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Determination of Some Physicochemical Parameters and Some Heavy Metals in Boreholes from Fagge L.G.A of Kano Metropholis Kano State- Nigeria

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Abstract There are some settlements in Fagge L.G.A of Kano metropolis that are located along Jakara river and thus there's the fear that the drinking water they consume could be hazardous, as such, there's a need for a study to be carried out to assess the levels of some physicochemical parameters and some heavy metals in borehole water that is meant for drinking and domestic purposes. Thirty water samples were randomly collected from different sampling sites and were analyzed using standard methods of analysis. The results showed that pH had a mean level of 7.26±0.43, Conductivity mean level was 856.1±388.6 μScm^{-1}, the mean total hardness was 295.9 ±137.2 mg/l, turbidity had a mean level of 0.98±0.73 NTU, the total dissolved Solid TDS mean levels was 509.4±200.9 mg/l. The heavy metals analyzed include Lead, Cadmium, and Chromium using Buck scientific model 210 VGP atomic absorption spectrometer and they had mean levels of 0.103±0.07, 0.012±0.03 and 0.065±0.095 respectively. As the results indicated all the physicochemical parameters and heavy metals are within the maximum contaminant levels set by WHO, 2005. Except for pH level in Weather head and Lead level in Kwarin Gogau sampling sites respectively. The statistical analysis of Anova showed that there is a significant difference between the physicochemical parameters and heavy metals analyzed as probability factor $p<0.05$.

Keywords: *physicochemical parameters, heavy metals, borehole, water samples, Fagge L.G.A Kano metropolis*

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1. Introduction

Water is one of the most valuable natural resources and is essential for the maintenance of all forms of life [4]. [1] reported that, the importance of water in our daily lives is what makes it imperative for thorough analysis to be conducted, the analysis is the concern of the chemist to ensure that supply of water is safe for all purposes and to ensure that only water with good qualities are used for both domestic and industrial uses.

[9] Observed that the rate of discharge of pollutants into the environments, which ultimately find their way into the water bodies is higher than the rate of purification. This could be due to rapid urbanization, industrialization and growing population. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels [7]. It has been suggested that it is the leading worldwide cause of deaths and diseases and that it accounts for the deaths of more than 14,000 people daily [7]. It has been estimated that 580 people in India die of water pollution related illness every day. [13].

In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. A report from China's national development agency in 2007 said that, 1/4th the length of China's seven main rivers were so poisoned the water harmed the skin [13].

2. Material and Method

In the preparation of reagents chemicals of analytical Analar grade were used with deionised water. All glass ware were cleaned and rinsed with detergents and immersed in 25% nitric acid and finally rinsed with de ionized water.

2.1. Sampling

Thirty samples of borehole water were collected from different areas of Fagge local Government of Kano State in triplicate using clean new polyethene plastic containers which were covered with Black polyethene bags to prevent growth of Algae. The pH and conductivity, ware determined immediately after sampling and the sample was stored at a temperature below 4°C, this is to prevent the growth of microorganisms. However, the sampling was conducted between 23rd -26th December, 2013.

2.2. Study Area

Fagge is a local government area in Kano state Nigeria, within the greater Kano Area, its headquarter is in the Suburb of Waje. It has an Area of 21 km and a population of 198,828 at the 2006 census. In Nigerian map, it is located in 12 24°N, 8 31°E with 3 digit postal code prefix 700 [8].

Table 1. The sampling sites and their ID

S/N	SAMPLING SITES	ID code	S/N	SAMPLING SITES	ID code
1	Garba A.D Street	A	16	Abba Gana Street	P
2	Titinbo Street	B	17	Dan Wawu Street	Q
3	Kwalta Street	C	18	Galadima Road	R
4	Kwarin Gogau	D	19	Abacha Street, Sabon Gari	S
5	Samaru Fagge	E	20	Fagge South	T
6	Kwari Market	F	21	Niger Road	U
7	Yan Babura	G	22	Singer Market, S/Gari	V
8	Dingazimi Street	H	23	Weather Head, S/Gari	W
9	Salam Opp. Triumph	I	24	Festing Road, S/Gari	X
10	Mutari Atamma Street	J	25	Abeokuta Road, S/gari	Y
11	Triump Juma'at Mosque	K	26	Atiken Road, S/Gari	Z
12	Haido Islamiyya	L	27	Sani Giwa Road, S/gari	AB
13	Fagge Model Primary Sch.	M	28	Abedie Street, S/Gari	AC
14	Ammani Inuwa Street	N	29	Amire Road, S/Gari	AD
15	Alh. Mudi Street	O	30	Sarkin Yaki Road, S/Gari	AE

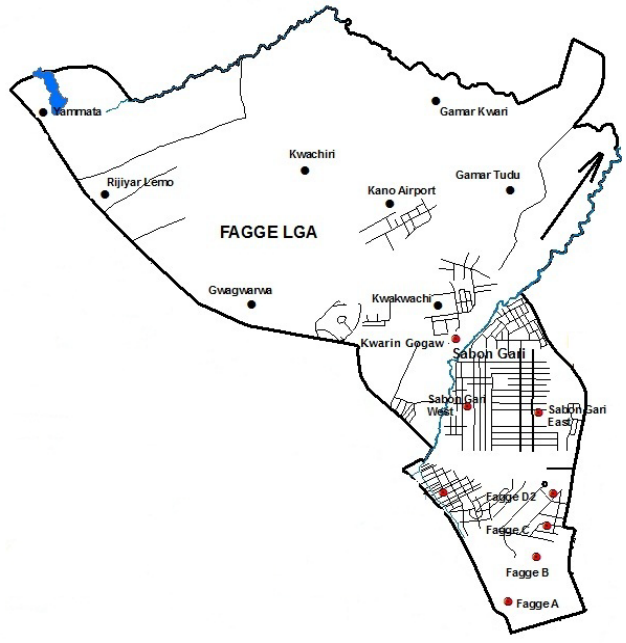

Figure 1. Showing the Sampling Sites

3. Methodology

3.1. pH Measurement

The pH was measured using a digital pH meter (HARCH SENS ION). The meter was switched on and was allowed to warm for 5 minutes. It was then standardized with a buffer solution. The meter was then immediately introduced into the water sample and measurement was taking after a stable reading was taken. The electrode was then rinsed with deionized water before taken another measurement [2].

3.2. Conductivity Measurement

Conductivities of the water samples were measured using a digital conductivity meter (HARCH Model). The meter was switched on and then standardized using 0.1N KCl at 25°C. The electrode was then immersed into the water sample and conductivity reading of each sample was recorded [12].

3.3. Turbidity Measurement

The turbidities of the water samples were measured using a digital turbidity meter (2100AN HARCH Model). The meter was standardized with a clean deionized water, and this was introduce into the water samples. The turbidity reading of each sample was then recorded [6].

3.4. Determination of Total Dissolved Solid

The total dissolved solid was determined using a Conductivity meter, the programme menu of the Conductivity meter was switched to total dissolved solid, 100 cm^3 of the sample was measured into the beaker and the electrode was introduced into the sample. The results of total dissolved solid were displayed and recorded [2]. Similarly, gravimetric method was also used to determine the Total Dissolved Solid by evaporation in an oven at 200°C for 2 hrs. This is to ascertain the accuracy of the above mentioned method by comparing the two results no significant difference was recorded only that it has more time consuming as reported by [3].

3.5. Determination of Total Hardness

10 cm^3 of water sample was pipetted into a conical flask. 1 cm^3 of buffer solution (NH_4Cl) of pH = 10 and 3 drops of Erichrome black T indicator were added to the flask. The mixture was then titrated with 0.0IM EDTA (ethyl diammine tetra acetic acid) until the color changed from wine red to blue.The procedure was repeated two more times to obtain the average litre value [1].

3.6. Determination of Alkalinity

Procedure: 100 cm^3 of Sample was taken followed by 2-3 drops of phenolphthalein indicator and the color change was observed followed by titrating with 0.1N HCl until the color changed from pink to colorless [4]

4. Results and Discussion

People are increasingly concerned about the safety of their water, as of now the main source of our drinking water in urban and rural areas is mainly boreholes. Current improvements of analytical methods which allow for the detection of impurities even at lower concentrations make it easier to ascertain the quality of the water we drink.

The results of some physicochemical parameters and some heavy metals analyzed in borehole drinking water samples from some sampling sites across Fagge L.G.A. of Kano metropolis are presented in tables 1,2,3, and 4 respectively:

Table 2. The Mean levels of pH, conductivity and Total Dissolved Solid, Sodium and Potassiumof the water samples

S/N	SAMPLES	pH	CONDUCTIVITY (µS/cm)	TDS (mgl^{-1})	Na (mgl^{-1})	K (mgl^{-1})
1	Garba A.D Street	7.6±0.13	1280±12.1	729.6±12.1	1.9±0.1	0.3±0.0
2	Titinbo Street	7.2±0.15	767±16.5	475. ±15.4	2.6±0.2	6.2±0.2
3	Kwalta Street	8.2±0.24	865±14.2	682±12.5	0.6±0.0	1.4±0.5
4	Kwarin Gogau	7.9±0.22	593±12.9	367.66±1.0	4.8±0.4	1.0±0.0
5	Samaru	7.1±0.11	860±12.7	498.8±1.0	8.2±0.2	2.0±0.0
6	Kwari Market	7.4±0.14	1101±14.7	748.68±33.5	4.9±0.2	0.2±0.1
7	Yan Babura	7.6±0.12	540±21.9	329.4±21.4	4.2±0.1	3.9±0.1
8	Dingazimi Street	7.1±0.31	1450±31.2	832.6±1.3	2.0±0.1	6.4±0.8
9	Salam Opp. Triump	8.0±0.21	1270±41.6	624.1±2.1	2.6±0.3	5.9±1.3
10	Mutari Atamma Street	7.6±0.34	1250±21.1	877.4±4.3	0.7±0.0	3.9±0.3
11	Triump Juma'at Mosque	7.2±010	1700±31.1	677.5±19.3	1.2±.01	6..6±0.0
12	Haido Islamiyya	6.8±0.14	750±41.2	501.3±2.6	2.8±0.2	5.2±0.4
13	Fagge Model Primary Sch.	7.3±0.23	556±21.3	420.5±21.5	7.1±0.3	3.5±1.0
14	Ammani Inuwa Street	7.5±0.11	630±41.6	362.64±23.5	3.0±0.6	0.8±0.0
15	Alh. Mudi Street	7.2±0.24	1234±31.2	653.1±53.4	1.0±0.0	3.8±0.5
16	Abba Gana Street	7.0±0.14	543±21.0	418.5±45.3	1.4±0.1	4.6±0.7
17	Dan Wawu Street	6.8±0.18	567±11.2	320±53.2	5.8±1.0	6.6±0.6
18	Galadima Road	7.5±0.22	431±31.2	284.1±41.2	10.6±2.2	1.9±0.5
19	Abacha Line Sabon Gari	7.3±0.13	532±41.2	322.3±53.2	2.0±0.1	0.2±0.3
20	Fagge South	7.6±0.15	421±51.2	313.1±44.3	11.2±1.6	6.7±0.2
21	Niger Road	6.9±0.31	678±21.4	377±12.5	1.0±0.1	4.8±0.4
22	Singer Market S/Gari	7.1±0.11	1321±13.4	876.8±21.4	3.1±0.18	4.6±0.6
23	Weather head S/Gari	6.2±0.14	345±21.1	237.2±11.5	5.5±0.3	6.2±1.3
24	Festing Road S/Gari	6.5±0.17	542±21.3	401.4±19.8	5.5±0.4	6.2±1.4
25	Abeokuta Road S/gari	6.8±0.43	654±13.5	376.9±21.4	4.8±0.2	5.4±0.1
26	Atiken Road S/Gari	7.5±0.21	1324±14.6	691.6±24.3	1.5±0.3	5.6±0.7
27	Sani giwa Road S/gari	7.7±0.42	346±11.9	220.5±13.4	0.9±0.5	4.9±0.4
28	Abedie Street S/Gari	7.3±0.16	1234±41.5	661.4±32.1	4.2±0.6	0.6±0.5
29	Amire Road S/Gari	6.9±0.23	543±14.6	293.5±34.5	6.0±1.6	2.9±0.1
30	Sarkin Yaki Road S/Gari	7.1±0.11	1356±13.2	707.6±21.3	0.5±0.2	4.9±0.1

Table 3. Mean Levels of Total Hardness, Alkalinity, and turbidity of the water samples

S/N	SAMPLES	TOTAL HARDNESS (mgl-1)	ALKALINITY (mgl-1)	TURBIDITY (NTU)
1	Garba A.D Street	430.5±3.67	560±12.1	0.57±0.02
2	Titinbo Street	580.2±10.5	414±12.9	0.47±0.012
3	Kwalta Street	206.6±11.5	850±31.6	1.65±0.017
4	Kwarin Gogau	292±8.6	420±31.5	1.17±0.01
5	Samaru	262.9±2.7	574±51.3	2.3±0.022
6	Kwari Market	198.7±1.2	480±12.3	0.428±0.013
7	Yan Babura	224.3±5.4	400±23.1	0.315±0.01
8	Dingazimi Street	424.8±3.9	450±3.5	1.58±0.014
9	Salam Opp. Triump	284.3±4.1	706±13.1	1.42±0.02
10	Mutari Atamma Street	290.4±8.4	500±42.4	0.601±0.016
11	Triump Juma'at Mosque	456.3±12.4	400±22.8	1.264±0.014
12	Haido Islamiyya	210.8±6.3	360±11.9	0.699±0.011
13	Fagge Model primary School	132.2±2.4	560±17.7	0.589±0.013
14	Ammani inuwa Street	160.4±5.3	440±11.9	1.26±0.02
15	Alh. Mudi Street	292.8±5.6	460±14.7	1.413±0.011
16	Abba Gana Street	300.3±11.6	460±31.9	0.554±0.01
17	Dan Wawu Street	404.5±4.9	480±18.8	1.74±0.013
18	Galadima Road	606.±13.45	500±34.8	3.34±0.01
19	Abacha Street Sabon Gari	466.6±13.21	460±15.2	0.02±0.014
20	Fagge South	488.1±0.32	320±23.6	0.885±0.011
21	Niger Road	482.3±0.56	354±12.9	0.821±0.02
22	Singer Market S/Gari	174.1±15.3	454±19.5	0.35±0.015
23	Weather head S/Gari	236.8±3.22	353±24.1	0.852±0.01
24	Festing Road S/Gari	202.9±0.35	678±18.0	1.98±0.013
25	Abeokuta Road S/gari	260.3±2.4	464±11.9	0.53±0.02
26	Atiken Road S/Gari	184.4± 1.45	597±16.6	0.40±0.014
27	Sani Giwa Road S/gari	154.8±3.45	546±11.5	1.872±0.016
28	Abedie Street S/Gari	142.3±1.42	471±0.00	0.275±0.024
29	Amire Road S/Gari	152.4±0.94	205±5.6	0.432±0.027
30	Sarkin Yaki Road S/Gari	172.9±0.56	489±32.9	0.585±0.016

Table 4. Mean levels for Lead, Cadmium, and Chromium of the water samples

S/N	SAMPLING SITES	Pb (mgl^{-1})	Cd (mgl^{-1})	Cr (mgl^{-1})
1	Garba A.D Street	0.11±0.001	ND±0.00	0.02±0.014
2	Titinbo Street	0.13±0.012	0.01±0.00	0.11±0.007
3	Kwalta Street	0.02±0.000	ND±0.00	0.15±0.000
4	Kwarin Gogau	0.31±0.011	0.03±0.01	0.45±0.001
5	Samaru fagge	0.14±0.012	ND±0.00	0.12±0.002
6	Kwari Market	ND±0.000	ND±0.00	0.01±0.000
7	Yan Babura	0.14±0.060	ND±0.00	ND±0.000
8	Dingazimi Street	ND±0.000	0.02±0.01	0.03±0.011
9	Salam Opp. Triump	0.11±0.002	ND±0.00	0.01±0.000
10	Mutari Atamma Street	0.02±0.011	ND±0.00	0.11±0.000
11	Triump Juma'at Mosque	0.13±0.009	0.01±0.00	0.15±0.010
12	Haido Islamiyya	0.14±0.015	ND±0.00	ND±0.000
13	Fagge Model primary Sch.	ND±0.000	ND±0.00	0.01±0.012
14	Ammani inuwa Street	0.12±0.018	ND±0.00	ND±0.000
15	Alh. Mudi Street	0.18±0.002	ND±0.00	ND±0.000
16	Abba Gana Street	0.15±0.004	ND±0.00	0.01±0.012
17	Dan Wawu Street	ND±0.000	ND±0.00	0.12±0.011
18	Galadima Road	0.16±0.006	ND±0.00	0.14±0.010
19	Abacha Line Sabon Gari	0.19±0.020	ND±0.00	ND±0.000
20	Fagge South	0.10±0.017	ND±0.00	ND±0.000
21	Niger Road	0.11±0.014	ND±0.00	ND±0.000
22	Singer Market S/Gari	0.13±0.016	ND±0.00	0.01±0.000
23	Weather head S/Gari	0.12±0.022	ND±0.00	0.02±0.003
24	Festing Road S/Gari	ND±0.000	0.02±000	0.03±0.047
25	Abeokuta Road S/gari	0.02±0.014	ND±0.00	0.01±0.003
26	Atiken Road S/Gari	0.03±0.052	0.15±0.01	0.13±0.000
27	Sani Giwa Road S/gari	0.21±0.095	ND±0.00	ND±0.000
28	Abedie Street S/Gari	0.20±0.081	ND±0.00	0.01±0000
29	Amire Road S/Gari	0.10±0.032	ND±0.00	0.1±0.020
30	Sarkin Yaki Road S/Gari	0.11±0.022	0.01±0.00	0.2±0.004

5. Discussion

The Results of pH levels in the various water samples are presented in figure 2, from the result it can be seen that all the sampling sites had pH level falling with the W.H.O recommended range value of 6.5 – 8.5 [16] except in sampling site at weather head Sabon Gari in which the pH level was found to be 6.2 which is slightly below the recommended range set by WHO. This could be attributed to acid rain, industrial waste, mining, sewage, waste dumping through leaching into the soil which ultimately increase the soil acidity and consequently the pH is lowered as observed by [4].

For Conductivity, Measurements were conducted in the water samples and the results revealed that about 33.3% of the sampling sites had conductivity level above W.H.O maximum contaminant level of 1200 μscm^{-1} [16] as shown in Table 2. However, the high conductivity level at the sites mentioned could be linked to sewage materials, leaching of inorganic contaminants as observed by [5].

The turbidity level in all the sample sites determined showed that they are within the recommended levels of 5 NTU [16] as shown in (Table 3). Higher turbidity in water could be due to Suspended materials, bacteria, plankton and dissolved organic and inorganic substance and higher turbidity is associated with Surface water sources as observed by [10].

The hardness levels were also analyzed and presented in (Table 4). Based on classification of water conducted by [11] in terms of softness and hardness in the following order in terms of mg/l. 0-60 soft, 60 – 120 moderately soft, and 121 – 180 moderately hard and above 180 is hard. Thus, considering this classification, it can be deduced that almost all the water samples analyzed are hard, but safe for drinking and other domestic purposes. However, the hardness could be removed by simple boiling, addition of chemicals e.g washing soda, sodium hydroxide, and ion exchange method.

From the results presented in (Table 1) the highest Sodium concentration was recorded in Mutari Atamma Street with a Concentration of 11.2 mg/l. Although it is generally agreed that that sodium is essential to human life, there is no agreement on its maximum daily requirement. However, it has been estimated that a total daily intake of 120-140 mg will meet the daily needs of growing infants and young children and 50 mg for adults [6].

For potassium the highest concentration of potassium was recorded in Abacha Street, Sabon Gari with average concentration of 6.7±0.24 mg/l as shown in (Table 1). Potassium concentration in water is generally very small, although excessive amounts may have a laxative effect; potassium chloride is used as a replacement for salt in water softeners [10].

The alkalinity levels were assessed in the water samples and presented in (Table 4) the results indicate that majority of the sampling sites have alkalinity levels above the WHO maximum contaminant levels of 500 mg/l [16]. The Alkalinity value in water provides an idea of natural mineral salts present in the water. The main species that contribute to alkalinity includes bicarbonates, hydroxides, phosphates and borates [14].

The total dissolved solid was also analyzed and it can be observed that water from all the sampling sites had total dissolved solid levels below WHO maximum contaminant levels of 1000 mg/l [15], this is shown in Table 4. The higher total dissolved solid reduce water clarity, which could contribute to the decrease in photosynthetic activities and might lead to an increase in water temperature as observed by [6]

5.1. Heavy Metals

The heavy metals analysed were Pb, Cd, and Cr. From the results (Table 3) it can be seen that all the samples

ware within the safe limit recommended by [16] except for lead in Kwarin Gogau which is higher than the maximum contaminant level of 0.01 mg/l [15]. This may originate from corrosion of brass fitting of certain types of submersible pumps used in ground water wells as reported by [4]. It could also be due to passage of River Jakara stream Channel through the area as shown in Fig. 1 from sewage and industrial waste, refuse which may include lead battery that could ultimately leach into the ground thereby contaminating the water.

However the heavy metals concentrations are in the order Cr> Pb > Cd respectively as shown in (Table 3)

6. Conclusion

Physicochemical assessment of borehole water samples from Fagge L.G.A of Kano metropolis was carried out. Most of the physical parameters are within the W.H.O safe limit. The levels of heavy metals were also found to be within the recommended levels set by W.H.O with exception of lead (Pb).

Similarly, the Results of the analysis indicated that most of the physical parameters are related to one another. This can be seen in the Table 2, Table 3, and Table 4 respectively which show that higher Conductivity is related to higher Total Dissolved Solids, Salinity, Sodium, Potassium and hardness which rise as a result of the presence of Ca^{2+} and Mg^{2+} ions respectively.

Also it is observed that Turbidity and Total Suspended Solid are also related to one another as the TSS level was high the Turbidity was also high.

Moreover, the heavy metals concentrations are also related to the proximity of the sampling Area with Contaminated area that is River Jakara which is believed to have contain a lot of contaminants (pollutants) such as sewage, industrial effluents, dumping refuse that may include car batteries (Lead accumulator) and some other environmental pollutants.

However, since some of the results indicate high levels above the Standard set by W.H.O safe limits, there is the tendency of high potential health hazards to the inhabitants of the areas that uses these water sources for drinking and other domestic purposes without treatment.

Recommendations

As the results indicated, some of the parameters analyzed showed higher concentration above the WHO contaminant level especially the sampling sites very closer to jakara River which is believed to be contaminated, the following steps may lower the concentration. Heating the water before used can remove the temporary hardness. Domestic and industrial waste should be properly disposed of recycled. Relevant agencies should make concerted effort to control, regulate and educate the community on indiscriminate waste disposal from domestic and industries within the study area and also further research should be carried out to assess the level of some other parameters, replacing home plumbing components made from brass. Some other techniques like phytoremediation can be introduced to reduce the levels of the heavy metal contamination.

The limitation of this research is that trivalent metals ions and bacteriological analysis was not conducted this can be done for further research work.

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