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Comparative Physicochemical Analysis of Well Water Sample from Gidan Dare and Gidan Igwai Areas in Sokoto Metropolis.

Muhammad Gidado Liman* and Musa Muhammad Galadima Yusuf
(Department of Pure and Applied Chemistry, Faculty of Science, Usmanu Danfodiyo University, Sokoto Nigeria)
** Corresponding Author: gidado.liman@udusok.edu.ng*

Abstract:
Importance of safe drinking water at a time of global health challenges cannot be overemphasized. Gidan Dare and Gidan Igwai are suburb of Sokoto Metropolitan city in Nigeria and is very vulnerable to waterborne diseases. Comparative physiochemical analysis of well water samples from Gidan Dare and Gidan Igwai areas in Sokoto City were carried out. AAS, Flame Photometry as well as classical analytical methods were employed in this research. Physicochemical parameter analyzed includes; colour, temperature, odour, pH, conductivity, turbidity, total hardness, total suspended solid, total dissolved solid, chemical oxygen demand, and alkalinity. Metals such as Na, K, Pb, Cr, were also analyzed. The colour, odour, taste, are found unobjectionable. The mean values of the parameters determined from Gidan Dare and Gidan Igwai well water are (pH 7.5 and 7.8, conductivity 29.7 and 29.75 µs/cm, Turbidity 2.0 and 9.94 NTU, TSS 0.15 and 0.155mg/L, TDs 0.2 and 0.2mg/L, total hardness 77 and 65.8 mg/L, total alkalinity 82.5 and 80.5mg/L, COD 1.04 and 1.33mg/L, Na 75 and 85mg/L, K 59 and 61mg/L) respectively. The Pb mean value of Gidan Dare well water was 0.002 mg/L while that of Gidan Igwai was 0.001mg/L. The Cr mean value of Gidan Dare well water was 0.003mg/L while that of Gidan Igwai was 0.0015mg/L. All the Physicochemical parameters and metal values are within the acceptable values of WHO/NSDWQ, guidelines value for drinking water quality. However, the turbidity from Gidan Igwai which is slightly high. It may be concluded that, even though, the parameters analyzed are within the standard limits, effort shall be made by the Government to provide efficient and adequate disposal avenues in the areas and also increase awareness to the local community on Health Safety and Environmental Protection education.
***Keywords –** AAS, Flame Photometry, Gidan Dare, Gidan Igwai, Physicochemical, Well water*

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I. Introduction

Water (H_2O) is transparent fluid which forms the world streams, lake, oceans, and rain, and is the major constituent of fluids of organisms. As a chemical compound, water molecules contain one oxygen and hydrogen atom that is connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but if often co-exists on earth with its solid state, ice and gaseous, steam (water vapor). It also exists as snow, fog, dew and cloud. Ground water is the major source of drinking water 65% of human being, more than 50% of it is consumed for industrial activity and only a small proportion is used for drinking purpose (Jindal et al., 2014). Good quality of drinking water is very necessary for improving the life of people and to prevent from disease (Mohammed et al., 2013). 70% surface of earth is covered by water, majority of water available on the earth is salin in the nature, and only 3% exists as fresh water. Fresh water has become a scare commodity due to over exploitation and pollution (Ghosh and Basu, 1968; Gupta and Shukla, 2006). According to (Efe et al., 2005), it has been reported in most cities, towns and villages in Nigeria that valuable man-hour was spend on seeking and fetching water, often of doubtful quality from distance sources. About 1.1 billion people lack access to drinking water supply (WHO, 2006). Water in its pure state is acclaimed key to health and one of the most abundant and generally essential to life. Water according to (Ukpong and Okon, 2013) covers about 97% volume on earth' surface, 0.8% underground, 0.009% in inland freshwater such as lake, while 0.00009% is contained (Adobawore et al., 2017). Today human activities are constantly adding industrial, domestic and agricultural wastes to groundwater reservoir at alarming rate (Aremu et al., 2011). In the same, vein both the quality and quantity of water are affected by an increase in anthropogenic activities and any pollution either physical or chemical causes changes to the quality of the receiving water body (Aremu et al., 2011), the chemical contaminant occur in drinking water through the world which could possibly threaten human health. Determining the health effects of these contaminants is difficult, especially researching and learning how different chemical react in the body to damage cells and causes illness (Hornsby, 2009). The majority of human uses requires freshwater 97% of the water on the earth is salt water and only 3% is freshwater, slightly over two-thirds of this is frozen in glaciers and polarize caps. The remaining unfrozen fresh is found mainly as groundwater, with only a small fraction present above ground or in the air. Water naturally exist in three main sources; rain water, groundwater and surface water. Rain water is naturally the purest source of water but as it gets down it dissolves conmpound from the atmosphere. Its main components are chlorides, nitrates, sulphates, sodium, potassium and ammonia. The concentration can vary from 0.1 to 10μg/cm^3. The rain can be collected from the roofs and prepared water sheds which could assists in polluting and making it one of the most unfit source of water for drinking (Gleeson et al., 2012).

Water pollution is a global problem that needs to be solved urgently and has a significant impact on the efficiency of sustainable cities (Zhanbo et al., 2019). Rudimentary household water rations have been suggested as 50 liters per person per day apart from the water needed in the gardens (Boss, 2004). The water we drink is needed for cell function and its volume rations, any decrease in our daily water intake will affect the efficiency of cells and other body activities (Batmanghelid, 2009). In addition to water intake by humans and for health necessities, water is also needed in agriculture, industrial, recreational and other purposes. In most religions, water is considered a purifier and makes life unique (Foel and Nennemen, 1986).

The major consequences of water pollution in Nigeria communities are socio-economic, health and environmental problem on one side, the government is experiencing terrible and devastating cost inconsistencies, polluted water containing sediments and parasites is very expansive to be treated to the desired standard for any household or even industrial application. This can also be coupled with the financial implication of eradicating the associated disease (Galadima et al., 2011). Indiscriminate disposal and dumping of water has become a common practice in Nigerian cities. Most of the waste dumps are located close to residential areas, markets, farms, roadsides and creek. The composition of the water dump varies widely with human activities located close to dump side (Musa and Akpokerie et al., 2013).

According to (Galadima et al., 2011) lack of efficient law-enforcement instruction has significantly resulted to wasted disposal into fish water ways by sellers of different food and cosmetic in our market. This could be fully addressed by improving awareness and ensuring total compliance with the applied law and practices. Prosecution of defaulter would be very important here. Waste food materials, papers, decaying vegetables and plastics should not be thrown in the open or underground drains. Also effluents with high organic content and slurries from distilleries and industries should be sent to biogas plant for generation of energy (Zhanbo et al., 2019). Similarly, sewage should be treated before it is discharged into the river or oceans; this is possible through the uses of modern technologies (Akinwole, 2016). Adequate finding and proper health education in all communities in Nigeria are necessary. The current state of the system, involving very few "Community Health Extension Worker (CHEW)" per locality should be fully funded and enhanced by ensuring that many youth enrolled into the community health studies. This could be achieved by standardizing school of health technologies, nursing and universities at large (Evelyn and Tyau, 2013).

In many developing countries including Nigeria, clean pipe borne water availability is limited and inadequate for the teeming population. Thus, an increasing number of people in semi-urban areas in the country depend on dug walls and water vendors for water supply (Idowu et al., 2011).

Also around the world, groundwater makes a critical contribution to progressive realization of the human right to water. In developing country context where 2.1 billion people still lack access to safety managed water and 844million lack even basic water (WHO/UNICEF, 2017). Development of groundwater is considered a key strategy for addressing gaps in service delivery (Velis et al., 2017) and for building residence to the impacts of climate change (Velis et al., 2017 and Howard et al., 2016). Groundwater is already the preferred source of drinking water globally (Guppy et al., 2018), often considered more reliable than surface water and more accessible, given it can be directly exploited by users (Margat et al., 2013). However, data on actual use is lacking with knowledge gaps evident across local regional and global scales (Giordano, 2009). However, surface water is water in rivers, lakes or freshwater wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapo-transpiration and groundwater recharge. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors (Gleeson et al., 2012). These factor include storage capacity in lake, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water loss, human activities can have a large and sometimes devastating impact on these factors. Human often increase storage capacity by constructing reservoirs and decrease it by draining wetland, human often increase runoff quantities and velocities by paving areas and channeling stream flow. Water can dissolve many different substance giving it different taste and colour (Niemi and Itelicise, 1990). Many attempts were made in order to overcome water pollution challenges via different methods. Among the methods employed were Photocatalysis.

Synthesis of ZnO nanoparticles via two routes and under different conditions was reported by Liman et al. (2014) and Liman et al. (2018).. The synthetic methods adopted were sol-gel and a combined sol-gel and hydrothermal methods. Two different surfactants, namely, ethylene glycol and polyethelene glycol were used. Different calcination temperature and time were considered. The ZnO nanoparticle was further modified with cobalt nitrate hexahydrate with different dopant concentration and the ZnO produced was characterized and utilized in investigating the photocatalytic degradation of nitrobenzene under different operational conditions. The results obtained revealed a successful development of ZnO Photocatalyst Nanocatalyst capable of degrading Nitrobenze, a persistent organic pollutant with up to 91.34% percentage removal (Liman et al., 2014 and Liman et al., 2018).

II. Experimental

Materials

Apparatus/Instrument and Laboratory reagents/chemical used in the research are shown in Tables 1 and 2.

Table 1: List of Apparatus/Instrument used

Apparatus	Type	Manufacturer
Turbidity meter		HACH U.S.A
pH meter	Glass	Camplap Limited, England
Conductivity meter		Camlap Limited, England
Weighing balance		England
Atomic absorption	Metal	Atico Medical
Spectrophotometer (AAS)		PVT Ltd, U.K
Flame Photometer		Callen Kamp England
Water bath		England

Table 2 Chemical Used in the Research

Reagents	Formula	Grade	Manufacturer
Hydrochloric acid	HCl	A.R	BDH chemical England
Methyl orange	$C_{14}H_{14}N_3O_7N_a$	A.R	BDH Chemical England
Erichrome black T	$C_{20}H_{12}N_3N_aO_3S$	A.R	BDH Chemical England
EDTA	$C_{10}H_{16}N_2O_8$	A.R	BDH Chemical England
Sodium thiosulphate	$Na_2S_2O_3$	A.R	BDH Chemical England
Potassium permanganate	$KMnO_4$	A.R	BDH Chemical England
Nitric acid	HNO_3	A.R	BDH Chemical England
Potassium Iodide	Kl	A.R	BDH Chemical England
Ammonia Buffer	NH_4Cl		M & B
Sodium Hydroxide	NH4OH		M & B

Keywords
A.R = Analytical Reagent
BDH = British Drug House
M & B = May and Baker

Method of Collection of Water Samples

Water samples were collected from four different wells at various locations in Gidan Dare and Gidan Igwai areas in Sokoto Metropolis. Each sample was collected using a clear two litre plastic containing with a screw cap which was thoroughly washed with detergent soaked with acid and raised with deionised water. At the point of collection, the container was rinse three times with the water sample.

Preparation of Reagents

1. Ethylene Diamine Tetracetate (0.01m)

Small amount (0.4 g) of EDTA was measured and dissolved in 40 cm^3 of deionized water in a volumetric flask.

2. To prepare 0.02 M HCl

Small volume (10 cm^3) of HCl was measured and dissolved in 250cm^3 of deionized water.

3. Erichrome black T indicator

Small quantity (0.5 g of Erichrome black T was dissolved in 100 cm^3 of Triethanolamine.

4. To prepare 0.0125M $kmn0_4$

Small quantity (1.25 g) of $KMn0_4$ was dissolved in 100 cm^3 of deionized water

5. To prepare 0.0125M$Na_2S_2O_3$

Small quantity (1.25 g) of $Na_2S_2O_3$ was dissolved in 100cm^3 deionized water.

6. Methyl orange indicator 0.10%

Small quantity (0.12 g) of methyl orange was deionized in 100cm^3 distilled water.

7. To prepare of NH_4Cl

Appreciable quantity 16.9g of ammonium chloride and 1.25g of magnesium salt of EDTA was dissolved in 143cm^3 concentration ammonium hydroxide and diluted to 250cm^3 deionized water.

8. Potassium dichromate 5%

Five percent (5 %) of K_2CrO_4 was dissolved in 100cm^3 of deionized water and the volume was adjusted to 100cm.

Procedures for the Physicochemical Determination

The pH was determined using pH meter, temperature using Mercury thermometer, conductivity using conductivity meter, Turbidity using turbidity meter, total dissolve solid (TDS), and total suspended solid (TSS) by gravimetric method, Alkalinity, Acidity, total hardness and chemical oxygen demand (COD) using titrimetric method, sodium and potassium using flame photometer and other metals by (AAS) machine.

Analysis of the water samples were carried out in two categories:-

Physical Analysis

Determination of odour, colour and taste are usually tested during sampling. Odour test and colour strength are all donated to be sensory examination. For odour, the test involves smelling of the sample. The corresponding colour tone can also be given. For taste, is only carried out when it is certain that no infectious bacteria or polluting substance are present.

Determination of pH

This is done by instrumental analysis. The pH electrode machine was switched on, 50cm^3 of test sample was measured into the 100cm^3 beaker, the cell electrode was then calibrated with buffer solution 4,7 and 9 to sanitize it with acid, basic and neutral condition. The cell was wiped with tissue paper and rinse with distilled water. The meter was pressed on and the electrode was immersed in the sample and pH value was read from the meter screen.

Determination of turbidity

The 10cm^3 of water sample was measure in a 10cm^3 turbidity meter bottle, the bottle was cover and lid from the meter was open. The bottle was placed in a compartment and covered, read was pressed and result was display.

Determination of conductivity

The conductivity machine was switched on, 50cm^3 of the sample of the sample was measured in 100cm^3 of beaker, the cell electrode was then calibrated and dipped in to the container of the sample, and a stable reading was obtained and recorded.

Chemical analysis

Determination of total hardness

Fifty (50) cm^3 of water sample was measured in a 125cm^3 flask, 2cm^3 of buffer solution was added and small quality of Erichrome Black T indicator which gives red colour. The mixture was titrated with 0.01M EDTA slowly with stirring continuously and the colour change from red to blue.

The total hardness can be calculated by the formula below.

Total Hardness = A x D x 100

Ml of Sample $\times 1000$

Where a = volume of titrant used

D = mg $CaCo_3$ Equivalent to 1ml – EDTA used.

Determination of total alkalinity

Fifty (50) cm^3 of the water sample was measured and poured into the conical flask 0.5cm^3 of Bromocesol indicator was added in which he mixture turns to brilliant green. The mixture was titrated against a standard 0.02M H_2SO_4 until a brilliant green colour turns to pink and value was recorded. Total alkalinity can be calculated by the relation below.

Total alkalinity = A x N

Ml of sample

Where A = volume of acid used

N= molarity of acid used (0.02M)

$\times 50,000$

Determination of total Dissolve Solid (TDS)

Twenty Five (25) cm^3 of water sample was filled in 3 sample cell and another sample cell was filled with distilled water for the blank test. Before the analysis of the entire 3 sample, the distilled water was inserted to carry out blank analysis, after which we inserted the water sample to measure the turbidity of the sample.

Determination of Suspended Solid (TSS)

Hundred (100) cm^3 clear evaporating dishes was placed in an oven for 1hour at 105^0c it was removed and placed in to desiccator to cool and then weight. $50cm^3$ of water was measured and poured into the dishes. The dishes was the placed into an oven at 150^0c for two hours, it was then removed and cooled in the desiccator and weight, it was then returned in to the oven for 10minute and remove again, cooled in the desiccator and reweight, the processes will be repeated until the weight actual is obtained

$$\text{Total suspended solid} = \frac{Y - X}{\text{ml of sample}} \times 10^6$$

Determination of Chemical Oxygen Demand (COD)

Two Hundred and Fifty (250) cm^3 of well water sample was warmed to 27^0c and transferred to cleaned flask, $10cm^3$ $KMnO_4$ 0.012ml was added and 10ml was added and 10ml of 20% V/V H_2S0_4 was also added. It was mixed gently and incubated at 27^0c for 4hours, the mixture was examined at interval. Where the pink colour of permanganate tend to disappear, $10cm_3$ $KMnO_4$ was added after 4hours.

Ml of Kl solution was added and titrated with 0.0125M $Na_2S_20_3$ using strand as indicator, until the blue colour just disappears.

The C.O.D can be calculated by the relation below

$$\text{C.O.D} = \frac{\text{ml of sample required} - \text{ml of blank} \times 100}{\text{A} \times \text{volume of sample used}}$$

Where A = Total volume of $KMnO_4$ 0.0125 added to sample.

Determination of Sodium

The filter of the flame photometer was set at 768nm (marked for potassium, K) the flame was adjusted for blue colour. The scale was set to zero and maximum using the highest standard value. A standard curve of different concentration was prepared by feeding the standard solution.

The sample was filtered using filter paper and fed into flan photometer, and the value was read directly from the machined.

Determination of Potassium

The filter of the flame photometer was set at 589nm (marked for sodium, Na). by feeding distilled water the scale was set to zero and maximum using the highest standard value. A standard curve between concentration and emission is prepared by feeding the standard solution. The sample was filtered using filter paper and fed into flame photometer, and the value was read directly from the machined.

Determination of Metals

Metals were analyzed using atomic absorption spectroscopy. The water sample was prepared for the analysis by digesting it with $10cm^3$ concentrated nitric acid (NHO_3). $50cm^3$ of the water sample was measured and poured into a $250cm^3$ conical flask. The sample mixture was subjected to heat using a hot water bath where it was allowed to stay for about 30minutes. The water sample was removed and allowed to cool. The water was filtrate using filter paper. Distilled water was added to the filtrate water to a $50cm^3$ contain and then submitted for A.A.S analysis. Where different hollow cathode lamps were used to determined different material present. The result collected was then interpreted and record.

III. Results and Discussion

Results

The physicochemical analysis result of the four samples carried out are presented in the tables (3 and 4) below.

Table 3: Result of the analysis carried out on Gidan Dare well water.

S/N	Parameter	Gidan Dare 1	Gidan Dare 2	Mean value
1.	Taste	Tasteless	Tasteless	
2.	Colour	Colourless	Colourless	
3.	pH	7.4	7.6	7.5
4.	Conductivity Ns/cm	29.7	29.7	29.7
5.	Turbidity (NTU)	2.15	1.99	2.07
6.	Total hardness mg/L	79	75	77
7.	Alkalinity mg/L	84	81	82.5
8.	Total suspended solid mg/L	0.21	0.09	0.15
9.	Total dissolved solid mg/L	0.1	0.3	0.2
10.	C.O.D mg/L	1.02	1.06	1.04
11.	Na mg/L	79	71	75
12.	K mg/L	60	58	59
13.	Pb mg/L	ND	0.002	0.002
14.	Cr mg/L	ND	0.003	0.003

Table 4: Result of the analysis carried out on Gidan Igwai well water

S/N	Parameter	Gidan Igwai 1	Gidan Igwai 2	Mean value
1.	Taste	Tasteless	Tasteless	
2.	Colour	Colourless	Colourless	
3.	pH	8.1	7.6	7.85
4.	Conductivity Ns/cm	29.8	29.7	29.75
5.	Turbidity (NTU)	9.89	9.99	9.94
6.	Total hardness mg/L	68	63	65.5
7.	Alkalinity mg/L	81	80	80.5
8.	Total suspended solid mg/L	0.3	0.01	0.155
9.	Total dissolved solid mg/L	0.2	0.2	0.2
10.	C.O.D mg/L	1.36	1.3	1.33
11.	Na mg/L	81	87	87
12.	K mg/L	62	60	61
13.	Pb mg/L	0.001	ND	0.001
14.	Cr mg/L	0.002	0.001	0.0015

IV. Discussion

Colour, Odour and taste

All the well water samples are clear with unobjectionable taste and odour as prescribed by WHO.

P^H

P^H is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the water are slightly alkaline, the pH mean values of Gidan dare well water was 7.5 and that of Gidan Igwai was 7.85 and the values were found within the limit prescribed by WHO, (Adefemi and Asaolu, 2007) reported similar result of pH range of 5.90-7.60 on their study of some surface and ground water resources in Ile-Ife. Most treatment of drinking water are done with Alum, calcium hypochlorite and line (Zhanbo et al., 2019).

Conductivity (Ec)

Electrical conductivity is a measure of water capacity to convey electric current. It signifies the amount of total dissolve salt (Vaclavik et al., 2007). Electrical conductivity mean values of gidan dare well water was 29.7µs/cm while that of Gidan igwai was 29.75µs/cm, in which the water from gidan igwai are slightly in high conductivity than gidan dare. The electrical conductivity value was found within the limit prescribed by WHO (2004).

Turbidity (T)

Turbidity was measured using turbidity meter, the value was found within the limit prescribed by WHO as (5UTN). The mean value of Gidan dare well was found as 2.07NTU is within the limit prescribed by WHO (2008) and that of Gidan igwai 9.94NTU was found slightly high than the value prescribed by (WHO, 2008).

Total Hardness (TH)

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water manily depends upon the amount of calcium or magnesium salts or both. The mean value of total hardness of Gidan dare well water was 77mg/L while that of gidan igwai was 65.5mg/L. The value obtained was found within the limit prescribed by (WHO, 2008), in which the water from Gidan dare are harder than those from Gidan Igwai. The total concentration of divalent metal ion (primarily Ca and Mg) expressed in mg/L is term as total hardness (Asaolu, 2007). Hence, on the average, Gidan dare and Gidan Igwai well water can be said to be soft and assess good for domestic uses like washing clothes, cooking, drinking.

Total alkalinity (TA)

Alkalinity of water is its capacity of neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. The mean value of total alkalinity of Gidan dare well water was 82.5mg/L while that of Gidan Igwai is 80.5mg/L with much difference. This values was found within the limit prescribed by WHO/NSDWQ.

Total suspended solid (TSS)

Total suspended solid are solid material including organic and inorganic, that are suspended in the water. Sources of total suspended solid include erosion from urban runoff and agricultural, industrial waste, bank erosion , algae growth waste water discharge. All this can lead to increase the TSS as well as TDS (Gbamanja, 1998) increased level of suspended solids results in increased turbidity and lower photosynthesis. Rise in water temperature and decrease in dissolved oxygen (Sharma et al., 2008).

This TSS mean value of gidan dare well water was 0.15mg/L while that of GIdan igwai was 0.155 or 0.16, the value obtained was found within the limit prescribed by (WHO, 2004).

Total dissolved solids (TDS)

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500mg/L is also allowed (Ukpong and Abaraogu, 2004). The TDS mean values of well water from gidan dare was 0.2mg/L while that of gidan igwai is 0.2mg/L. the permissible limit prescribed by (WHO, 2003) is 500mg/L, are close to the mean values recorded for Ekiti dam water (Adefemi et al., 2001).

Chemical oxygen demand (COD)

Chemical oxygen demand (COD) is a measures of pollution in aquatic system. High COD may cause oxygen depletion on account of decomposition by Microbes (Kumar et al., 2014), to level detrimental to aquatic life. In the present study, chemical oxygen demand mean values of gidan dare well water was 1.04mg/L while that of gidan igwai was 1.33mg/L, the values obtained was found within the limit prescribed by (WHO, 2006).

Sodium and Potassium (Na and K)

The mean values of sodium and potassium obtained from gidan dare and gidan igwai well water were 75mg/L to 59mg/L and 84mg/L to 61mg/L respectively. These values were also within the (WHO, 2008) recommended limit for drinking water.

Lead (Pb)

Lead was detected in all samples except in Gidan dare 1 and Gidan Igwai 2 of the well water sample. The values obtained for lead range from Gidan dare was 0.002 and that of Gidan Igwai was 0.001mg/L values obtained for lead were found within the recommended limits by (WHO, 2004). Excess concentration of lead causes damage to nervous system, and causes brain disorder, excessive lead also causes blood disorders in mammals.

Chromium (Cr)

Chromium was detected in all samples except in gidan dare 1, the concentration of chromium range from 0.003mg/L of gidan dare while the mean value from gidan igwai was 0.0015mg/L, the values was found within permissible prescribed by WHO/NSDWQ. Similar result was reported in sediment of major dams in Ekiti state (Adefemi et al., 2007).

V. Conclusion:

The physicochemical analysis of well water samples collected from Gidan Dare and Gidan Igwai areas of Sokoto Metropolis were found to be within the acceptable limits of the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ). However, based on the rapid expansion of the areas (as suburb of Sokoto city) and poor drainage systems and poor waste disposal methods there is the need for constant routine analysis to ensure safety and non-contamination of the wells.

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