UJPICR Volume 1 Number 2 : December, 2021
UMYU Journal of Pure and Industrial Chemical Research
Volume1 No. 2 December, 2021.
ISSN: **2814 – 1628**

PHYSICOCHEMICAL ANALYSIS AND DETERMINATION OF HEAVY METALS CONCENTRATION OF BOREHOLE WATER SAMPLES COLLECTED FROM BINDAWA LOCAL GOVERNMENT AREA OF KATSINA STATE, NIGERIA.

[1]Nuraddeen Abdurrahman, [1]Buhari Sagir Bindawa, [2]Abdulrashid Yusuf, and [3]Imam Naziru

[1]Department of Pure and Industrial Chemistry, Umaru Musa Yar'adua University, Katsina, Nigeria P.M.B 2218 Dutsinma Road

[2]Scientific Department, Technology Incubation Centre Katsina, National Board for Technology Incubation, Federal Ministry of Science and Technology, Block C 3rd Floor Federal Secretariat, Phase II, P.M.B 365, Garki-Abuja

[3]Department of Industrial Chemistry, Federal University Oye-Ekiti, Nigeria

Corresponding author: nuraddeen.abdurrahman@umyu.edu.ng

ABSTRACT

This study assessed the levels of some physicochemical parameters of borehole water samples from Bindawa local government area of Katsina State. The water samples were collected from Doro, Shibdawa, Tama, Agalawa and analyzed for heavy metals (Cd, Fe, Pb, Cr & Cu) using AAS, while physicochemical parameters were determined using standard analytical methods. The concentrations range for Cd are 0.1 mg/L to 0.2 mg/L(0.13±0.05), above (WHO, 2017) limit, Fe 0.04mg/L to 0.11mg/L(0.07±0.03) within WHO limit, Pb 0.1mg/L to 1.1mg/L(0.51±0.48) above WHO limit, Cr 0.04mg/L to 0.07mg/L(0.06±0.02) with samples from Doro and Agalawa above WHO limit, Cu 0.45mg/L to 0.7 mg/L(0.56±0.11) within WHO limit. The results for the pH were 6.9, 6.4, 6.6, and 7.2 for Doro, Shibdawa, Tama, and Agalawa respectively (6.8±0.35). Calcium hardness were found to be; (146.25, 99.45, 157.95 and 163.02) mg/L, while Magnesium hardness were; (1.17, 7.02, 8.78 and 1.95) mg/L for Doro, Shibdawa, Tama and Agalawa respectively. Most of the physicochemical parameters determined were within standard limits, except for water sample in Shibdawa with pH value that deviate the WHO limit. The findings of the research suggested that the water in these areas is not fit for human consumption but can be used for some other purposes.

Key words: Shibdawa, Tama, Concentration, physicochemical parameters, Heavy metals, borehole water

Introduction

Water is a substance which has the chemical formula H_2O. The molecule is made up of two hydrogen atoms and one oxygen atom held together by a covalent bond. Water covers 70.9% of the earth surface and is vital for all known form of life. Water on Earth is mostly found in Oceans and other large water bodies [1]. Water is one of the essential components of the physical environment, it is estimated that water covers almost 70 % of the earth's surface [22]

Although water is very vital for life, it also serves as the community route of transmission of a number of infectious diseases. The majority of the populations in developing countries are not adequately supplied with portable water and this obliged to use unsafe water for domestic and drinking purposes [2]. Safe water is defined as water with chemical and physical characteristics that meet the WHO (World Health Organization) guidelines of natural and standards on drinking water quality [3]. 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. In another development, more than one billion people globally do not have access to enough and safe water supply, out of which more than 800 million live in rural areas. Similarly, around 2.5 billion people do not have proper sanitation, as a result of this, around 6-8 million people die annually due to water related diseases and disasters [4] [5]

Therefore, water quality control is a top priority agenda in many parts of the world [6]. The quality of water depends on various chemical constituents and their concentrations which are mostly derived from the natural anthropogenic activities taking place in a particular region. In many parts of Nigeria, the available water is rendered non-portable due to many anthropogenic activities. Therefore, access to safe drinking water remain a problem for over a billion people worldwide and inadequate sanitation services affect at least 2.5 billion people [7] [8].

Heavy Metals

Heavy metals are elements with a specific gravity that is at least 5 times the specific gravity of water. Using a density as a defining factor, heavy metals are those elements with a specific density of 5g/cm3 or more. They can also be defined as chemical elements with the density greater than 4g/cm3 found in all kinds of soils, rocks and water in terrestrial and freshwater ecosystem. Furthermore, heavy metals can be referred to as any metallic element that has a relatively high density and is toxic even at low concentrations. Generally, metals enter into aquatic environment through atmospheric deposition, erosion of geological milieu or due to anthropogenic activities caused by industrial effluents, domestic sewage and mining waste[23]. Heavy metals are naturally occurring in the environment due to the natural weathering of bedrock. These naturally released heavy metals are usually contained in forms that are not readily available to plant roots [24] [25]

Materials and Methods

Selection of Study Area

The study area is selected because a significant percentage of the population living in Bindawa depend entirely on new hand pump water system built by Non-governmental Organizations (N.G.Os) as their source of drinking water. There were also reports from hospitals on cases of water borne diseases in the area.

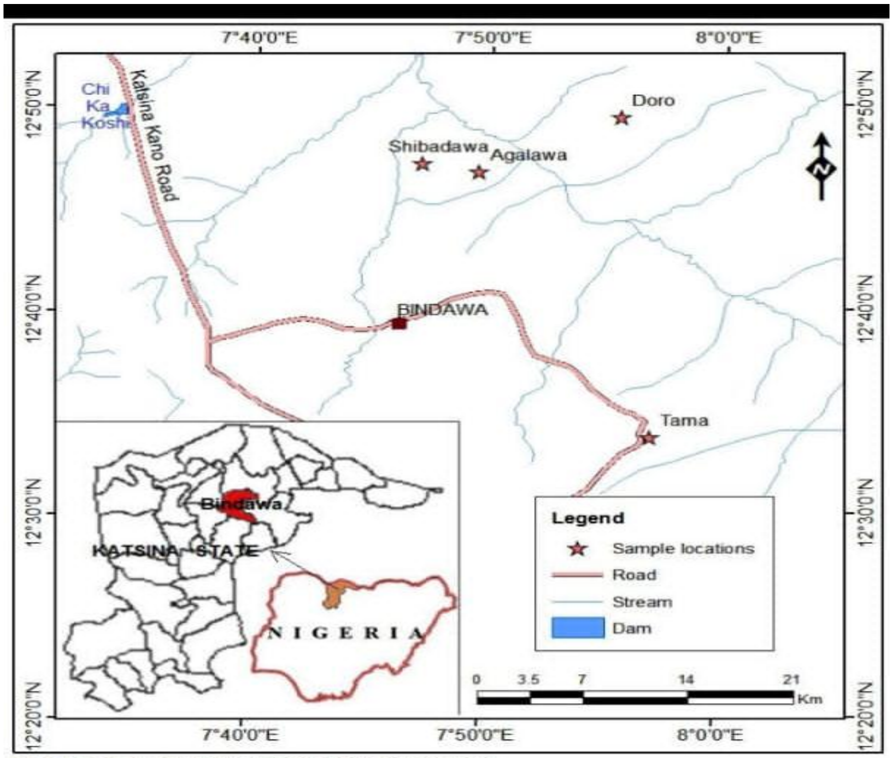

Fig.1: Map of the Study Area showing Sample Locations
Source:- Geography Department Umyu 2020

Fig. 1: Map showing the location of borehole water samples collected from

Bindawa Local Government Area of Katsina State.

Sample Collection

The water samples were collected from four different locations on the same day using Polyvinyl Chloride (PVC) sampling bottles. The PVC bottles were washed thoroughly prior to sample collection. The water sample was collected directly from the boreholes using systematic sampling at 5 minutes interval. It was ensured that standard method was followed in order to avoid contamination in transporting the sample to the laboratory.

Methods of Determining the Physico-Chemical Parameters

Determination of pH

The pH was measured using pH meter. It was first calibrated with a standard buffer solution. The glass electrode was washed thoroughly with distilled water, then the glass electrode was dipped into the beaker containing water sample until when the reading stabilized at a certain point. The pH reading was noted down. The procedure was repeated for all other water samples.

Determination of Electrical Conductivity (EC)

The electrical conductivity of the water samples was determined using a conductivity meter. The meter was first calibrated with standard 0.01M potassium chloride solution. The electrode was dipped in each portion of the sample and allowed to stabilize before the reading was recorded.

Determination of Total Suspended Solids (TSS)

A Whatman (125mm) filter paper was weighed accurately and placed in a funnel; 50mL of water sample was measured using a measuring cylinder and filtered, transferring all the solids to the filter paper. The residue was washed with about 20mL of distilled water. The filter paper was removed carefully and dried in an oven at 103-105^{0}C to a constant weight and the filter paper was allowed to cool in a desiccator and weighed.

Determination of Turbidity

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

Determination of Chloride (Cl^-)

The chloride was measured using titration method in which 20mL of sample was measured in to a conical flask, 5 drops of potassium chromate as indicator was added to the sample, and it was then titrated against silver nitrate until a permanent reddish-brown color appears.

$$\text{Chloride (mg/L)} = \frac{T.V * N * 35.5 * 1000}{\text{Volume of sample (mL)}}$$

T.V = Volume of $AgNO_3$ used

N = Normality of silver nitrate

Determination of Total Hardness (TH)

The total hardness was determined using titrimetric method, where 10mL of water sample was pipetted and diluted to 20-30mL with de-ionized water, then 3-5mL of buffer solution was added and a few drops of Eriochrome Black-T indicator. It was titrated with 0.01N EDTA until the color changes from red to blue. The readings were taken and the concentrations of Ca and Mg were calculated using;

$$\text{Total hardness (TH) (mg/L)} = \frac{V1 * N * 100}{W_1\ (mL)} \times 390$$

Where V1 = Titre value (volume of EDTA used)

N = Normality of EDTA

W_1 = volume of sample taken

Calcium Hardness

Calcium hardness was determined directly with EDTA when the pH is made sufficiently high; the magnesium was largely precipitated as hydroxyl compound (by adding NaOH and isopropyl alcohol). The solochrome black indicator was added to the solution containing calcium, all the calcium gets complexed by the EDTA at pH 12-13. The end point was observed by a sharp color change from red to blue.

$$\text{Calcium hardness } (C_{ca}^{2+}) \text{ (mg/L)} = \frac{V * N * 10}{W_1\ (mL)} \times 390$$

Where V1 = Titre value (volume of EDTA used)

N = Normality of EDTA

W_1 = volume of sample taken

Magnesium Hardness

Magnesium hardness was determined by calculating the difference between the calcium hardness concentration and the determined total hardness of water.

Magnesium hardness (Mg) = Total hardness (mg/L) – calcium hardness (mg/L)

Determination of Nitrate

Before starting a batch for distillation, the distillation unit was steamed out for about 10 minutes, the steam rate was adjusted to 7-8mL distillate per minute, and the water flow through the condenser jacket at a rate sufficient to keep distillate temperature below 22^oC, 20mL of water sample was pipetted into 100mL distillation flask, 1mL of saturated boric acid solution and 1mL of de-ionized water was pipetted into 50mL beaker. A second beaker was placed underneath the condenser tip, with the tip touching the solution surface, 0.2g Devarda's alloy was added immediately with a calibrated spoon, to the same flask, then attached back to distillation unit with a clamp, and the distillation started. After 4 minutes, when about 35mL distillate or more was collected, the steam supply was turned off and the distillation flask (second distillate) was then removed. The tip of the condenser was washed into a beaker with small amount of de-ionized water. The distillate was titrated with standardized 0.01N H_2SO_4 and the nitrate was calculated as below;

$$NO_3^- \text{(ppm)}, N = \frac{V1 * N * 14.01 * 1000}{V}$$

Determination of Phosphates

Phosphates were determined using spectrophotometer. Accurately 219.5mg of dried AR potassium hydrogen phosphate was dissolved with distilled water and made up to 1000mL where 1mL = 50.0mg of phosphate. Then 10mL of the stock solution was made up to 1000mL to give 1mL = 0.05mg. Standards of strength ranging from 0 (blank) to 0.05mg/L at interval of 0.01mg was prepared by diluting the stock with distilled water.

$$\text{Phosphates} = \frac{Absorbance\ of\ sample\ x\ concentration\ of\ standard}{Absorbance\ of\ standard.X\ sample\ taken}$$

Determination of Sulphates

Sulphates were determined using Nephelometer. Sulphates ions were precipitated in acetic acid medium with barium chloride to form barium sulphates crystals of uniform size. The scattering of light by precipitated suspension (barium sulphates) was measured by a Nephelometer and the concentration was recorded.

Determination of Dissolved Oxygen (D.O)

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

Determination of Biological Oxygen Demand (BOD)

The D.O values of the samples were taken the first day, after which the samples were tightly closed and then incubated in a light absence condition at 20^{o}C for five days. On the 5th day, the D.O values were taken again, the difference between the two values gives the BOD values.

$BOD = DO_1 – DO_2$

Where DO_1 = first day Dissolved oxygen measured

DO_2 = fifth day Dissolved oxygen measured

Determination of heavy metals concentration

Procedure for digestion Materials: volumetric flask, measuring cylinder, beaker, watch-glass, filter paper, hotplate.

Reagents: Nitric acid, distilled water

50mL of sample was transferred into a beaker after which 5mL of concentrated nitric acid was added, it was boiled slowly on a hot plate. About 20mL was evaporated and then further 5mL of concentrated nitric acid was added and covered with watch glass and heated until the solution appears slight colored and cleared. The solution was filtered and transferred into a 50mL volumetric flask and allowed to cool and was then made up to the mark with distilled water.

Results

Table 1: **Results of Some Physicochemical Parameters of Borehole Water Samples Collected from Bindawa Local Government Area of Katsina State.**

Parameters	Units	Sample			
		Doro	Shibdawa	Tama	Agalawa
pH	-	6.9	6.4	6.6	7.2
Conductivity	µS/cm	3.4	7.6	4.4	3.4
Turbidity	NTU	3.0	4.0	3.0	5.0

TSS	mg/L	16.0	20.0	20.0	16.0
DO	mg/L	4.20	4.36	4.15	4.19
BOD	mg/L	0.63	0.91	0.69	0.71
Chloride	mg/L	98.51	71.90	111.83	86.10
Nitrate	mg/L	16.1	17.5	16.1	22.8
Phosphate	mg/L	0.07	0.08	0.05	0.07
Sulphate	mg/L	34.0	47.0	32.0	44.0
T Hardness	mg/L	147.42	106.47	166.73	164.97
Calcium	mg/L	146.25	99.45	157.95	163.02
Magnesium	mg/L	1.17	7.02	8.78	1.95
Cadmium	mg/L	0.10	0.20	0.10	0.10
Iron	mg/L	0.04	0.07	0.04	0.11
Lead	mg/L	0.10	0.70	1.10	0.13
Chromium	mg/L	0.07	0.04	0.04	0.07
Copper	mg/L	0.70	0.60	0.45	0.50

Table 2: Descriptive Statistics of Some Physicochemical Parameters Analyzed in the Water Samples Collected from Bindawa Local Government Area of Katsina State.

Parameters	Units	Minimum	Maximum	Results (Mean ± SD)	WHO Limit
pH	-	6.4	7.2	6.8 ± 0.35	6.5 - 8.5
Conductivity	µS/cm	3.4	7.6	4.7 ± 1.99	500
Turbidity	NTU	3.0	5.0	3.8 ± 0.96	5
TSS	mg/L	16.0	20.0	18.0 ± 2.31	25
DO	mg/L	4.15	4.36	4.23 ± 0.09	7.5
BOD	mg/L	0.63	0.91	0.74 ± 0.12	-
Chloride	mg/L	71.90	111.83	92.09 ± 17.07	400
Nitrate	mg/L	16.1	22.8	18.1 ± 3.2	50

Phosphate	mg/L	0.05	0.08	0.07 ± 0.01	0.1
Sulphate	mg/L	32.0	47.0	39.3 ± 7.37	200
Total Hardness	mg/L	106.47	166.73	146.40 ± 28.01	200
Calcium	mg/L	99.45	163.02	141.67 ± 29.01	200
Magnesium	mg/L	1.17	8.78	4.73 ± 3.74	200
Cadmium	mg/L	0.10	0.20	0.13 ± 0.05	0.01
Iron	mg/L	0.04	0.11	0.07 ± 0.03	0.3
Lead	mg/L	0.10	1.10	0.51 ± 0.48	0.05
Chromium	mg/L	0.04	0.07	0.06 ± 0.02	0.05
Copper	mg/L	0.45	0.70	0.56 ± 0.11	1.0

Discussion

pH

pH is classified as one of the most important water quality parameter as it relates to the acidity or alkalinity of the water. From Table 1 above it shows that three of the samples analyzed were weakly acidic while the last one was weakly alkaline. The pH results were 6.9, 6.4, 6.6 and 7.2 for samples Doro, Shibdawa, Tama, and Agalawa respectively. Table 2 indicates the mean to be around 6.8 which is within the World health organization permissible range of 6.5-8.5 [9]. Although the pH values obtained for all the water samples from the analysis were in agreement with that of the World health organization set limit. Still there is fear that with increasing human activities near the study area such as Farming, and Mining, there may be increases in the flow of chemicals that may alter the pH.

Turbidity

Turbidity is the expression of optical property [9]. It is the cloudiness state of water caused by certain undissolved particles. It is also related to the content of diseases causing organisms in water which may come from soil run off [10]. Turbidity is an extremely important describer that can produce useful information rapidly and moderately. Measurement of turbidity is applied in various settings, from low-resource small systems all the way through to large and sophisticated water treatment plants [8]. Lower levels of turbidity have been recorded from the four samples analyzed. The turbidity values in table 1 were 3.0, 4.0, 3.0 and 5.0 NTU (Nephelometric Turbidity Units) for samples obtained from Doro, Shibdawa, Tama, and Agalawa respectively. This indicate low degree of pollutants as the average turbidity being 4.0 NTU presented in table 2 above, below to the set limit of not more than 5.0 NTU as recommended by world health organization [9] and not more than 10, 10, 25 NTU by ISI, CPCB and ICMR respectively [5]. Even though the turbidity of crystal-clear water is 1 NTU but still became visible at 4 NTU and above [9].

Chlorides

Chlorides occur in most water bodies as a result of sodium or calcium [11]. High chloride content in water samples may give salty taste to water and beverages [9]. It was found that the chloride values in the samples were 98.51 mg/L, 71.mg/L, 111.83mg/L, and 86.1mg/L, for samples from Doro, Shibdawa, Tama, and Agalawa respectively. The average value of chloride content in the water samples was found to be 92.09mg/L. These values were found to be within the standard limit of 400mg/L as established by WHO [9] as indicated in Table 2.

Calcium Hardness

Hardness of 146.25mg/L, 99.45mg/L, 157.95mg/L, and 163.02mg/L for samples obtained from Doro, Shibdawa, Tama, and Agalawa were recorded respectively, with mean value of 141.67mg/L**.** Calcium is one of the two principal causes of hardness in water [6] and the world health organization international standard for drinking water classified water hardness of $CaCO_3$ less than 50mg/L as soft water, 50-150mg/L as hard [6]. Water with low amount of calcium is usually regarded as potable as well as suitable for domestic purposes. All the water samples were within the WHO standard limit for drinking water as presented in Table 2.

Magnesium Hardness

Magnesium concentrations of 1.17mg/L, 7.02mg/L, 8.78mg/L and 1.95mg/L for samples obtained from Doro, Shibdawa, Tama, and Agalawa were recorded respectively, with mean values of 3.73mg/L**.** Magnesium is one of the principal hardness causing ions. It is usually found low in drinking water [6]. Similarly, the world health organization international standard for drinking water classified water hardness of $MgCO_3$ less than 50mg/L as soft water, 50-150mg/L as hard [6]. Based on this classification the magnesium hardness of the analyzed water from Bindawa local government could be grouped as soft water considering the WHO standard limit as in Table 2.

Total Hardness

The total hardness value obtained from the areas in Table 1 were 147.42mg/L, 106.47mg/L, 166.73mg/L and 164.97mg/L for Doro, Shibdawa, Tama, and Agalawa respectively. The principal hardness causing ions are Ca^{2+} (aq) and Mg^{2+} (aq) and the accepted limit can be up to 200mg/L [12]. According to the [16] hardness of water can be classified into four; Soft (0-60mg/L), moderately hard (61-120mg/L), hard (121-180mg/L) and very hard (>180mg/L). Similarly, the world health organization international standard for drinking water classified water with a total hardness of $CaCO_3$ less than 50mg/L as soft water and 50-150mg/L as hard water [6]. Based on this classification, the total hardness of the analyzed water from the recently constructed hand pump water system by NGOs in Bindawa local government could be grouped as hard water considering the values obtained in the analysis even though it is within the WHO permissible limits of 200mg/L.

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is essential to aquatic creatures for respiration [13]. Insufficient and imbalance DO may lead to sudden death of these creatures [6]. In this study values of DO in the samples analyzed were 4.20mg/L, 4.3mg/L, 4.15mg/L and 4.19mg/L for Doro, Shibdawa, Tama and Agalawa respectively as in Table 1 which is not suitable for aquatic organisms this is because the WHO minimum permissible level is 7.5mg/L [6]. Even the average mean of the DO present in the samples was 4.26mg/L which is in contrary with the permissible limit set by world health organization as well. This may be attributed by dissolution of discharged domestic effluents in the area. It may also be connected with the logical assumption that ground water has limited oxygen due to the absence of interface with the atmosphere.

Total Suspended Solid (TSS)

The maximum recommended TSS (Total Suspended Solid) safe limit set by world health organization is 50mg/L [6]. The TSS values of all the four samples were found to be within the limit set by world health organization. The TSS values of all the samples as illustrated in Table 1 are 16.0mg/L, 20.0mg/L, 20.0mg/L, and

16.0mg/L for the Doro, Shibdawa, Tama, and Agalawa samples respectively. The average TSS value of the samples under study is 18.0mg/L which is also within the WHO set limit. The water in the area is therefore good for drinking and other purposes based on the contents of TSS.

Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) is the measure of the amount of oxygen in the water that is required by the aerobic organisms [6]. The biodegrading of organic materials exerts oxygen tension in the water and increase biological oxygen demand [14]. From the result of the analysis as presented in Table 1, the respective concentration of BOD in all the four samples analyzed were 0.63mg/L, 0.91mg/L, 0.69mg/L, and 0.71mg/L for samples from Doro, Shibdawa, Tama, and Agalawa respectively. The mean concentration of BOD in the water body analyzed is approximately 0.74mg/L and ranges between 0.63mg/L to 0.91mg/L. Although there is no restriction to the allowable limit of BOD in drinking water, but it gives an indication of bacterial contamination. Water with a sufficient amount of BOD is exclusively regarded as contaminated.

Nitrates

The maximum recommended Nitrate safe limit set by world health organization is 50mg/L [6]. The Nitrate values of all the four samples were found to be below the set limit by world health organization. The Nitrate values of all the samples as illustrated in Table 1 are 16.1mg/L, 17.5mg/L, 16.1mg/L and 22.8mg/L for samples from Doro, Shibdawa, Tama, and Agalawa respectively. The average Nitrate value of the water from Bindawa local government area under study is 18.1 mg/L. All the samples are therefore individually and in group safe for drinking considering their nitrates contents.

Phosphates

The maximum recommended phosphate safe limit set by world health organization international standard for drinking water is 0.1mg/L [9]. The phosphate values of all the four samples were found to be 0.07mg/L, 0.08mg/L, 0.05mg/L and 0.07mg/L for Doro, Shibdawa, Tama, and Agalawa samples respectively as presented in Table 1. The average phosphate values of water from Bindawa local government area under study is 0.07mg/L therefore all the water samples are individually and in group good for drinking, based on the Phosphate content.

Sulphate

The values of all the four samples as illustrated in Table 1 were 34.0mg/L, 47.0mg/L, 32.0mg/L, and 44.0mg/L for samples from Doro, Shibdawa, Tama, and Agalawa respectively. The maximum recommended sulphate safe limit set by world health organization international standard for drinking water is 200mg/L [6]. The sulphate values for all the four water samples were found to be within the standard limit set by world health organization of international standard for drinking water. The average of sulphate values of water from Bindawa local government area under study is 39.5mg/L, therefore based on these results the individual water and the groups are good for drinking and other applications.

Electrical Conductivity (EC)

Conductivity values of 3.4 µS/cm, 7.6µS/cm, 4.4 µS/cm and 3.4 µS/cm for the water samples from Doro, Shibdawa, Tama, and Agalawa were recorded respectively. Electrical conductivity (EC) is the ability of a solution to conduct an electric current. This is governed by the migration of ions which is exclusively dependent on the nature and number of ionic species in that solution [15]. Table 2 revealed that the mean value of EC was 4.7 µS/cm which is in agreement with that of the world health organization international standard for drinking water 500 µS/cm [6] and 200 µS/cm as given by CPCB [5]. This clearly indicates that the presence of chloride and Alkalinity of the water contributed to the conducting ability of the water [16]. Moreover, water with low conducting capacity is usually considered very essential and portable for both domestic and other purposes.

Lead

The major sources to which lead finds its way into drinking water is from the presence of lead compounds in plumbing fittings and as solder in household water systems. Lead pipes may be used in older distribution systems and plumbing [4] [17].

The lead concentrations were found to be 0.1mg/L, 0.7 mg/L, 1.1mg/L and 0.13mg/L for samples of waters from Doro, Shibdawa, Tama, and Agalawa respectively, while the mean concentration of lead from the analysis was found to be 0.51 mg/L. All values obtained were above the permissible limit of 0.05 mg/L stipulated by world health organization [6]. The higher value of Pb recorded is a cumulative general poison and maybe associated with severe health hazards [18], reproductive effects [19], cancer, mental retardation in infants, toxic to central and peripheral nervous system [20]. The higher concentrations of the Pb may be attributed to the anthropogenic activities in these areas, such as dissolution of the metal from its natural sources and/or other farm discharges in the area.

Cadmium

The concentrations of cadmium determined in the water samples from this study were 0.1mg/L, 0.2mg/L, 0.1mg/L and 0.1mg/L for samples of water from Doro, Shibdawa, Tama, and Agalawa respectively, while the mean concentration of cadmium in the samples collected was 0.13mg/L, which is far above the world health organization permissible limit of 0.01mg/L [3]. High level of cadmium in the water samples in the area may be connected with the farming activities and weathering of rocks naturally in the area. Therefore; care must be taken, the way the water is being used, especially for drinking purposes in all the areas due to the high level of cadmium which render it unfit for drinking.

Chromium

The concentration of chromium determined in the four water samples from Doro, Shibdawa, Tama, and Agalawa respectively were 0.07mg/L, 0.04mg/L, 0.04mg/L and 0.07mg/L with average mean concentration of 0.06 mg/L. Water samples analyzed from Doro and Agalawa had values above the WHO standard limit of drinking water which is 0.05mg/L [3] and this may be as a result excessive dying and other agricultural activities in the area, while water sample from Shibdawa and Tama were below the WHO maximum permissible levels. This indicates that water samples from Doro and Agalawa boreholes are not good for drinking even though the increase above the WHO limit is just 0.02mg/L which is insignificant. However, Water samples from Shibdawa and Tama boreholes are good for drinking as the level indicates. High level of chromium in drinking water is found to cause Cancer and lethal to healthy well-being of human especially at the concentration above 1.0mg/L [20].

Iron

Iron is found widely in soils and is a constituent of many surface and underground waters. It may be brought into solution in reducing condition and the excess metal will be later deposited as the water is flowing [8]. The iron level of the water samples was found to be 0.04mg/L, 0.07mg/L, 0.04mg/L and 0.11mg/L for Doro, Shibdawa, Tama and Agalawa respectively, with mean concentration of 0.07mg/L. The concentrations of iron in all the water samples from the study areas were found below the set limit of 0.3mg/L [3]. Therefore the water samples in the areas are all good for drinking and other applications, with regards to the iron concentrations.

Copper

This element is present naturally with iron deposits but more often, its presence in water is due to attack on copper pipes [21]. A higher level of copper in drinking water may impart a stringent taste and can cause a gastrointestinal disorder. At levels above 2 mg/L, copper imparts an undesirable bitter taste to water, at higher levels the color of water is also affected [8]. The concentrations of copper in all the water samples were found to be 0.70 mg/L, 0.60 mg/L, 0.45 mg/L and 0.50mg/L for Doro, Shibdawa, Tama and Agalawa respectively, with mean concentration of 0.56 mg/L. All water samples from the areas are within the 1.0mg/L standard limit for drinking water, as recommended by the world health organization [3].

Conclusions

This research focused on assessing the water quality parameters as emphasized by the WHO. The water analyzed in the areas is used by the people in the localities for drinking and other domestic activities. The results of the study show that several of the parameters tested were within the standard permissible limit with the exception of Pb, Cd and Cr (for water samples in Shibdawa and Tama). According to the results of the parameters and some heavy metals analyzed, the water investigated from the selected areas is not fit for human consumption but can be used for some domestic applications. However, for the water to be fit for drinking purposes, it should be subjected to treatment processes prior to consumption.

References

1. Haliru, K., and Nuraddeen, A., Comparative Analysis between Sachet Water and Borehole Water in Funtua Local Government Area of Katsina State. *FUDMA Records of Chemical Science*, 2019, 1(2):1–6.

2. Afonne, O.J., Chukwuka, J. U., and Ifediba, E.C., Evaluation of Drinking Water Quality Using Heavy Metal Pollution Indexing Models in an Agrarian, Non-

Industrialized Area of South-East Nigeria. *J. Environ. Scie. Health – part A Toxic/Hazard Subst. Environ Eng.*, 2020, 1 – 9.

3. Massoud, M.A., Assessment of Water Quality along a Recreational Section of the Damour River in Lebanon Using the Water Quality Index. *Enviro Monit Assess.*, 2012, 184(7): 4151-60, https://doi.org/10.1007/s10661-011-2251-z

4 U.N., An increasing demand, facts and Figures, UN Water Coordinated by *UNESCO in Collaboration with UNICEF and UNDESA*, 2013, Retrieved at *http://www.unwater.org/water-coorperation-2013/en/*

5. Kumar, M., and Puri, A., A Review of Permissible Limits of Drinking Water. *Indian Journal of Occupational and Environmental Medicine*, 2012, 16(1): 40–44. https://doi.org/10.4103/0019-5278.99696

6. Arafat R., Ishrat j., and Yeasmin N. J., Assessment of physico-chemical properties of water and their physical variation in an urban river in Bangladesh. *Water science engineering journal*, 2021, 14(2): 139 – 148

7. U.N., General Assembly Declares Access to Clean Water and Sanitation as a Human Right. *U.N. News Center*, 2016.

8. W.H.O., Guidelines for Drinking Water Quality, 4th Edition, Incorporating the First Addendum. *World Health Org., Geneva*, 2017a, p155e2000.

9. W.H.O., UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLASS) 2017 Report: Financing Universal Water, Sanitation and Hygiene under the Sustainable Development Goals. *World heath org., Geneva*, 2017b.

10. Tessemer, A., Muhammad, A., Birhanu, T, and Negu, T., Assessment of Physicochemical Water Quality of Bira Dam, Bati Wereda, Amhara Region, Ethiopia. *Journal of Aquatic Research and development*, 2014, 5(6): 1-4, https://doi.org/10.4172/2155-9546.1000267

11. Chandawat P. U, D. K., and Solanki, H. A., Pollution status of Nikol Lake located in Eastern

Ahmedabad, Gujarat-India. *International Journal of Innovative Research in Science, Engineering and Technology*, 2013, 2(8): 3603-360

12. UNESCO (2019). The Global Water Quality Challenges and SDGs. Retrieved at https://en.unesco.orgwaterquality-iiwq/wq-challenge

13. Harrafi, H., Khedri, M. and Karaminejad, K., Determination of Chemical Oxygen Demand in Spent Caustic by Potentiometric Determination. *World Engineering and Technology Academy of science*, 2012, 6(7): 190-192, https://www.doi.org/10.5281/zenodo.1333666

14. Hasan, M. K., Shahura, A., A., and Jim, K.U., Water Pollution in Bangladesh and its Impacts on Public Health. *Heliyon*, 2019, 5(8): e2145, https://doi.org/10.1016/j.heliyon.2019.e02145

15. Anhwange, B. A., Agbaji, E. B, and Gimba, E.C., Impacts of Assessment of Human Activities and Seasonal Variation on River Benue, within Makurdi Metropolis. *International Journal of science and Technology*, 2012, 2(5): 248-254

16. Osei A., Albert A., Hanson, E., T., and Francis O., A Comprehensive Evaluation of Surface Water Quality and Potential Health Risk Assessment of Sisa River Kumasi. *Ground water for sustainable development*, 2021, 15: 100654. https://doi.org/10.1016/j.gsd.2021.100654

17. Moore M. R., Haematological effects of lead. *Sci Total Environ*, 1988, 71: 419-31.

18. Yao, X., Xu, S.X., Yang, Y., Zhu, Z., Zhu, Z., Tao, F., and Yuan, M., Stratification of Population in NHANES 2009-2014 Based on Exposure Pattern of Lead, Cadmium, Mercury and Arsenic and their Association With Cardiovascular, Renal and Respiratory Outcomes. *Environ. Int.*, 2021, 149: 106410.

19. Ihunwo, O. C., Dibofori-Orji, A. N., Olowo, O., and Ibezim-Ezeani, M. U., Distribution and Risk Assessment of Some Heavy Metals in Surface Water Sediments and Grey Millet (Mugil Cephalus) from Contaminated Creek in Woji,

Southern Nigeria. *Mar. Pollut. Bull.*, 2021, 154(Feb): 111042

20. Ugochukwu E., Nnaemeka O. A., and Stephen U. N., An Appraisal of Data Collection, Analysis and Reporting Adopted for Quality Assessment: A Case of Nigeria Water Quality Research. *Heliyon*, 2021, 7e07950, https://doi.org/10.1016/j.heliyon.2021.e07950

21. Uchhariya, D. K., and Saksena, D.N., Study of Nutrients and Tropic Status of Tighra Reservoir, Gwalior (Madhya Pradesh), India. *Journal of natural science research*, 2012, 2(8): 97-111.

[22] Yusuf Abdulrashid and Nuraddeen Abdurrahman, “Assessment of Selected Heavy Metals in Drinking Water Consumed Within Katsina Metropolis,” *FUDMA J. Sci.*, vol. 4, no. 3, pp. 531–537, 2020, [Online]. Available: doi: https://doi.org/10.33003/fjs-2020-0403-303.

23.Y. Abdulrashid, N. Abdurrahman, K. Abdullahi, and A. Ado Shehu, “Impact of Water Treatment Processes on Selected Heavy Metals Concentrations in Drinking Water Within Katsina Metropolis,” *Int. Res. J. Sci. Technol.*, vol. 2, no. 1, pp. 336–342, 2020, doi: 10.46378/irjst.2020.020106.

24. Tyler, G., Pahlsson, A. M., Bengtason, G., Baath, E., & Trawvik, L. (1989). Heavy metal ecology and terrestrial plants, microorganisms and invertebrates. A review. Water, Air and Soil Pollution, 47, 189–215

25 Nuraddeen A., Sani M., and Jamilu I. (2017). “Comparative Study on Heavy Metal Concentration in Some Soils Samples,” vol. 6, no. 2, pp. 112–118, 2017.