosr-experimental-sciences/
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INOSR Experimental Sciences 7(1): 24-32 2021.

International Network Organization for Scientific Research ISSN: 2705-1692

Physico-Chemical Analysis of Hirnare Borehole Water in Nafada Local Government Area, Gombe State of Nigeria

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ABSTRACT

Studies on the Physico-chemical analysis of Hirnare borehole water was conducted with the aim of determining the physico-chemical parameters of the water. Samples of water were collected from Hirnare main source of Borehole water in Nafada Local Government Area, Gombe State of Nigeria. Nine (9) physico - chemical parameters were analyzed. (pH, Conductivity. Total dissolved solid (T D.S), Turbidity, Dissolve Oxygen (DO) were determined by the use of Henna instrument meter [Meter No: H198907] while (Alkalinity, Total Hardness, Chloride) were determined by titration method. Some of the physico-chemical parameters analyzed comply with the requirement of WHO, NAFDAC and NSDWQ. Which include the pH (6.95), Alkalinity (95.4mgl/), Conductivity (778.6us/cm).While other parameters of the water sample does not comply with the standard recommended by WHO, NAFDAC and NSDWQ. Which include total dissolved solid (T.D.S) (571 ppm). Turbidity (8. 1ONTU), Total Hardness (189.8mex), Chloride (281.6mg/I) and Dissolve Oxygen (D OX 6 84 mg/l of the water sample also exceeded the standard requirements.
Keywords:Physico-Chemical, Borehole, Water, Chloride and Dissolve Oxygen

INTRODUCTION

Water is one of the most important and valuable natural resources. It is essential in the life of all living organisms [1,2,3]. Although water covers about seventy percent (70%) of the earth's total surface, only 0.3% of it has quality and is drinkable to humans [4]. The quality of drinking water is a powerful environmental determinant of health [5]. However, studies had it that more than 80% of diseases in developing countries, Nigeria inclusive are due to the lack of good quality water [6]. Water quality is described by it being colorless, transparent, odorless and tasteless in conformity with certain physical, chemical and microbiological standards of 7.0 pH value 0^{o}C freezing and 100^{o}C boiling points at 760 mmHg [7]. This values ensures the quality and safety of portable water. The World Healt Organization (WHO), Food and Agriculture Organization (FAO). United States Environment Protection Agency (USEPA), as well as the Nigerian Industrial Standard for drinking water (NIS), have set up standard for heavy metal contamination from there different sources of water. These standards are based on the physical, chemical constituents of the water from their sources [8,9,10,11]. Water can be obtained from a number of sources, among which are streams, lakes, rivers, ponds, rain, springs, and boreholes [12,13]. In Nigeria, majority of the rural populace do not have access to portable water and therefore, depend on well, stream, boreholes water for domestic uses [14,15,16]. In line with the non-availability of portable water in many Nigerian rural communities, people of Hirnare ward of Nafada local Government obtained their domestic water from Boreholes. The Boreholes are complimented in the dry season by hawkers who sell water in wheel barrow or fetch it from the nearby Nafada River to meet up with their daily needs. However, numerous studies have shown that Borehole water is contaminated by domestic sewage, wastes and livestock manure especially if there is a puncture in the soil layer [17]. These waste and sewage when deposited near the

boreholes may travel with percolating rain water directly into the boreholes or may travel along the well-wall or surrounding material of the drill-holes [18]. There are several variants of faecal-oral pathway of water borne disease transmission. These include contamination of drinking water catchments (example, human or animal faeces). Water within the distribution system (such as leaky pipe or obsolete infrastructure) or of stored household water as a result of unhygienic handling [19]. Consequent upon consumption of contaminated water, water- borne diseases such as cholera and typhoid often ensure especially during dry season [20]. [21], found that diseases due to drinking of contaminated water leads to the death of five million children annually and make 1/6 of the World Population sick. Water contaminated with toxic inorganic chemicals causes either acute or chronic health effect. Acute effects include nausea, lung irritation, skin rash, vomiting and dizziness, sometimes death usually occurred. Chronic effect, like cancer, birth defects, organ damage, disorder of the nervous system and damage to the immune system are usually more common [22]. In addition, borehole water have excessive contaminants from microbial and chemical actions [23]. It is against this background that this study seeks to determine the physical and chemical parameters of some borehole water in Hirnare with the view to ascertaining the water portability of the community.

Purpose of the Study

The main purpose of this study is to determine the physico-chemical property of some borehole water in Hirnare community, Nafada Local Government, Gombe State.

Aim of the Study

To determine the physico-chemical parameters contained in some borehole water in Hirnare community

Objectives of the Study

The specific objectives of this study were to:

Determine whether the pH level of Hirnare borehole water satisfy the requirement of world health organization (WHO).

Determine whether the water fits the requirement of Nigerian standard drinking water quality (NSDWQ).

Research Questions

The following research questions were raised to guide the conduct of this study

1. What is the level of water portability in relation to Nigerian Standard Drinking Water Quality (NSDWQ)?
2. Is the water fit and portable for consumption?
3. Is the water properly purified?

Research Hypotheses

The following null hypotheses will be tested in this study at 0.05 alpha levels:

Ho1: There is no significant differences between water portability of Hirnare and Nigerian Standard Drinking Water Quality (NSDWQ).

Ho2: There is no significant differences between water fitness for consumption in Hirnare Borehole and NSDWQ.

Ho3: There is no significant differences between the purity of water in Hirnare Borehole and NSDWQ.

Significance of the Research Study

The study was used to elucidate the physical parameters of water such as the transparency/Turbidity, pH, EDTA. Dissolved salt/Salinity. Dissolved phosphate, Temperature, among others. The study will also bring about the level of physical and chemical properties of the Hirnare Borehole water. The study will also be of immense importance in determining the portability and quality of

the water in relation to standard drinking water quality (NSDWQ).

Materials and Methods

Description of the Study Area

Hirnare is a ward located at Nafada local Government Area of Gombe State. The geographical location of Nafada is between the latitude of 11' 45'' N 11 and longitude of Gombe state. It borders with Gadari in the north and Gube in the south and shole in the east and Barwo in the west. Nafada town is one of the local government areas (LGA) of Gombe State. Nafada is in the east of the area at 11o 05 44 N 110 19 58 E on the Gongola River which traverses the area "post office with map of LGA" retrieved from internet on 02-03-2015.it has an area of 1,586 km^2 and a population of 138,185 according to 2006 national census.Gombe state is located within the North-Eastern region of Nigerian and occupies a total area of about 20, 2659 sq. km. the state has isolated hills while the elevation of the plain is about 600m above sea level, and the hills reach between 700m and 800m. And also the state had an estimate population of about 2,353,000 by 2007/05/04 (Nigerian new retrieve).

Sample collection

The water sample were collected from the main source (Hirnare borehole) using washed bottles and sterilized glass containers, for three (3) weeks, after that the water samples was transported to the laboratory of Federal University of Kashere for analysis.

Methodology for physico-chemical analysis

The physico-chemical determined the pH, conductivity, temperature, total dissolve solid,Alkalinity, chloride, and total hardness (i.e magnesium, calcium) using the method of [9].

pH value

The pH were determined using the pH meter according to the standardization method of buffer solution of pH reading recommended by [1].

Electrical conductivity

Electrical conductivity were estimated with conductivity meter at standard rate with buffer solution and temperature of different samples for steady reading according to [1].

Temperature

Temperature is the (numerical value) that expresses the coldness or hotness of a substance. And were measured at the time of sampling (sampling point). The temperature of each sampling was determined with mercury-bulb thermometer by immersing the bulb vertically into the water samples allowed to stand till the temperature reading is steady according to [1].

Turbidity

The turbidity measures the degree to which the water losses its transparency due to the presence of suspended particles. Turbidity in water arises from the presence of very finely divided solids (which are not filterable by routine methods).The existence of turbidity in the water affects its acceptability to consumers and it is also affecting markedly it utility in certain industries [7]. The maximum, acceptable turbidity value recommended by both NIS and WHO is 5 NTU, The high level turbidity in water from wash borehole is a source of concern because the particles forming the turbidity could harbour and shield pathogenic organisms and hence escape the action of the dis infection [7]. Turbidity of water was measured using pocket-sized turbidity meter.

Determination of total hardness

The total hardness which is the sum of the calcium and magnesium concentration in mg/l, was determined using EDTA trimetric method by [4]. The total Hardness will be determined using EDTA Trimetric method (Apha, 1995). Using

Erichrome Black T as indicator and 1ml of buffer solution. Calculation was done as described by [1].

Total hardness mg/1 (CaCo3) = A x M (F) x 100
MI of Sample
Where
A = Average of time used
F = Factor of the titrant (EDTA)

Methodology of Alkalinity Test

25ml of the water sample was pipette and poured into the conical flask and then 3 drop of phenolpthelin indicator. No colour changed then alkalinity is zero (0) no need of titration (alkalinity is determined), then 3 drop of methyl orange was add and the colour was observed and recorded as initial colour. H2SO4 (titrant) was poured into the cylindrical burette to the zero (level) lower meniscus for the colourless reagent was observed. The burette tap (value) was then released the reagent (titrant) into the sample and drop wisely, the procedure will be continues at the same time shaking the conical flask unit when the pink colour was observed (determined) and recorded, the value from the burette (initial and final) were recorded accordingly. The procedure was repeated for about 2-3 times. In order to obtain the variations and changed final readings was recorded. The initial values were subtracted from the final values and the average value of the titration was recorded.

Calculation was done as described by [1].

S A = V x M x 100.00
MI of Sample
Where
V = Volume of Acid used
M = Molarity of the reagent (H2SO4)

3.6 Determination of chlorine (chlorine test)

Apparatus

Conical flask, Funnel, pipette (25ml standard), Dropper, Retort stand.

Reagents

Silver nitrate (AgNO3) as titrant
Sample water
Potassium chromate (K2CrO4) (indicator)

Methods of Chloride Test

The burette was titrated (AgNO3) to the zero (0) level and 25ml of the water sample was release into the conical flask. 1ml of potassium chloride (KCrO4) was added and shakes a yellow color was observed and recorded as initial color. The silver nitrate (AgNO3) solution was released into the sample in drop –wise and shakes the conical flask. A reddish brown colour is obtained. The burette reading was recorded (initial & final). The procedure was repeated about 2-3 times in order to obtain the variation. The initial values were subtracted from the final value and the average values of the titration was recorded.

Calculation will be done as described by [1].

Chloride mg/1 = A x V x 70900
MI of Sample
Where
A = Average volume of titrate used
V = Volume of the reagent ($AgNO_3$)

RESULTS

The results of the physico-chemical analysis of Hirnare Borehole water of Nafada local government based on the research conducted showed that the water samples analyzed have objection in the some physical and chemical parameters of the water which are not in agreement with the standard range they include Turbidity, Total Dissolve Solute (T.D.S), Chloride, Dissolve Oxygen (D.O). Also the colour of the water is not in agreement with the standard colour due to the high turbidity which affect the physical appearance of the water sample (i.e. colour). While some of the parameter were found within the standard range required they are pH. Alkalinity. Total Hardness, and Conductivity. The result was shown in the Tables below. Table 1 indicates the physicochemical parameters of the water which include the total hardness, chloride andalkalinity

Table: 1 Result of the physio-chemical parameter of hirnare borehole water of nafada local government and their means values

Parameters	Week 1	Week 2	Week 3	mean
1. Ph	7.09	7.25	6.52	6.95
2. Temperature (^{o}C)	33.0	30.2	34.0	32.4
3. Turbidity (NTU)	6.60	8.50	9.40	8.16
4. T.D.S (PPM)	630	530	553	571
5. Total hardness (mg/l)	189	197.6	183	189.8
6. Alkalinity (mg/l)	99.9	87.5	98.8	95.4
7. Chloride (mg/l)	268.9	290.4	285.7	281.6
8. Conductivity (µs/cm)	799.2	841.0	695.6	778.6
9. D.0 (mg/l)	5.80	6.80	7.92	6.84

Key:
NTU = Nephelometric Turbidity Unit. PPM = Part Per Million Ambient: No Standard Value.

Table: 2 World Health Organization (WHO) Nigerian Standard Drinking Water Quality (NSDWQ) and
National Agency for Food Drug Administration and Control (NAFDAC) standard values

Parameters	NSDWQ	NAFDAC	WHO	HIRNARE
1. pH	6.5 - 8.5	6.5 - 8.5	6.5-8.5	6.95
2. Temperature (^{o}C)	ambient		12 - 30	32.4
3. Turbidity (NTU)	5.0 - 5.25	5.0		8.16
4. T.D.S (PPM)	500		500	571
5. Total hardness (mg/l)	61 - 12	500	250	189.8
6. Alkalinity (mg/l)	98 - 278	98 – 275	400	95.4
7. Chloride (mg/l)	250	250	250	281.6
8. Conductivity (µs/cm)	1000	100	NS	778.6
9. D.0 (mg/l)			5.0	6.84

NOTE: for hardness 0 - 60 (soft) 61 - 120 (moderate).121 - 180 (hard). 181 above (very hard).
KEY: NSDWQ = Nigerian standard drinking water quality, NTU = Nephelometric turbidity unit, PPM = part per million, AMBIENT = no standard value

Table 1: Shows the result of physico-chemical parameters of Hirnare Borehole water obtained and their mean in order to analyze the quality of the water sample in relation to the standard quality. The Total hardness, chloride and Alkalinity of the water sample were found to be from 183-19 mg/l. 268.9-290.4 mg/l and 87.5-99.9 mg/I respectively. The temperature of the water samples at the time of the analysis ranged from 30.2 to 34 °C, with the third weeks having the highest temperature of 34°C while the turbidity ranged from 6.6 NTU to 9.4 NTU, also June have the highest turbidity of 9.5 NTU. The samples had objectionable colour. The pH of the water samples ranged from 6.5 to 7.2, while the total dissolved solid ranges from 530 to 630 mg/l and conductivity measured at 695.6 – 799.2 µs/cm and lastly D.O ranges from 5.80 – 7.80 mg/l

DISCUSSION

Water quality is neither a static condition of a system, nor can it be defined by the measurement of only one parameter. There is a range of chemical, physical and biological components that affect water quality. These variables provide general indication of water pollution, whereas others enable a direct tracking of pollution sources [4]. The pH of the water samples collected from the main source (Hirnare Borehole water) was (6.95) slightly below neutral level (Table 1) and this value fall within the accepted range of 6.5-8.5 indicative of good water quality. The result is in agreement with the findings of Obi, and Okocha, 2007 in

Umuahia, Abia State. Nigeria. Temperature values of the water sample analyzed was (32.4°C) and also fall within the normal temperature range since the temperature standard is ambient(No standard depend on the environment where the samples are collected). This is in consistence with the result of Fajobi 2008 in Oyo state, Nigeria. Significantly high total dissolved solids (TDS) (571 ppm) of the water is implicative of a high level of pollution of the sewage and pit latrines when compared to the WHO standard limit for good water quality which is 1,000 mg/l, which fall in consistence with the findings of Kolhatkar 2004 in India. High TDS content values of the water show significant direct relationships to the high bacterial population obtained from the water samples. The turbidity of water sample used in this study (8.16 NTU) is not in agreement with the standard of both WHO and NWDSQ (5.0-5.25).Which is in consistence with the findings SfOtere 2002 in Benin City. Water turbidity is very important because high turbidity is often associated with higher level of disease causing microorganism, such as bacteria and other parasites [9]. The total alkalinity of water sample is in agreement (95.4 mg/l) with both WHO and NAFDAC (100 mg/l) standard. This is also in agreement with the findings of Adebiyi 2009 analysis of Sachet water in Ogbomosho, Nigeria. Conductivity of (778.6 us/cm) was observed in the water sample collected from Hirnare borehole water does not exceeds the required range of WHO and NSDWQ, although there is no disease or disorder associated with conductivity of drinking water. This is also in consistence with the result of Shittu et al., (2008) in Ojota, Lagos Nigeria. The total Hardness of the water was (189.8 mg/l) which does not fit the requirement of WHO, NSDWQ due to the high concentration of calcium and magnesium in the-water sample, the result agree with the findings of [24,25]. Dissolve oxygen (D.O) was (6.84 mg/l) which is above the standard requirement of WHO and NSDWQ (which is 5 mg/l). This is in consistence with findings Of Oladipo 2009. So also the chloride of the water sample (281.6 mg/l) is not in agreement with that of both WHO and NSDWQ (1000). But in agreement with the findings of [26,27,28,29,30] in Abeokuta. The water sample analyzed in this study have objectionable colour which is not in agreement with the standard colour due to the high turbidity which affect the physical appearance of the water sample (i.e. colour). Water sample Collected in the third week had the highest temperature which does not fit the requirement of WHO and NSDWQ (10 total coliform per 100ml). The result is in consistence with the findings of Onifade 2008 in Ondo state. Nigeria. This finding is not surprising considering the high population and close proximity of the wash borehole to pit latrines, the sewage could seep slowly into underground water, there by polluting it.

CONCLUSION

This study concluded that the drinking water quality in Hirnare of Nafada local government area needs serious effort. According to WHO and USEPA recent news and reports, borehole water used are not safe for drinking due to heavy industrial and environmental pollution. Toxic chemical, heavy metal make people sick while exposing them to long term health Condition. Water quality should be controlled in order to minimize acute problem of water related disease which are endemic to health of man. Therefore, an effective and thorough sanitary condition should be given to these water bodies in order to maintain a good water quality.

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