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ANALYSIS OF PHYSICOCHEMICAL PARAMETERS OF SELECTED OPEN-WELLS IN SOUTHERN SENATORIAL ZONE OF KADUNA STATE, NIGERIA

Saidu, M. A. and Gimba, B. E.

Geography Department, Kaduna State College of Education, Gidan Waya, Kaduna State, Nigeria

Corresponding Author Email: gimbabulus@yahoo.com

ABSTRACT
This research is aimed at determining the physicochemical parameters of wells in southern Kaduna. In order to help the people of the study area to understand how to use these wells sustainably, and also to provide information to organizations like WHO, UNICEF and UNDP that are concerned with water quality in improving and monitoring performance to enable better planning and management at the national level. This was achieved by determining, physical and chemical characteristics of the wells water. The samples were taken from five Local Governments in the area using a base map. The water samples were collected using American Standard procedure of sample water collection. The laboratory analysis revealed a significant level of chemical contamination as well as differences in the concentration level of the physical and chemical parameters of the samples within the study area and the World Health Organization Standard of 2014. pH, electrical conductivity, total dissolved solid, total hardness, alkalinity and chloride were within the permissible level of the World Health Organization 2014 while salinity, turbidity suspended solid were above the permissible level of WHO 2O14 in some samples. Therefore proper waste disposal, treatment of the contaminated water, proper sitting of wells and public enlightenment were recommended.

Keywords: Water Quality, WHO, Physicochemical, Concentration, Contamination, Open-wells

INTRODUCTION

The importance of water in the control of diseases had long been recognized (Dan-Azumi and Bichi 2010; WHO, 2011). Water is a factor of production in virtually all enterprise, including agriculture, industry and the services sector (UNESCO, 2006). The importance of safe drinking water is underlined by the assertion that: "safe drinking water is the birthright of all humankind – as much as clean air" Third World Academy of Sciences [TWAS] 2002). The documents also reported that the majority of the world's population, especially in most parts of Africa and Asia, does not have access to safe drinking water and that as much as 6 million children dies daily as a result of waterborne diseases which is linked to scarcity of safe drinking water or sanitation (TWAS, 2002). WHO (2011) pointed out that diseases related to contamination of drinking-water constitute a major burden on human health and that interventions to improve the quality of drinking-water provide significant benefits to health.

Water quality is a term used here to express the suitability of water to sustain various uses or processes. Any particular use will have certain requirements for the physical, chemical or biological characteristics of water. The physicochemical quality of most drinking water in many rural areas in Sub-Sahara Africa is worrisome. Interestingly, water-borne diseases like typhoid fever, amoebic and bacillary dysentery, cholera, and diarrhoea as well as food and equipment damages were cause by bacteria's (Emmanuel and Adepeju, 2015; Amadi et al., 2012).

Many countries all over the world have their own regulations and quality standards for drinking water due to the fact that water quality is a matter of regional interest. The primary prerequisite to good health is an adequate supply of safe drinking water that is of a good sanitary quality. Supply of clean and treated drinking water is one of the challenges faced by many developing countries. Due to increase in population and industrialization, provision of pipe borne water by government becomes inadequate and private individuals had to drill boreholes or dug wells to take care of their water needs. Well water became less expensive, dependable and most common (Ayotte, Focazio and Eberts, 2011).

A well is an excavation or structure created in the ground by digging, driving, boring, or drilling to access groundwater in underground aquifers. The well water is drawn by a pump or using containers, such as buckets, that are raised mechanically or by hand (Marios, 2002). Wells can vary greatly in depth, water volume, and water quality. Well water typically contains more minerals in solution than surface water and may require treatment to soften the water (Al-kasim, 2011).

Wells have low operational and maintenance costs, in part because water can be extracted by hand bailing, without a pump. The water is often coming from an aquifer or groundwater, and can be easily deepened, which may be necessary if the ground water level drops. The yield of existing hand-dug wells may be improved by deepening or introducing vertical tunnels or perforated pipes (Sangodoyin, 1991).

Groundwater has been recognized as playing a very important role in the development of our rural populace as most dwellers depend solely on water from hand dug wells and boreholes for their daily needs. Its quality is related to several factors including geology, climate, and land use. Many naturally occurring chemicals in groundwater come from dissolving rocks,soil, and decaying plant materials (Egharevba, Amadi, Olasehinde and Okoye 2010).

Well water can be contaminated; human activities can increase the concentration of naturally occurring substances like salts, minerals, and nitrate. Poor well construction or placement close to a potential source of contamination can affect domestic well water quality (Hassan and Tavir, 2008). Other compounds, such as pesticides and Volatile Organic Compounds (VOCs), do not occur naturally in the environment. These substances can enter well water through spills, irrigation, wastewater percolation fields, septic systems, animal facilities, leaking underground fuel storage tanks, and other sources (Morris 2002).

Patil and Patil (2010) examined water from a large number of wells of Amalner town in Jalgaon district Maharshta India for different chemical parameters and found contamination in a majority of the cases, caused by influx of industrial and domestic waste water. Rajana (2009) studied drinking water of Dudu town in Rajasthan India at and around Vijapur district and discovered that most of the drinking water quality varies based on their sources. Jinwal and Dixit (2008) studied the physicochemical parameters of ground water of Bhopal city in India and observed high concentration in turbidity, Phosphate and Sulphate in bore-well waters of the city.

El-Rayis & Abdallah (2006) made a study on huge Egyptian drain in Egypt and observed high iron, magnesium, fluoride and nitrate present in Water, also in Ethiopia the levels of Cd, Cr and Zn in well water exceeding recommended limits was attributed to soil type and Geology around Akaki region, which is polluted with untreated sewage and industrial effluent (Prabu, 2009). Contamination of well water around Iture Estuary in Ghana with Pb and Cd has been attributed to waste carried by the Sorowie and Kakum Rivers, which flow through a rapidly industrialized central region (Fianko *et al*., 2007).

In Nigeria Hussein, Adeniyi,Omollo and Bhekumusa (2012) studied the Physicochemical Parameters of selected wells in Ilorin town they discovered that, the values obtained in all the sampling sites are well below the limit set standard by World Health Organization (WHO). Aminu and Amadi (2014) studied the Bacteriological Contamination of Groundwater from Zango in Katsina State their studied revealed the evidence of total coliform and faecal coliform counts contamination in all the shallow hand dug wells in the study area. This was linked to the poor sanitary situation in the area and the proximity of the hand dug wells to the pit-latrines/soakaways and dumpsites in the area.

Ugya, Umar and Yusuf (2015) assess well water quality in Kaduna South Local Government Area and discovered that, all the water samples were found to be heavily polluted with respect to iron and magnesium; attributed this to land use practices around the wells. Also Gimba, (2002) analyse the quality of open well water in Zango Kataf Local Government Area in Southern part of Kaduna and observed that, the concentration of magnesium (mg), Chloride (cl_2), Calcium (ca) and Nitrate (N) were 16mg/l, 21.99mg/l, 12.0mg/l, and7.2mg/l respectively are below the WHO 1997 standard for drinking water. This was attributed to the good hygiene condition around the wells. Also Dogonyaro (2018) investigate the quality of drinking water from different sources in Jama'a Local Government Area in Southern part of Kaduna State. The studies revealed that, wells water which are the major source of water for domestic uses in the study area, are within the permissible limit of Standard Organization of Nigeria (SON) 201.

In general, the importance of groundwater for existence of human society cannot be over emphasised. Hence, there is always a need for the protection and management of groundwater quality. With respect to the above mentioned groundwater quality, this study aims at carrying out qualitative analysis of physicochemical Parameters of selected wells in Southern Kaduna Senatorial Zone.

STUDY AREA

The study area is situated approximately between Latitude 9º 08′ N and 10º 04′ N and Longitude 7º 15′ E and 7º 50′ E (Abaje and Giwa 2007). It is bounded in the North by Kajuru and Chikun L.G.As in the South it is bounded by the Federal capital Territory (FCT) and Nassarawa State. In the west, it is bounded by Niger State in the East it is bounded by Lere and Kubau Local Government while at the Southeast it is bounded by Plateau State (see fig.1.).

Southern Kaduna has a population of 2.3 million (National Population Commision (NPC) 2006) and consist of eight Local Governments namely; Jema'a, Jaba, Kauru, Kaura, Zango-Kataf, Kagarko, Kachia and Sanga. Adara, Bajju, Ham, Atyap, Oegworok and Anghan are the majority tribal groups in the region (Ishaya and Abaje 2008). The area has two distinct seasons according to koppen classification, is found under AW climate types. The dry season lasts from November to Mid-April while the rainy season, starts from mid-April and reach its peak in August and end in October. The mean annual rainfall within the region ranges between 1,800- 2,000mm, with Kagoro, Kafanchan and Gidan-Waya having the highest amount due to high relief an extension of Jos Plateau. The mean monthly temperature is about 25ºC while the relative humidity is about 62% during the rainy season (Abaje and Giwa 2007).

The Region extends from the tropical grassland vegetation known as the Guinea Savannah at the extreme South to Sudan Savannah toward the North. The vegetation is thick and the grasses are about 3.6 meters tall with big trees, which grow shorter as one approaches the Sudan Savannah. River Kaduna is the major river that flows through southern Kaduna and has its source in the highlands around the Jos Plateau. It is however fed by many tributaries and in turn runs into River Niger. (Abaje, Achiebo, and Matazu, 2018).

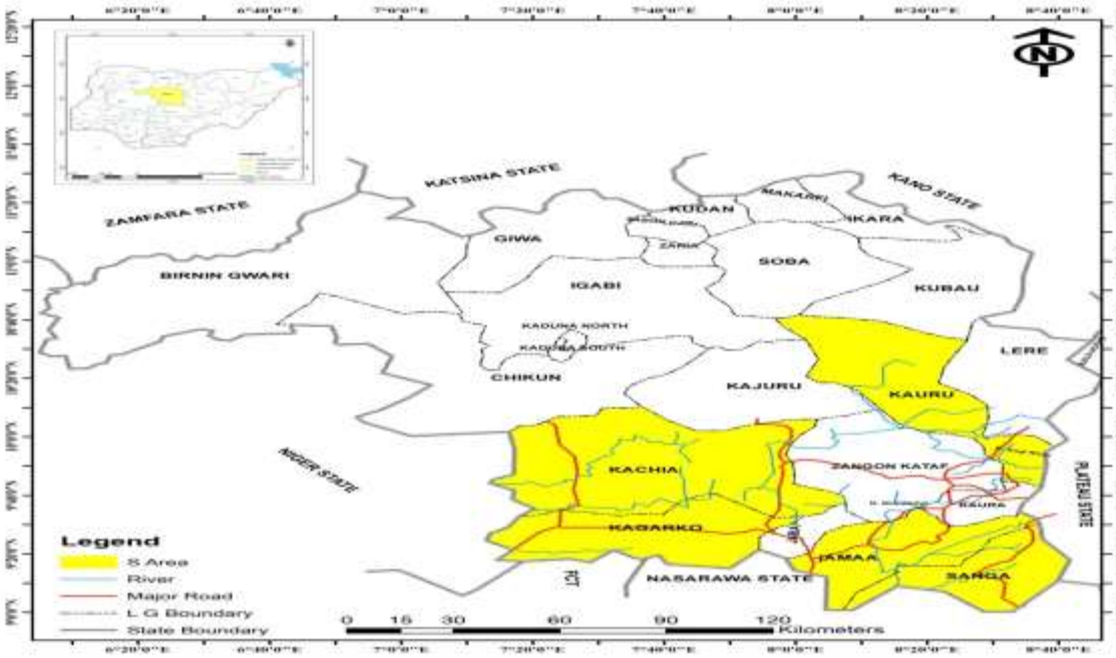

Fig. 1. Study Area
Source: Adopted from Google earth map 2018

MATERIALS AND METHODS

Selection of the Sampling Sites

The map of the study area was obtained and used to select five Local Government Areas each from the North, South, East, West and the central part of the study area namely Kauru, Kagarko, Sanga, Kachia and Jama'a respectively to ensure that, the study area was properly covered. Abbreviations were used to represent the local Governments above as follows Kauru was represented by KR, Kagarko by KG, while Sanga, Kachia and Jama'a were represented by SG, KC and JM respectively (Fig. 2.). The samples were collected along the major road due to accessibility and security purpose.

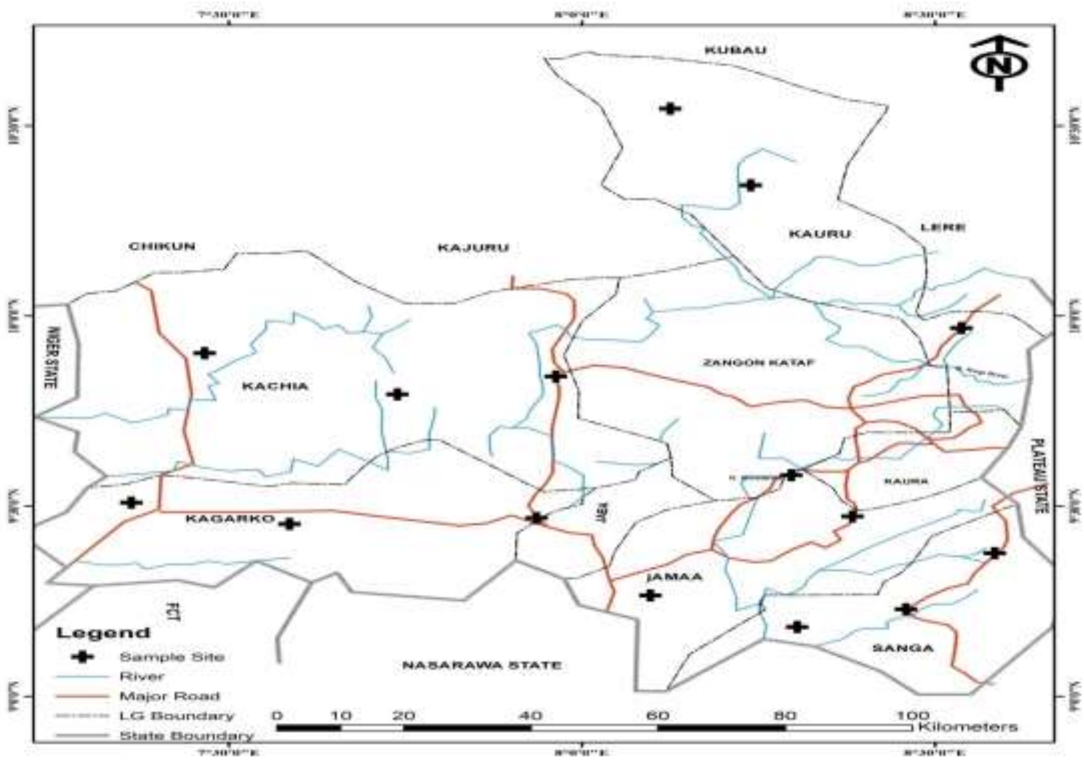

Fig. 2: Sampling site
Source: Adopted from Google Earth Map 2018

Sampling of Well Water

The water samples were taken at the peak of the dry season in March as this mark the period of maximum utilization or dependency on well water in the area. Open dug well were involved in the study and three wells were selected from each local Government Area due to financial constraint. Fifteen (15) samples were collected one from each well, and they were used for physicochemical analysis.

A strong thread was attached to the neck of each sterile bottle and gently released into the well; the opened bottle was allowed to sink below the water and was pulled up after observing there were no more bubbles from the bottle. The bottle was gently raised out of the well without allowing bottle to touch the sides of the wells. The caps were carefully replaced and the samples were transported in ice bag to the laboratory for analysis.

Samples Laboratory Analysis

The analytic methods adopted were based on international acceptable methods and analytical application principles. Even though various kinds of instrument by different manufacturers were use in the course of analysis of the samples, the principles employed were all based on approved standard methods. The summary procedure used for testing each parameter is given below:

Colour: Colour measure was carrying out using Lovibond Computer with calibrated colour disc. A cell was filled to the mark with distilled water and placed in the left sample position on the comparator. In addition, a second cell was filled with water sample to the mark and placed in the right sample position. The colour disc was placed and rotated to match the colour with the sample. The figure on the disc was recorded as colour of the sample.

pH: This was measured using electromagnetic method. The pH meter was warm for 3 minutes. The electrode was removed, rinsed with fresh distilled water and wiped with soft tissue. The pH meter was calibrated using the pH 4, 7, and 10 Calibration Standard Solution. The water electrode was then rinse with sample to be measured and inserted into the sample, switched "ON" pH knob and the temperature reading taken on the scale. The electrode was rinsed again with distilled water and stored immersed in the distilled water.

Electrical Conductivity and Total Dissolved Solids (EC and TDS): These were determined using Wagtech WE30120 Conductivity/TDS meter. The analyses were conducted by submerging the probe into the water sample in a plastic beaker to minimize any electromagnetic interference, stirred once and reading allowed to stabilize. Calibration of the EC/TDS meter was conducted on daily basis using compactable EC standard solution (12.88ms/cm).

Temperature: This was measured by using the EC/TDS meter, because the EC value automatically compensated for temperature.

Turbidity: This was measured using Wagtech WE30140 Potalab Turbidity meter. The turbidity measurement was conducted by placing the meter on a flat surface, filling a clean sample vial to mark, placing in a sample well and covering the vial with light shield cap. The display reading was recorded as sample turbidity. Calibration of turbidity meter was conducted on daily basis using cal. 1: 800NTU; followed by cal. 2: 100NTU; then cal. 3: 20NTU and; finally cal 4: 0.02NTU standards.

Total Alkalinity: It was measured by titrating 100ml sample using 0.01mol dm^{-3} of H_2SO_4, phenolphthalein indicator, methyl orange indicator and pH meter at the end of pH of 4.5 and the amount was computed by calculation as follows:

Total Alkalinity as mg/L $CaCO_3$ = Titre value/Vol. of sample used x 1000

Total Hardness: was measured by complexometric titration of 100ml sample using 0.01 mol dm^{-3}disodium slat of ethylene diamine tetra acetic acid (EDTA) in the presence of Eriochrome Black T. At the titration endpoint colour changes from wine-red to bluish green and the total hardness content was computed by calculation as follows:

Total Hardness as mg/L CaCO3 = Titre x A/ Vol. of sample used x 1000

Where:-

A = $CaCO_3$ equivalent to 1.00mLof EDTA titrate

Chloride: It was measured by argentometric titration of 100ml sample using 0.141mol dm^{-3} silver nitrate ($AgNO_3$) in the presence of 1ml Potassium Chromate indicator (K_2CrO_4), at pH of 7-8. At the endpoint titration colour changes from yellow to pinkish-yellow and the chloride concentration was computed by calculation as follows:

mg /L Chloride = (A-B) x N/Vol. of sample used x 35, 450

Where:-

A = sample titrate value; B = Blank titrate and N = 0.0141

RESULTS

The results of the data analyzed are presented in tables and figures. These were used in order to characterized the physical and chemical characteristics of the wells waters, using the statistical measures of mean, standard deviation and co-efficient of variability. These values are summarized in tables. Total Suspended Solid is having the highest concentration throughout the study area Figure 3 revealed that it is, as high as 520mg/l at location SGA (Ungwan Isa) followed by 490mg/l at location JMA(Gidan-Waya) in Sanga and Jama,a Local Government Area respectively, while pH and turbidity are the least in concentration as pH value is below 4.3 at location KCA (Mazuga) while turbidity is lower than 2.3 at Location KGB (Kushamfa) at Kagarko Local Government Area. Akoteyon and Soladoye (2011), Manhata, Sarkar, Singh, Saikia and Paul, (2004) used multivariate analysis to assess the groundwater quality of Eti-Osa in Lagos Nigeria. The result revealed that Groundwater is not free from Physicochemical and Microbial contamination and they attributed it with geological and environmental influences.

Table 1: Physical Characteristics of the selected wells

S/N	LGA	LOCATION	POSITION	PH	TEMP (^{0}C)	COLOUR (H_Z)	ELETRICAL CONDUCTIVITY (µs/cm)	TOTAL Disolved solid (mg/l)	Turbidity (NTU)	TOTAL SUSPENDED SOLID(mg/l)
	SANGA	SGA	Lat.9^{0}24' 24'' Long.8^{0}34'31''	4.9	23.0	240	83.7	41.8	83	490
		SGB	Lat.9^{0}25'38'' Long.8^{0}33'51''	4.6	21.0	110	24.0	11.7	38	225
		SGC	Lat.9^{0}28'4'' Long.8^{0}34'5''	5.6	21.2	110	85.3	42.6	38	225
	KAURU	KRA	Lat.9^{0}58'5'' Long. 8^{0}32.14''	5.9	21.1	18	130.5	66.1	3.2	19.4
		KRB	Lat.9^{0}55' Long.8^0 30'33''	4.9	20.8	18	18.68	9.41	6.1	36.9
		KRC	Lat.9^{0}53'14'' Long.8^{0}29'33''	5.0	21.9	25	39.2	20.0	8.2	52
	KACHIA	KCA	Lat.9^{0}52'20'' Long.8^{0}02'4''	4.2	22.4	19	21.0	10.2	6.7	37
		KCB	Lat.9^{0}50'28'' Long.7^{0}57'47''	6.0	22.6	9	22.4	112	3	18
		KCC	Lat.9^{0}40'43'' Long.7^{0}57'05''	5.6	20.4	120	47.6	23.3	43	255
	KAGARKO	KGA	Lat.9^{0}32'51'' Long.7^{0}55'28''	4.5	21.8	60	14.29	7.20	20	110
		KGB	Lat.9^{0}28'17'' Long.7^{0}54'22''	5.3	20.9	7	99.9	49.9	2.2	13.8
		KGC	Lat.9^{0}28'07'' Long.7056'09''	6.2	21.2	75	190.1	94.2	26	150
	JAMA'A	JMA	Lat.9^{0}28'30'' Long.8^{0}29'57''	4.7	20.7	19	25.9	12.6	6.2	37.5
		JMB	Lat.9^{0}28'23'' Long. 8^{0}22'59''	5.0	20.7	261	95.2	48.0	88	520
		JMC	Lat.9^{0}36'50'' Long.8^{0}18'56''	5.4	22.3	16	117.5	58.5	5.7	31

Source: Author's fieldwork 2018.

Table 2: Chemical Characteristics of the selected wells

S/N	L.G.A	LACATION	POSITION	TOTAL HARDNESS (mg/l)	ALKALINITY (mg/l)	CHLORIDE (mg/l)	Salinity (mg/l)
1	SANGA	SGA	Lat.9^{0}24' 24'' Long.8^{0}34'31''	33	261	12.75	21.03
2		SGB	Lat.9^{0}25'38'' Long.8^{0}33'51''	5	140	13.75	22.68
3		SGC	Lat.9^{0}28'4'' Long.8^{0}34'5''	41	290	22.24	37.70
4	KAURU	KRA	Lat.9^{0}58'5'' Long. 8^{0}32.14''	61	368	8.24	13.60
5		KRB	Lat.9^{0}55' Long.8^0 30'33''	70	60	11.24	18.56
6		KRC	Lat.9^{0}53'14'' Long.8^{0}29'33''	11	71	11.25	18.56
7	KACHIA	KCA	Lat.9^{0}52'20'' Long.8^{0}02'4''	10	100	22.44	37.53
8		KCB	Lat.9^{0}50'28'' Long.7^{0}57'47''	112	682	28.24	46.59
9		KCC	Lat.9^{0}40'43'' Long.7^{0}57'05''	12	128	46.74	77.11
10	KAGARO	KGA	Lat.9^{0}32'51'' Long.7^{0}55'28''	7	35	9.25	15.26
11		KGB	Lat.9^{0}28'17'' Long.7^{0}54'22''	13	124	24.7	40.8
12		KGC	Lat.9^{0}28'07'' Long.7056'09''	39	379	15.75	25.98
13	JAMA'A	JMA	Lat.9^{0}28'30'' Long.8^{0}29'57''	6	7	34.74	58.97
14		JMB	Lat.9^{0}28'23'' Long. 8^{0}22'59''	30	90	17.74	29.28
15		JMC	Lat.9^{0}36'50'' Long.8^{0}18'56''	56	353	15.25	25.15

Source: Author's fieldwork 2018.

Figure 4 revealed that, Alkalinity is the chemical parameters with the highest concentration within the study area with 682mg/l at location KCB (Kasan Kamantan) in Kachia Local Government followed by total hardness and salinity with 112mg/l and 77.11mg/l respectively location KCB (Kasan Kamantan) and KCC (Kurmin Gwaza) respectively all in Kachia Local Government Area. A similar decreased in water quality of wells in Kaduna South Local Government Area was also discovered by Ugya et al. (2015). The result revealed that most of the wells in Kaduna South were below the WHO standard of drinking water quality.

Table 3: Descriptive analysis of the laboratory result for Physical Parameters

S/No	Parameters	Range	Mean	Std. Deviation	Sample variance
1	pH	4.2-6.2	5.19	0.59	0.35
2	Temperature	20.4-23.0	21.47	0.81	0.65
3	Colour	7-261	73.8	82.04	6730.74
4	Electrical Conductivity	21.0-190.1	67.68	52.19	2723.30
5	Total Dissolved Solid	7.20-112	40.50	32.12	1031.68
6	Turbidity	3-88	25.15	28.28	799.99
7	Total Suspended Solid	13.8-520	212.71	307.87	94786.13

Source: Author's fieldwork 2018.

In Table 3 the Temperature and pH are within the World Health Organization (WHO) 2014 range while Electrical Conductivity and Total Dissolved Solid are below the WHO recommended limit. Total suspended solid, turbidity and colour varies with location where some locations are below WHO limit while some higher than the permissive limit. This agrees with Adeyemo et al. (2002) who observed that water quality parameters varies based on environmental factors and human activities. The temperature of the samples ranged between 20.4°C-23.0°C. This is in compliance with WHO permissible level of 25^{0}C. The pH value of the samples ranged from 4.2-6.2 which places the values within the WHO acceptable limit also, but less than those of Adeyemo et al. (2002).

The electrical conductivity of the samples range between 21.0-190.1µs/cm with a mean value of 67.68µs/cm and a deviation of 52.19 that is below the WHO permissible level of 1000µs/cm. Though these figures are lower than the WHO limit for portable water, they are nevertheless higher than FAO recommended limit for Agricultural purposes such as Irrigation (Adeniyi, 2009).

The Total dissolved solids (TDS) of the samples ranges between 7.20- 112mg/l and a mean of 40.50mg/l, the samples deviate from the mean at 32.2mg/l. This suggest that, the samples Total Dissolved Solid had almost a uniform distribution throughout the study area and quite low compared to the recommended limits (WHO, 2014), but above that of Arimoro, (2009) which was 7.10-95mg/l.

The turbidity level of the water samples range between 3-88 NTU and a mean value of 25.15NTU and a deviation of 28.28NTU, this value is above the World Health Organization recommended value of 5NTU for drinking water. The turbidity level of the study area is uniform, similar to (Yusuf, Ibrahim and Famakinwa, 2012).

Total Suspended Solid ranges from 13.8-520 mg/l and a mean of 212.17mg/l the samples deviate from the mean value by 307.87mg/l. This revealed that, Total Suspended Solid within the study area is not uniformly distributed and is above the recommended value of WHO for drinking water. Also, Adekule. (2009) observed disparity in value of suspended Solid from well water within Ilorin town.

Table 4: Descriptive analysis of the laboratory result for Chemicals Parameters

S/No	Parameters	Range	Mean	Std. Deviation	Sample Variance
1	Total Hardness	5-112	33.73	30.55	933.35
2	Alkalinity	7-682	205.87	182.18	33191.35
3	Chloride	9.25-46.74	19.62	10.61	112.54
4	Salinity	13.60-77.11	32.59	17.70	313.45

Source: Author's fieldwork 2018.

Table 4 revealed that Salinity values ranges between 13.60-77.11 mg/l with a mean value of 32.59 which is above the WHO recommended value of 0.1mg/l. This is much higher than the result of Adekule. (2009) and still above the WHO 2014 limit of 0.1.

The Total hardness of the samples range between 5-112 mg/l with a mean of 33.73mg/l and deviation of 30.55mg/l were quite low, compared to the recommended limits of 1500mg/l for potable water. Total hardness within the study area is uniform this is similar to the result of Alexander, (2008) quality of ground water in Mubi.

Alkalinity of the water samples ranges from 7-682mg/l with a mean of 205mg/l and a deviation of 182.18mg/l. The mean value is below the WHO recommended limit of 400mg/l, the alkalinity value of the samples varies considerably over the study area with 7mg/l as the lowest value while 682mg/l as the highest value.

The range for chloride is 9.25-46.74mg/l while mean and standard deviation are 19.62mg/l and 10.61 mg/l respectively. The mean value is below WHO permitted level of 40mg/l though some samples are above the permitted level.

On testing the concentration levels of the variables and that of WHO, inferential statistics of chi-square (Table.5) was used to test the hypothesis. The result shows that the chi-square calculated value for all the parameters were greater than the tabulated value; as such the null hypothesis is thereby rejected. This is in agreement with McJunkin (1982) who compared water quality and Human Health in the United States using the WHO standard for water quality

Table 5 Concentration levels of Tested Variables and the World Health Organization

Sources of Variation	N	df	Calculated value	Tabulated value	Decision
Physical	8	7	2179.68	14.067	H_O Rejected
Chemical	4	3	1190.37	7.815	H_O Rejected

Source: Author's Field Work, 2018.

DISCUSSION OF RESULTS AND FINDINGS

Based on the results of the analyses conducted, research findings revealed some state of contamination of the well water in Sanga, Kauru, Kachia, Kagarko and Jama'a local Government Areas, which serves as a source of drinking water for these communities. Any water meant for human consumption must be free from any type of chemical substances of an amount that could be hazardous to human health.

Table 6: World Health Organization Standard 2014

Parameters	Unit	WHO Standard 2014
Alkalinity	Mg/l	400
Salinity	Mg/l	0.1
Temperature	^{0}C	25
Electrical Conductivity	µs/cm	100
Chloride	Mg/l	40.0
Turbidity	NTU	<5NTU
Total Suspended Solid	Mg/l	50
TDS	Mg/l	<500
pH	-	6.5-8.5

Source: WHO, 2014

The physical test results from the five Local Government Areas shown in Table 1. Indicated that, the pH, electrical conductivity and Total Dissolved Solid level of all the samples were below the maximum permitted level of World Health Organization (WHO, 2014). Drinking water standards (table 6) of 6.5-8.5, 1000µs/cm and 500mg/l respectively. While turbidity and total suspended solid were above the maximum permitted level of WHO, 2014 standard of drinking water of 5 NTU, 50mg/l respectively (table 6). There is variation in colour of the sampled water as two samples from Kachia and Kagarko were below WHO, 2016 maximum permitted level of 15Hz while the remaining samples were above the standard.

Table 2 revealed that, Total hardness, Alkalinity and Chlorine are below the maximum permitted level of the WHO, 2014 drinking water standard of 150mg/l, 400md/l and 250mg/l respectively.

The salinity of the water sampled varies as six out of the fifteen sampled were above the WHO 2014 maximum permitted standard for drinking water of 35 parts per thousand. Yusuf, Ibrahim and Famakinwa (2012) observed that most of the chemical parameters of boreholes water in Kwara and Osun States were within the permissible limits of the Standard Organisation of Nigeria (SON) Act 2007 but magnesium contents were above the permissible limits (0.20) by a range of 0.09 mg/L, iron (II) above the limits (0.30) by a range of 0.50 mg/l. The study revealed that, the chemical parameters of the sampled water were closely related to the geology of the study area.

CONCLUSION

Higher concentrations of most of the measured parameters are suggestive of human and environmental influence into the well water. Some of the water samples by the virtue of their present quality status are potable as pH, electrical conductivity, total dissolved solid, total hardness, alkalinity and chloride are within WHO 2014 permissible level while parameters like turbidity, and total suspended solid which depend on the amount of materials present in water are observed to be higher in some samples as a result of the nature of geology and soil of the study area.

However, to sustain the potability status of the wells water in Southern Kaduna Senatorial Zone, public enlightenment on the danger of using unhygienic containers to extract water and waste management practice of waste reduction, re-use and recycling should be encouraged. Also simple physical treatment of effluents should be carried out.

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