

## ANALYSIS OF PHYSICO-CHEMICAL AND MICROBIOLOGICAL PROPERTIES OF BORE HOLES AND WELL WATER COLLECTED FROM DIFFERENT LOCATIONS IN KUJE AREA COUNCIL, ABUJA, NIGERIA

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**Abstract:** The quality of borehole and well waters from six locations in Kuje area council, (Kuchiyako, Angwar sanyi, Angwar gede, Sauka extension, Bayan town hall and Gudaba) in the Federal Capital Territory Abuja was assessed by undertaking their physical, chemical and microbiological analyses. The risk involved in the everyday uses of these water sources by the residents of these villages was assessed using odour, colour, pH, conductivity, turbidity, alkalinity, acidity, total dissolved solids (TDSs), total suspended solids (TSS), hardness, BOD, elemental composition (manganese, iron, lead and Cadmium), chloride, nitrate, phosphate, Sulphide and total coliform. Results obtained showed that the average values for parameters like colour range, conductivity, TDS, hardness, chloride, nitrate, manganese, Cadmium, though may vary according to water sources and locations, all fall below permissible limits but values for others like iron, lead, pH and alkalinity exceed the permissible limit. The microbial growth for all the samples obtained is below detectable limit; therefore the water samples have minimal potential risk for microbial pathogens. The water sample from these study areas are not suitable for drinking but can be used for other domestic purpose, such as laundry, washing etc.

**Key Words:** pollutants, contaminants, ground water, surface water, drinking

### INTRODUCTION

Water is vital to life. Adequate supply of fresh and clean drinking water is a necessity for all human beings on the earth. The main sources of fresh water are ground and surface water. These sources of freshwater resources are threatened by overexploitation, poor management and pollution. The Greek philosopher Pindar described water as the "best of all things". This view is not surprising since the need for water, throughout human history, has always been appreciated. Water is present everywhere without which life will simply cease to exist. Population growth and increasing demands for water, however, coupled with contamination from point and nonpoint sources, threaten the quality and quantity of our water resources (USGS, 2010). The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Metwally, et al (2006) reported that the implications of lack of clean water are

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widespread. People died as a result of suffering from diarrheal, typhoid illnesses and dangerous diseases caused by the contaminated drinking water such as cancer, neurological disorder etc.

Serious ill health can be caused by water contaminated with faeces being passed or washed into river, stream, pool or being allowed to seep into well or borehole. There has been a report of borehole water contamination through much domestic waste water and livestock manure especially if there is a puncture in a layer of soil (Obi and Okacha, 2007). These waste and sewage, when deposited near the boreholes may travel with percolating rain water directly into the boreholes or may travel along the well-wall or surrounding material of the drill-holes (Obi and Okacha, 2007). The high prevalence of diarrhoea among children and infants is associated with the use of unsafe water and unhygienic practice (Oladipo et al., 2009; Tortora et al., 2002). Thus, many infectious diseases are transmitted by water through faecal oral contamination. Water may contain toxic inorganic chemicals which may cause either acute or chronic health effect (Tortora et al., 2002).

Many people living in rural settlements who do not have access to clean water rely on unimproved water sources such as Dam, reservoir, rivers and groundwater (Jibrin et al, 2015). The most available sources are the groundwater and the people depend mostly on it to get their daily needs of water for domestic uses. The quality of groundwater is highly related to local environmental and geological conditions, such as the quality of soil and rock types found in the area. According to Jibrin et al (2015) groundwater is the most common source of water in rural communities; it has proved to be the most reliable resource for meeting water demand in rural areas. Availability of groundwater depends primarily on the geology of the area.

Natural water contains different types of impurities. Impurities are introduced in to aquatic system by different ways such as weathering of rocks, leaching of soils, dissolution of aerosol particles from the atmosphere. Besides, impurities can be from several human activities, such as mining, processes and pollution with metal based materials (Oladipo et al., 2009) of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Also faecal pollution of drinking water causes water born disease which has led to the death of millions of people (Adefemi and Awokunmi, 2010). Water to be used for human consumption must meet certain requirements. It must be free of all disease causing microorganisms, low in concentration of compounds that are acutely toxic or that have serious long term effect on health. Ideally water for drinking should be clear, free of odor and compound that can cause color or taste.

In certain regions of southern and western Africa, as the water percolates through the soil, harmful physical, biological and chemical constituents (e.g. fine suspended matter, fecal coliform and fluoride) become contained in the water making it unsuitable for human consumption (Fredrick,1990). The quality of drinking water has attracted great attention worldwide because of implied

public health impacts. Boreholes and wells are the most common drinking water sources in Nigeria. The majority of the population consume it, hence the need to ascertain the qualities of borehole and well water in order to safeguard the health of consumers. Many common and widespread health risks have been found to be associated with drinking water in developing countries, a large percentage of which are of biological origin (Fredrick, 1990). The importance of high quality water cannot be over-emphasized as it sustains human life and maintains health.

Most waters, before they reach the consumer, have been exposed to greater or lesser amount of contamination, but in the majority of case, they have also undergone a more or less complete purification by natural agencies (Gidado et al, 2017). Domestic water is the water used for household and sanitary needs as well as urban, industrial and municipal requirements. The water should be harmless to the health of man, have proper organoleptic properties and be suitable for domestic uses. Waters are considered of doubtful quality unless proven otherwise. It is therefore important that drinking water be monitored to ascertain the level and nature of pollution. Any information derived would subsequently be used in determining the type and degree of treatment required to make the water potable and to guarantee health and safety (Batram, 1996).

Due to the increasingly use of well and borehole waters in the country as a major source of drinking water, there is need to constantly analyze these water sources in order to check the level of contamination and its effects on human health. The results of such a study can be a basis to provide recommendations that could help in controlling and minimizing present and future contaminations of such drinking water sources.

The aim of this work is to ascertain the quality of borehole water from six different locations (Bayan town hall, Angwar gede, Angwar sanyi, Gudaba and Sauka Extension) in Kuje area council of FCT Abuja. The quality indices include physical, and chemical, parameters and some mineral contents of the samples which shall be used to ascertain the safety index and potential risk to the communities.

### **Material and Methods**

#### **Samples Collection**

The water samples were collected from six different areas (Bayan town hall, Angwar gede, Angwar sanyi, Gudaba and Sauka Extension) within kuje area council, FCT Abuja. The sampling was done during afternoon hours and the samples were collected from both the well and bore hole in the polyethylene bottles and were brought to the laboratory for further analysis:

#### **Methods of Analysis**

Analysis of the water samples was carried out in THREE different categories namely:

- (I) Physical analysis
- (II) Chemical analysis
- (III) Microbiological analysis

## **Physical analysis**

### **Determination of Color**

Distilled water and the sample were poured into the test tube. The numbered hazen disc was inserted in the lovebird (Model F-BS684). The hazen disc being positioned on the distilled water was then watched to know the particular disc number that have the same color with the sample and the disc number was recorded.

### **Determination of Electrical Conductivity**

The electrode was wetted with distilled water thoroughly and then plugged into the conductivity meter before it was inserted in to a 250ml beaker containing distilled water. The conductivity meter (Jenway model 4010) was then switched on, and zero error was corrected. The distilled water was replaced with raw water samples and the electrode was inserted in each case. The system was allowed to stabilize and the reading was recorded.

### **Determination of pH value**

The electrode of the pH meter (model PBS - 51, EL - Hama instrument) was standardized by dipping it into a buffer solution of pH 7. The electrode was then dipped into the sample and reading was recorded (Apha, 1998).

### **Determination of Turbidity**

The turbidity of the water samples was measured by turbidity meter (model HACH 2100Q Colorado); the meter contains a bottle in which the water samples were induced. The bottle was inserted into a cavity hole on the turbidity meter and allows it to read for 30 seconds before the reading was recorded.

## **Chemical Analysis**

### **Determination of Dissolved Solids**

An empty beaker was weighed; 50mls of the water sample was measured and filtered into the beaker. The filtrate was heated to dryness, cooled and reweighed with the beaker, until a constant mass is obtained and the value was recorded.

$$\text{Dissolved solids (mg/L)} = \frac{(W1 - W2) \times 1000}{\text{Sample volume (ml)}}$$

W1 = weight of dried residue + dish, W2 = weight of empty dish

### **Total Hardness**

Exactly 50ml of the sample is pipetted into a conical flask, to which 1ml of ammonium buffer and 2-3 drops of Eriochrome black T indicator is added. The mixture is titrated against standard 0.01M EDTA until the wine red color of the solutions turns pale blue at the end point (Apha, 1998).

$$\text{Total hardness} = \frac{\text{volume of EDTA} \times N \times 50 \times 1000}{\text{Volume of sample taken}}$$

N= normality

### **Determination of Alkalinity**

Water (10ml) sample was pipette into a conical flask. Three drops of methyl orange indicator were added and titrated with 0.1M NaOH to give an orange color. Alkalinity was calculated using the formula given below;

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Formula:  $TV \times 50,000 \times N$   
Vol. of the sample

Determination of dissolved oxygen (DO) (APHA, 1998)

The dissolved oxygen (DO) content of the surface water and underground water samples was measured using the Jenway Model 9070 waterproof meter according to the standard method described by APHA (1998)

**Determination of Nitrate, Phosphate and Sulphate (Greenberg et al., 1992)**

The HANNA multi parameter logging spectrophotometer (HI83200) was used to digitally determine the nitrate, phosphate and sulphate in the surface water and underground water samples. The concentrations of nitrate, sulphate and phosphate were determined using standard procedures. Nitrate as nitrogen was determined by the cadmium reduction metal method 8036. The cadmium metal in the added reagent reduced the entire nitrite in the samples to nitrate; Sulphate was determined using Sulfa Ver methods 8051. Phosphate was determined using direct reading from HI 83200 HANNA multi parameter.

Determination of biochemical oxygen demand (BOD) (Ademoroti, 1996)

The BOD determination of the surface water and underground water samples was carried out using standard methods described by Ademoroti (1996). Samples were incubated for five days at 20°C in BOD bottles. The dissolved oxygen (DO) content of the samples was determined before and after the incubation. BOD was calculated after the incubation period.  $BOD_5 =$  Dissolved oxygen after incubation period (5 days) - Dissolved oxygen of the first day

**Determination of chemical oxygen demand (COD) (Ademoroti, 1996)**

The COD of the surface water and the underground water samples was determined using the standard method described by Ademoroti (1996). A portion (0.4ml) of H<sub>2</sub>SO<sub>4</sub> was placed in a refluxing flask. About 20ml of the samples was diluted with 20ml of distilled water. A standard solution (10ml) of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> was then added to glass beads already heated to 600°C for 1 hour. The flask was then attached to the reflux condenser and about 30ml of concentrated H<sub>2</sub>SO<sub>4</sub> containing Ag<sub>2</sub>SO<sub>4</sub> was added through the open end of the condenser. The resulting solution was thoroughly mixed by switching. The mixture was refluxed for 1 hour, cooled and the condenser was washed with about 25ml of distilled water. The mixture was diluted with 150ml of distilled water and cooled to room temperature. About 3 drops of (0.10-0.15ml) ferroin indicator was added. The mixture was then titrated with 0.25M Fe(NH<sub>4</sub>)<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub> taking as the end point the sharp color change from blue-green to reddish brown. In the same manner a blank containing 20ml distilled water was refluxed together with the reagent.

**Determination of Nitrates**

Water (50ml) was measured into a beaker. 1ml of sodium arsenate was added and shaken thoroughly. 5ml was measured from the mixture in a separate test tube. 1ml of Brucine Sulphate/ phenothroline ferrous sulphate indicator was added with 10ml of concentrated H<sub>2</sub>SO<sub>4</sub>. The remaining 45ml solution was mixed and allowed to equilibrate for about 30mins to 1hr. The absorbance was read at 410nm using spectrophotometer.

### Determination of Lead

Water sample (10ml) was measured into a beaker, and then 5 to 6 drops of 10% potassium cyanide was added together with 25ml of 1.2M ammonium solution and 0.5ml of 10% Na<sub>2</sub>S (sodium sulphide). This was made up to 50ml with distilled water, and then the absorbance was taken with the aid of spectrometer at a wave length of 217.0nm.

### Determination of Manganese

Water sample (20 ml) was added to the 50 ml volumetric flask containing 5ml of phosphoric acid. Into this mixture, 0.3g of potassium peroxide was added and shaken well. This was boiled for 15mins and allowed to cool, after which it was then made up to 50ml with distilled water. The resulting solution was then assayed for Manganese using spectrometer (ice 3000 aa02134104 v 1.30) at a flame mode at a wavelength of 279.5nm.

### Microbial parameters

#### Total Coliform

The membrane filtration technique (Hatch-Company, 2012) was employed in the determination of total coliform using Wagtech field kits. Water sample was appropriately diluted, filtered and incubated at 37oC. The sample which had characteristic yellow colonies after 18hours of incubation was selected and the colonies counted and calculated as follows:

Bacterial colonies = No. of colony x 100cfu/100ml sample filtered

### RESULTS

The average values of the determined parameters for the water samples from the different locations are in Tables below alongside with the Standard Organization of Nigeria (SON) are presented below

#### Physiochemical and biological properties of Bayan town hall water.

| Parameters     | Well water   | Borehole water | SON             |
|----------------|--------------|----------------|-----------------|
| Odour          | - Agreeable  | Agreeable      | Unobjectionable |
| Color          | - turbid     | Colorless      | 5               |
| pH             | - 6.65       | 6.08           | 6.5-8.5         |
| Conductivity   | us/cm 604.6  | 358.5          | 1000            |
| Turbidity      | NTU 1.8      | 1.2            | 5               |
| Alkalinity     | mg/L 440     | 340            | -               |
| TDS            | mg/L 393     | 233            | 500             |
| Hardness       | mg/L 3.2     | 3.4            | 150             |
| Chloride       | mg/L 3.644   | 2.187          | 250             |
| TSS            | mg/L 11      | 15             | -               |
| Phosphate      | mg/L 0.01    | 0.2            | -               |
| Sulphide       | mg/L ND      | 25             | 3               |
| BOD            | mg/L 0.75    | 6.6            | -               |
| Manganese      | mg/L -0.1951 | -0.4104        | 0.2             |
| Iron           | mg/L 1.85    | 0.75           | 0.3             |
| Lead           | mg/L 1.9655  | 0.1608         | 0.01            |
| cadmium        | mg/L 0.3254  | 0.5132         | 0.003           |
| Total coliform | cfu/ML ND    | ND             | 10              |

SON = Standard Organisation of Nigeria

ND = Not Detected

TDS = Total dissolved solid

### Physiochemical and Biological Properties of Angwar gede

| PARAMETERS/units      | BOREHOLE WATER | WELL WATER | SON        |                 |
|-----------------------|----------------|------------|------------|-----------------|
| Odour                 | -              | Odourless  | Odourless  | Unobjectionable |
| Colour                | -              | Colourless | Colourless | 5               |
| pH                    | -              | 6.54       | 6.22       | 6.5-8.5         |
| Conductivity          | us/cm          | 346.2      | 530.77     | 1000            |
| Turbidity             | NTU            | 0.8        | 1.12       | 5               |
| Alkalinity mg/ml      |                | 360        | 400        | -               |
| TDS mg/ml             |                | 225        | 345        | 500             |
| Total mg/ml           | hardness       | 2.4        | 3.6        | 150             |
| Chloride mg/ml        |                | 2.1876     | 3.498      | 250             |
| TSS mg/ml             |                | 0.001      | 0.01       | -               |
| Phosphate mg/ml       |                | 0.04       | 0.08       | -               |
| Sulphide mg/ml        | mg/ml          | -          | 5          | 3               |
| BOD mg/ml             | mg/ml          | 7.8        | 6          | -               |
| Mg/ mg/ml             |                | -0.5685    | 0.2608     | 0.2             |
| Iron mg/ml            | mg/ml          | 2.8        | 3.44       | 0.3             |
| Lead mg/ml            | mg/ml          | 0.1995     | 0.3624     | 0.01            |
| Cadmium mg/ml         | mg/ml          | 0.1940     | 0.1753     | 0.003           |
| Total coliform cfu/ml |                | nil        | Nil        | 10              |

### Physiochemical and Biological properties of Angwar sanyi.

| PARAMETERS/units      | BOREHOLE WATER | WELL WATER | SON        |                 |
|-----------------------|----------------|------------|------------|-----------------|
| Odour                 | -              | odourless  | Odourless  | Unobjectionable |
| Colour                | -              | Colourless | Colourless | 5               |
| pH                    | -              | 6.49       | 6.59       | 6.5-8.5         |
| Conductivity          | us/cm          | 109.7      | 349.2      | 1000            |
| Turbidity             | NTU            | 0.9        | 1.6        | 5               |
| Alkalinity mg/ml      |                | 680        | 140        | -               |
| TDS mg/ml             |                | 79         | 227        | 500             |
| Total mg/ml           | hardness       | 2          | 3.2        | 150             |
| Chloride mg/ml        |                | 0.58308    | 2.624      | 250             |
| TSS mg/ml             |                | 0.03       | 0.1        | -               |
| Phosphate mg/ml       |                | Nil        | Nil        | -               |
| Sulphide mg/ml        | mg/ml          | Nil        | Nil        | 3               |
| BOD mg/ml             | mg/ml          | 7.3        | 7.9        | -               |
| Manganese mg/ml       | mg/ml          | -0.0951    | -0.5773    | 0.2             |
| Iron mg/ml            | mg/ml          | 5.59       | 3.11       | 0.3             |
| Lead mg/ml            | mg/ml          | 0.4321     | 1.3462     | 0.01            |
| Cadmium mg/ml         | mg/ml          | 0.1964     | 0.2194     | 0.003           |
| Total coliform cfu/ml |                | Nil        | Nil        | 10              |

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### Physiochemical and Biological properties of Angwar sanyi.

| PARAMETERS/units | BOREHOLE WATER | WELL WATER | SON             |
|------------------|----------------|------------|-----------------|
| Odour            | -              | Odourless  | Unobjectionable |
| Colour           | -              | Turbid     | 5               |
| pH               | -              | 6.62       | 6.5-8.5         |
| Conductivity     | us/cm          | 313.85     | 892.3           |
| Turbidity        | NTU            | 1.6        | 1.5             |
| Alkalinity       | mg/ml          | 280        | 580.05          |
| TDS              | mg/ml          | 204        | 580             |
| Total            | hardness       | 2.8        | 2.001           |
| Chloride         | mg/ml          | 1.6034     | 6.997           |
| TSS              | mg/ml          | 0.01       | 0.05            |
| Phosphate        | mg/ml          | Nil        | 0.01            |
| Sulphide         | mg/ml          | 5          | Nil             |
| BOD              | mg/ml          | 8.3        | 4.5             |
| Manganese        | mg/ml          | -0.3755    | -0.4881         |
| Iron             | mg/ml          | 1.01       | Nil             |
| Lead             | mg/ml          | 0.9907     | 2.0678          |
| Cadmium          | mg/ml          | 0.2095     | 0.2647          |
| Total coliform   | cfu/ml         | Nil        | Nil             |
|                  |                |            | 10              |

### Physiochemical and biological properties of Gudaba water.

| PARAMETERS/units | BOREHOLE WATER | WELL WATER | SON        |
|------------------|----------------|------------|------------|
| Odour            | -              | Odourless  | odourless  |
| Colour           | -              | colourless | colourless |
| pH               | -              | 6.82       | 6.67       |
| Conductivity     | us/cm          | 373.9      | 669.2      |
| Turbidity        | NTU            | 0.9        | 0.9        |
| Alkalinity       | mg/ml          | 480        | 280        |
| TDS              | mg/ml          | 243        | 435        |
| Total            | hardness       | 2          | 2          |
| Chloride         | mg/ml          | 4.227      | 1.6035     |
| TSS              | mg/ml          | 0.001      | 0.01       |
| Phosphate        | mg/ml          | Nil        | 0.01       |
| Sulphide         | mg/ml          | Nil        | Nil        |
| BOD              | mg/ml          | 6          | 8.7        |
| Manganese        | mg/ml          | -0.6806    | -0.2593    |
| Iron             | mg/ml          | 2.54       | 2.94       |
| Lead             | mg/ml          | 1.7617     | 2.0396     |
| Cadmium          | mg/ml          | 0.1840     | 0.1378     |
| Total coliform   | cfu/ml         | Nil        | Nil        |
|                  |                |            | 10         |

### Physiochemical and biological properties of Sauka extension water.

| PARAMETERS/units      | BOREHOLE WATER | WELL WATER | SON             |
|-----------------------|----------------|------------|-----------------|
| Odour                 | - Odourless    | Odourless  | Unobjectionable |
| Colour                | - colourless   | Colourless | 5               |
| pH                    | - 6.55         | 6.98       | 6.5-8.5         |
| Conductivity us/cm    | 200            | 183.07     | 1000            |
| Turbidity NTU         | 0.9            | 1.9        | 5               |
| Alkalinity mg/ml      | 240            | 160        | -               |
| TDS mg/ml             | 130            | 119        | 500             |
| Total hardness mg/ml  | 1.6            | 1.2        | 150             |
| Chloride mg/ml        | 1.3119         | 1.6035     | 250             |
| TSS mg/ml             | 0.01           | 0.02       | -               |
| Phosphate mg/ml       | 0.22           | 0.29       | -               |
| Sulphide mg/ml        | Nil            | Nil        | 3               |
| BOD mg/ml             | 8.1            | 7.5        | -               |
| Manganese mg/ml       | -0.4978        | -0.1298    | 0.2             |
| Iron mg/ml            | 3.23           | 3.18       | 0.3             |
| Lead mg/ml            | 1.3969         | 1.6813     | 0.01            |
| Cadmium mg/ml         | 0.1818         | 0.2194     | 0.003           |
| Total coliform cfu/ml | Nil            | Nil        | 10              |

#### Odour

The odor of the well and borehole water samples from all the locations were found to be agreeable, and odorless. This signifies low concentration of dissolved solid since high concentration in water could be responsible for odour (ASTM, 2004). Similar results of odour were obtained from similar analysis conducted in different part of Abuja (Gidado, et al, 2017) where all of the locations the odour of the samples was found to be agreeable.

#### Color

The analysis of the samples from the six locations showed that they were colorless, except for borehole water in Gudaba and well water in Bayan town hall. The areas where the water samples are colorless may be as a result of low dissolved and suspended solids in the water samples, and high level of dissolved and suspended solids in the areas where the water samples were found turbid. Color is a critical quality parameter and the Color in drinking water can be caused by dissolved and suspended materials, which may be due to natural causes or human activity (mahananda, et al 2010)

#### pH

The mean results of pH obtained for BWGD, WWGD, BWAS, WWAG, and BWBT, were below 6.5 which indicate they are slightly acidic and are fairly comparable with the standard value of the SON (6.5 - 8.5). pH results obtained in this study suggest that isolates identified may tend to thrive in slightly acidic environments which are consistent with the report of Jideani (2003). The PH values of (WWSE, BWAG, WWBT, WWKY, WWAS, BWKY, BWSE), Are

all within the permissible limit specified by the SON. Drinking water with an elevated pH above 11 can cause skin, eye and mucous membrane irritation. On the opposite end of the scale, pH values below 6.5 cause ulcer and irritation due to the corrosive effect of the low pH level (Wikipedia-pH, 2010). The pH range in this study is close to neutrality and would allow the growth of most bacterial species. Eniola et al., (2007) obtained similar pH ranges of 6.54 - 7.80 and 6.54 to 7.90 for borehole water.

### **Conductivity**

The conductivity of the bore hole water samples in all the six locations ranged from 109.2 us/cm to 669.2 us/cm while that of the well water samples have the lowest to be 183.07 us/cm and the highest to be 892.3us/cm. Both categories of conductivity values fall below the permissible limit (1000us/cm) and are in agreement with Nigeria Standard of Drinking Water Quality (NSDWQ, 2007). The obtained values ,however are similar to the result obtained from similar analysis of the water samples by Bundela et al, 2012 which ranged between 571us/cm to 959us/cm indicating the presence of high amount of dissolved inorganic substances in ionized form.

### **Turbidity**

The turbidity mean results of the well and bore hole water from the six locations shows that, they are all below the permissible limit given by the SON (5 NTU). This is due to little or no presence of colloidal solids presents in the water that causes water to have cloudy appearance and reduction in transparency. Turbidity in waters results from colloidal clay particles and Colloidal organic matter originating from decay vegetation. The higher the turbidity level, the higher the risk that people may develop gastrointestinal diseases (Gidado et al, 2017). This is especially problematic for immune-compromised people, because contaminants like viruses or bacteria can become attached to the suspended solids (Gidado et al, 2017).

### **Alkalinity**

Alkalinity is defined by (Ademorati, 1996) as a measure of the ability of water samples to neutralize strong acids to an arbitrary pH or an indicator end-point. The measure of the capacity of natural water to neutralize acid is alkalinity. The alkalinity of well water samples from the six locations ranged from 140mg/l to 580.05mg/l while that for the borehole water samples were found to ranged from 240mg/l to 680mg/l. These values show that the borehole water samples from Bayan town hall (440mg/l), Angwar Gede(360mg/l), Agwar sanyi (680mg/l), Sauka extension(480mg/l) and well water samples from Angwar Gede(400mg/l), Gudaba (580.05mg/l), and Bayan town hall (340mg/l) contains high presence of hydroxides, carbonate and bicarbonate making them more alkaline than others. High concentration of dissolved solid which are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles in water is responsible for hardness, alkalinity (ASTM, 2004).

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### **Total dissolved solids**

The TDS in well water samples in the six locations ranged between 119mg/l to 580mg/l while that for borehole water samples ranged from 79mg/l to 435mg/l, which shows that the well water in the six locations contain higher content of TDS than the bore hole water samples but they are all below the standard value for drinking water (500mg/l) except for Gudaba well water having (580mg/l) which is above the permissible limit. All water sources in the study area are classified as fresh based on the proportion of TDS which fall between 0 to 1000 mg/L (Elueze, 2004). The TDS values observed are also within the range of the values (60 to 455 mg/L) observed by Oni (2000)

### **Hardness**

Hardness is caused by metallic salt (ion) of Calcium and Magnesium and sometimes Fe. These salts are usually in the form of bicarbonate, sulphates and chlorides (Apha, 1999). From the result obtained, the mean value for hardness in well water samples from the six locations ranged between 1.2mg/l to 3.6mg/l, while for borehole water samples, the mean values ranged between 1.6mg/l to 3.4mg/l, but they are all below the SON permissible limit (150mg/l) and FEPA(1991) standards for water quality: Drinking water (200mg/l)

### **Chloride**

Chloride content in the water quality serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects. In the present analysis, chloride content in well water samples from the three locations was found in the range of 1.6035mg/l to 6.997mg/l, and 1.3119mg/l to 4.227mg/l for boreholes, for all the three locations. All the mean values are below the standard value (250mg/l).

### **Manganese**

The maximum mean value of manganese of well water samples from the six locations was found in Angwan Gede (0.2608mg/l) with the minimum obtained in Angwar sanyi (-0.5773mg/l). In case of the borehole water samples, the maximum mean value was found in Angwar sanyi (-0.0951mg/l) while the minimum was recorded in Sauka Extension (-0.6806mg/l). The mean values for both well and borehole water samples from five locations fall below the standard value (0.2mg/l), except for well water Angwar Gede (0.2608mg/l) which is above the permissible limit. Drinking water containing high levels of manganese can lead to Neurological disorder (SON, 2007).

### **Iron**

The mean value of iron in well water samples from the six areas ranged between 0.92mg/l to 3.44mg/l, except for well water sample in Gudaba where it was not detected. While that of borehole water samples was found to range between 1.01mg/l to 3.59mg/l. It was found that the mean values of both well water and borehole water samples from all the six locations are above the standard value (0.3mg/l) except for Gudaba. However the mean values for borehole water samples shows they have higher values when compared to that of well water. Presence of high iron in drinking water may be due to the use of

various iron salts as coagulating agents in water-treatment plants and where cast iron, steel, and galvanized iron pipes are used for water distribution.

High presence of iron in water promotes undesirable bacterial growth ("iron bacteria") within a waterworks and distribution system, resulting in the deposition of a slimy coating on the piping. Aeration of iron-containing layers in the soil can affect the quality of groundwater if the nitrate leaching takes place.

#### **Lead**

The maximum mean value of lead in well water samples was found in Gudaba (2.0678mg/l) which is above the standard value (0.01mg/l). The minimum value for lead in well water samples was found in Angwar Gede (0.3624mg/l) which is also above the permissible limit, while in borehole water samples the maximum mean values was found in Sauka extension (1.7617mg/l), while the minimum mean value is Bayan town hall (0.1608) and are also above the permissible limit.

The presence of high lead concentration in water samples for the six locations might be due to the pesticides used decades ago or industrial activities that contaminated the soil and groundwater. Additionally, this could also result from household plumbing activities around the sampling sites. Excessive amount of lead in water can cause cancer, kidney disease, memory problems, high blood pressure, brain damage, hearing loss and behavioral problems (SON, 2007).

#### **Total coliform**

The concentration of the total coliform in well water and borehole water samples from the six areas was found to be (Nil). Therefore, there is no potential health risk that exists for the communities due to the presence of microbial pathogens in water.

#### **Conclusion**

From the overall results obtained, it is clear that Pb and Fe concentration of samples obtained from all the location are above SON standard value for drinking water and are attributed to the usage of iron salt for water treatment, steel and galvanizing iron for water distribution, pesticides and insecticides and plumbing activities. Most of the physicochemical parameters determined were within the SON permissible limit for drinking water. High level of dissolved and suspended matter were observed in Gudaba bore hole water and Bayan town hall well water which made them colorful. Bayan town hall bore hole, Angwar Gede bore hole, Agwar sanyi bore hole, Sauka extension bore hole, Angwar Gede well water, Gudaba well water, and Bayan town hall well water contains high presence of hydroxides, carbonate and bicarbonate making them more alkaline than others. The microbial growth for all the samples obtained is below detectable limit; therefore the water samples have minimal potential risk for microbial pathogens. The water sample from these study areas are not suitable for drinking but can be used for other domestic purpose, such as laundry, washing etc.

#### **Recommendations**

I. Domestic waste and effluents generated should be treated, re-processed for reuse purposes rather than being carelessly discharge into the water bodies.

II. Villagers should be regularly enlighten on how to defend their sources of drinking water from contamination and pollution

III. Government should enact laws that guarantee safe drinking water and minimize indiscriminate dumping of wastes on environment.

V. Regular monitoring of water sources to ensure conformity to the SON and or WHO standards and to assure the public of the portability of their water is necessary. In fact simple tests carried out regularly at short intervals are of more valued than detailed test mode occasionally.

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