Physicochemical Quality Assessment of Drinking Water Sources in Wukari Town, Nigeria

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Abstract

In this study, an assessment of drinking water sources in Wukari town, Nigeria was carried out using standard methods. Thirty (30) water samples collected from three sources (Borehole, hand dug wells and town supply) were evaluated for physicochemical properties. Among the parameters investigated, pH was found to range from 6.41 – 8.41, conductivity was in the range 80 – 600 µS/cm, turbidity ranged between 0.15 – 7 NTU, total dissolved solids (TDS) ranged from 7.54 – 154.6 mg/L and total hardness was in the range of 21 – 112 mg/L. Chemical oxygen demand (COD) and dissolved oxygen (DO) ranged between 50 – 110 mg/L and 3.12 – 14.47 mg/L. Chloride and sulphate contents ranged between 28 – 128 mg/L and 1.65 – 19.34 mg/L respectively. The levels obtained in this study were mostly within the WHO recommended limits with few exceptions which are; turbidity, dissolved oxygen and nitrates in some samples. Water quality Index (WQI) which was evaluated by means of the weighted arithmetic method revealed a score of 39.40 for borehole samples, 61.60 for town water supply samples and 88.04 for well water samples. These values indicate good water quality for the borehole source, poor water quality for town supply and very poor water quality for well water.

Key words: *Drinking water, Water quality index (WQI), physicochemical parameters,*

1. INTRODUCTION

Adequate, clean, accessible, and safe drinking water is a major requirement for all human life and an essential step towards improving living standards. Although water is available in most parts of the world, it is seldom safe for human drinking and mostly ranks below the requirements for basic health needs. The lack of potable water in most parts of the world is creating issues of serious public health concern; poor drinking water quality has been linked to the occurrence of many diseases all over the world. According to the World Health Organization (WHO) survey, 80% of the world's diseases and 50% of the world's child deaths are related to poor drinking water quality (Lin *et al.*, 2022). Diseases caused by poor drinking water include diarrhoea, skin diseases, gastrointestinal problems organ damage, cancer among others (www.epa.gov/report-environment/drinking-water). Chemical exposure through drinking water can lead to a variety of short and long-term health effects. Exposure to high doses of chemicals can lead to skin discoloration or more severe problems such as nervous system or organ damage and developmental or reproductive effects. Exposure to low doses over long periods of time can lead to chronic, longer-term conditions such as cancer. The effects of some drinking water contaminants are not yet well understood (www.epa.gov/report-environment/drinking-water). Overall, the negative health effects of water pollution remains the leading cause of morbidity and mortality in developing countries (Lin *et al.*, 2022).

Anthropogenic and geogenic pollutants are mostly responsible for chemical and physical contamination of water sources rendering significant amounts of water unfit for human use. For example, more than six million tons of petroleum hydrocarbons enter into the aquatic system yearly (Loyeh and Mohsenpour 2022). This is equivalent to indiscriminate dumping of many persistent toxic organic pollutants into the aquatic environments. The acceleration of urbanization and industrialization has lead to the generation of large volumes of toxic organic and inorganic substances which are haphazardly discharged into the atmosphere. Chemicals such as arsenic, cadmium, and chromium are among the harmful pollutants being discharged into water bodies (Chen *et al.*, 2019). The agricultural sector is also a significant contributor of harmful pollutants in water; pesticides, nitrogen fertilizers and organic farm wastes from agricultural activities lead to the contamination of water sources with nitrates, phosphorus, soil sediments, salts pathogens and many other harmful chemicals (Paris, 2011). In general, inadequate management of urban, industrial and agricultural effluents causes the drinking-water of millions of people to be dangerously contaminated or chemically polluted. Natural presence of chemicals, particularly in groundwater, can also be of great health significance. Other chemicals may be elevated in drinking-water as a result of leaching from water supply components in contact with drinking-water.

The global prevalence of many diseases associated with unsafe drinking water indicates requirements for regular evaluation of drinking water sources. The physical, chemical, biological and aesthetic properties of water are important parameters that should be regularly investigated in order to safeguard public health. Against this background, the current study is aimed at assessing some physicochemical properties of drinking water sources in wukari town, Taraba state, Nigeria. The major sources of water in wukari town are are hand-dug wells, boreholes and municipal town supply. The quality of the water samples from these sources will be evaluated against the standards for drinking water recommended by World Health Organisation (WHO) and their overall qualities will be established in accordance with laid down methods. Findings from this work would help ascertain the safety of the water sources in the community and the information obtained would be of great benefit to the population. The study would also add to the data on drinking water quality in Nigeria and help policy makers in taking decisions to safeguard sustainable access to adequate quantities and acceptable quality of water for sustaining human health and livelihoods.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is Wukari town in Wukari Local Government Area, Taraba State, North-eastern Nigeria. The town lies on the coordinates Latitude 7° 52' 47.86''N and Longitude 9° 46' 37.66''E covering an area of 4,308 km^2 and having a population of 241,546 based on the 2006 census. It shares boundaries with Benue and Nasarawa States of Nigeria and has a typical climate of the tropical zone with a mean annual temperature of 27.5°C. The climate is characterized by two distinct seasons; dry and wet. The dry season spans from October to April while rainy season is from May to September with an annual rainfall of 1058mm-1300mm and relative humidity of about 15%. The months of December, January and February are cold due to harmattan wind blowing from the north–east of Nigeria. The sediments are generally comprised of sandstones, siltstone and forest soils which are rich in humus and very good for crop production. The major occupations in the study area are farming, fishing and livestock production. More than 70% of the inhabitants are predominantly farmers while few engage in fishing business. The sources of water in the area are government owned and private boreholes, deep wells and state municipal water supply.

2.2 Sample Collection

Ten (10) water samples each were collected from boreholes, hand- dug wells and municipal water supply sources within Wukari town, Nigeria to make a total of 30 samples. The samples were collected between the months of February –May 2023. Sampling points were selected by a simple random sampling method. The water Samples were collected in sterilized glass bottles which were rinsed thoroughly with nitric acid and distilled water.

2.3 Physicochemical Analysis of Water Samples

The physicochemical parameters of the water samples namely; namely pH, conductivity, turbidity, total dissolved solids (TDS), total hardness (TH), chemical oxygen demand (COD), dissolved oxygen (DO), sulphate, nitrate, and phosphate were determined using standard methods of analysis; The pH was determined using the pH meter (Hanna HI 2020) which was standardized prior to the analysis with a buffer solution of pH range between 4 and 9. Determination of conductivity, turbidity and total dissolved solid was done using DDS-307 conductivity meter.

Total hardness was measured by complexometric titration using disodium salt of EDTA in the presence of Eriochrome Black T as indicator. For the determination of COD, 50 ml of the water sample was taken in a reflux flask, and 10 mL of potassium dichromate solution with 1 g mercuric sulphate was added and thoroughly mixed. To this, 10 mL of concentrated sulphuric acid containing silver sulphate was added through the open end of the condenser carefully and mixed by swirling motion. The reflux apparatus was operated for around 1 hour and allowed to cool. The flask was removed, and its content was diluted to 150 mL with distilled water. To the resulting solution, three drops of the ferroin indicator were added. This sample was titrated with standard ferrous ammonium sulphate to an end point where blue-green colour just changed to reddish-brown. Chemical oxygen demand (COD) of the blank and sample was then calculated.

Dissolved oxygen was determined using azide modification of Winkler's method. 200 mL of the water sample was carefully transferred into a 300 ml BOD bottle. 1 mL of manganese sulphate solution was added followed by 1 mL of the alkaline alkali-iodide-azide reagent. The resulting mixture was titrated against 0.025 N sodium thiosulphate to the end point where there was colour change. The titre value was recorded as DO (Biswas, 2015).

Chloride content was determined by the argentometric method. The samples were titrated with standard silver nitrate using potassium chromate indicator. Nitrate was determined via reduction method and the resulting nitrite determined by reaction with sulphanilic acid in the presence of N-(1naphathyl) ethylenediamine to form a reddish dye. Phosphate was determined by a colorimetric method where 2 ml aliquot of water sample was taken in a 25 ml volumetric flask, and one drop of the phenolphthalein indicator was added followed by 2 mL of ammonium molybdate, and then, 1 mL of freshly diluted stannous chloride solution. These were made up to 25 mL volume with distilled water and mixed thoroughly and after 5-6 minutes, the colour intensity (absorbance) was measured at a wavelength of 660 nm in a spectrophotometer.

Sulphate was determined by the gravimetric/turbidimetric method using $BaCl_2$ as precipitant. 50 mL of the sample was measured into a 250 mL beaker and diluted to 150 mL with distilled water. 1 mL of conc. HCl and four drops of the methyl orange indicator were added. To this, 10 mL of 10% barium chloride solution was added and then boiled for 5 minutes. The solution was retained overnight and then filtered using whatman filter paper. The filter paper was rinsed with distilled water and dried at 80°C in an oven by using the silica crucible and then ignited at 800°C in a muffle furnace for 1 hour, cooled and then weighed. Ignition, cooling, and weighing were repeated to give a constant value. Sulphate concentration was then calculated from the obtained weight of $BaSO_4$ precipitate.

2.4 Determination of Water Quality Index (WQI)

Water quality index for the three water sources was evaluated from eleven parameters; pH, conductivity, turbidity, total dissolved solids, total hardness , chemical oxygen demand dissolved oxygen (DO), sulphate, nitrate, and phosphate. The evaluation was done using the weighted arithmetic method (Boah *et al.*, 2015). The mean values of the physicochemical parameters were used with respect to the standard values set by WHO for drinking water in accordance with general equation:

$$WQI = \frac{\Sigma QnWn}{\Sigma Wn}$$

Where, Where: Qn = Quality Rating; Wn = Unit Weight The quality rating was determined using the formular:

$$Qn = \frac{100(Vn - Vio)}{Sn - Vio}$$

Where: Vn = Estimated value for nth water quality parameters of collected samples; Sn =Standard permissible value of the nth water quality parameters; Vio - Ideal value of the nth water quality parameter in pure water (it is 0 for all other parameters except for pH, which is 7 and DO which is 14.6). The unit weight (Wn) was obtained by calculating a value inversely proportional to the recommended standard value (Sn) of the corresponding parameter, (i.e Wn = 1/Sn).

3 Results and Discussions

Table 1 presents the range and mean levels obtained for the physicochemical parameters of the three water sources investigated in this study. The mean pH levels obtained for all the water sources were within the WHO recommended range. However, some samples from the hand dug wells revealed pH values slightly lower than the 6.5 recommended lower limit. Overall, the pH of the water samples did not vary significantly among sampling points.

The mean conductivity values were found to be 131, 307 and 90 µs/cm for the borehole, well and town supply water samples respectively. All the values obtained were below the permissible limit of 1000 µs/cm set by the WHO. A similar study carried out in Wukari town reported mean conductivity value of 268.5 and 329 µs/cm for borehole and well water samples respectively (Aremu *et al.*, 2017). These values are higher than what we report in the current study. Electrical conductivity is an important physicochemical parameter considered as an indirect indicator of pollution because it bears a close relationship with dissolved salt content present in water and it is often associated to sewage discharge. The low conductivity values recorded in this study could therefore be an indication of low content of dissolved salts.

Turbidity is a parameter that indicates the cloudiness or haziness of water. It is usually caused by very small particles will settle only very slowly or not at all if the sample is regularly agitated. The particles are colloidal in nature. The mean turbidity value obtained for borehole water was 0.32 NTU, well water was 5.4 NTU while town water supply was 2.0 NTU. The values obtained for bore hole and town supply were within acceptable range however the value for well water samples was above the recommended limit of 5.00 NTU. An elevated water turbidity is as an indicator of a water-quality-related problem that could include the presence of settleable and non-settable materials like sand, silt, or clay, iron, manganese, rust, biofilms, chemical scale or precipitates, or corrosion by-product The reason for the high turbidity of well water samples could also be attributed to the regular agitation involved in drawing water. A similar study carried in the same study area also recorded higher turbidity in well water than obtained in borehole water samples (Aremu *et al.,* 2017).

Water has the ability to dissolve a wide range of inorganic and some organic minerals or salts such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates etc. These minerals usually produce un-wanted taste and in water. This quality is represented by total dissolved solids (TDS). High TDS value indicates that water is highly mineralized. In this study, mean TDS values of 10.34, 123.4 and 68.2mg/L were recorded for the three sampling groups. All the values were below the maximum permissible limit of 500 mg/l which is prescribed for drinking purpose. Higher values (ranging from 100 – 360 mg/L) were reported in a study of borehole and well water samples in Akungba, Ondo state (Olubanjo *et al,* 2019). A similar study in Umuihi town, Imo state also reported higher values (77.3 – 787 mg/L) than our current study . High values of TDS in ground water are generally not very harmful to human beings, but may cause laxative or constipation effects (Saskiran *et al.,* 2012).

Total hardness (TH) of water is a property that is attributed to the presence of alkaline earth metals.. Water can be classified into soft (75 mg/L), moderately hard (75–150 mg/L), hard (150–300 mg/L) and very hard (300 mg/L) (Sawyer and McCarty 1967). The hardness of groundwater in the study area varied from 21-95 mg/L for borehole samples, 41-91 mg/L for well water and 43 - 112 mg/L for town water supply. From the result obtained, the well water had higher level of total hardness. This suggests the presence of more insoluble metals and salts in the well water than in the borehole and town water supply. However, all the samples analysed had TH levels below the WHO permissible limit of 500 mg/L.

Chemical oxygen demand (COD) is the amount of dissolved oxygen that must be present in water to oxidize chemical organic materials. It is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution. The World Health Organization (WHO) recommends that the maximum permissible limit of COD in drinking water should not exceed 200 mg/L. This limit is set to ensure that the water is safe for human consumption and does not cause any adverse health effects. In this study, mean COD values obtained were 54 mg/L for borehole samples, 89 mg/L for well water and 80 mg/L for town water supply samples. The COD values for all the samples were below the WHO permissible limit. Similar values for COD have been reported for borehole water samples analysed from the same study area: the reported values ranged from 88 – 90 mg/L for borehole water and 92 - 94 mg/L for well water samples ((Aremu *et al.,* 2017).

The test for dissolved oxygen (DO) is usually carried out to measure the changes that occur in biological parameters due to aerobic or anaerobic phenomenon, and to know the condition of the river water which is vital for aquatic organisms as well as human life (Gupta *et al.,* 2017). DO is a measure of the degree of pollution by organic matter and the destruction of organic substances, as well as the self-purification capacity of the water body. The result obtained in this study (Table 1) revealed DO values ranging from 3.12-14.47 mg/L with a mean value of 10.6 mg/L for bore hole samples, 2.03-12 mg/L with mean of 4.86 mg/L For well water and 1.09-6.87 mg/L with mean of 4.4 mg/L for town water supply. According to the WHO, the permissible limit of dissolved oxygen in most rivers, lakes and stream that is required for most aquatic organisms life is at least 5mg/l. Drinking water without conventional treatment should have DO of 6 mg/l or more and 4 mg/L or more after treatment and disinfection (http://117.252.14.242/rbis/india_information/water%20quality%20standards.htm). The low

DO levels recorded for some of the investigated samples could be attributed to the . unique environmental characteristics of underground spaces and geographical locations; a typically enclosed environment below the surface of earth which is prone to decreased oxygen concentrations and increased carbon dioxide concentrations. Oxygen concentrations in deep wells have been shown to decrease with increasing depth (Wuthichotwanichgij *et al.*, 2015). Low values of DO in well and borehole water samples have been reported by similar studies (Oko *et al.*, 2017).

Table 1 Physicochemical Assessment of Drinking water samples from different sources in Wukari, Nigeria

	Borehole Water		**Well water**		**Town water Supply**		**WHO standard**
Parameter	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ±SD	
pH	7.21-8.41	7.8 ± 0.8	6.41-7.72	7.0±0.61	6.97-7.82	7.38±0.34	6.5-8.5
EC (µS/cm)	80 - 241	131 ± 72.69	150-600	307.8±205	20-150	90±51.48	1000
Turbidity (NTU)	0.15-0.48	0.32±0.18	4-7	5.4±1.14	1.5-3.0	2.0±0.71	5
TDS (mg/L)	7.54-13.4	10.34±2.68	87.4. -154.6	123.4±35.1	47.8-77.4	68.2±22.8	500
TH(mg/L)	21-95	52 ± 37.65	41-91	74.9±19.87	43-112	66±28.46	500
COD (mg/L)	50-70	54±8.94	50-105	89±22.47	90-110	80±7.07	200
DO (mg/L)	3.12-14.47	10.6±6.25	2.03-12	4.86±4.12	1.09-6.87	4.4±2.17	5
Chloride (mg/L)	31-85	50.8±21.08	33-83	49.4±20.31	28-128	48±40.18	250
Sulphate (mg/L)	2.28-3.62	3.06 ±0.68	1.65-2.46	2.12±0.32	2.3-19.34	7.07±7.03	400
Nitrate (mg/L)	37.19-133.85	119.19 ±65.56	61.98-433.85	163.76± 154.71	10.19-185.93	101.2±80.2	50
Phosphate (mg/L)	5.92-7.05	6.5±0.48	3.89-8.35	5.97±1.61	5.86-6.68	6.33±0.35	6.5

The chloride levels recorded in this study were all below the WHO permissible limit of 250mg/L. the values obtained ranged from 31-85 mg/L for Borehole samples, 33-83 mg/L for well water samples and and 28-128 mg/L for town water supply samples. Chloride in water usually comes from the dissolution of salts such as sodium chloride (NaCl), magnesium chloride ($MgCl_2$) and calcium chloride. Chlorides can also be introduced into water from chlorine-based product such as sodium hypochlorite, calcium hypochlorite which are used as a disinfectants. Consuming drinking water containing chloride is not harmful to health however, high amounts of chloride can give a salty taste to water and can corrode pipes, pumps and plumbing fixtures.

Low levels of sulphates were recorded for all the water samples analysed in this study. The values ranged from 2.28- 19.34 mg/L with mean values of 3.06 mg/L 2.12 mg/L and 7.07 mg/L for bore hole, well and town supply samples respectively. The WHO established a limit of 400 mg/l as the highest desirable level of sulfate in drinking water. The results obtained in this study indicate that the concentration of sulfate in investigated samples are lower than the recommended limit hence would not be harmful to human health.

The nitrate contents obtained in this study varied in the range of 37.19-133.85 mg/L with a mean of 119.19 mg/L for borehole samples, 61.98-433.85 mg/L with mean of 163.76 mg/L for well water and 10.19-185.93 mg/L with mean of 101.2 mg/L for town supply. The mean levels obtained for the three sampling categories were all above the WHO permissible limit of 50 mg/L. Nitrate commonly occurs naturally in groundwater, but high concentration might be associated with animal and human waste, open septic or sewage systems and fertilization of farms (Akaahan *et al.*, 2010). Excessive NO_3^- in drinking water can cause a number of disorders including methemoglobinemia in infants, gastric cancer, goiter, birth malformations and hypertension (Majumdar and Gupta, 2000).

The values of phosphate obtained for borehole water samples ranged from 5.92-7.05 mg/L with a mean of 6.5 mg/L, for well water samples, the values ranged from 3.89-8.35 mg/L with 5.97 mg/L mean and for town water supply the values ranged from 5.86-6.68 mg/L with a mean of 6.33 mg/L. The obtained mean levels for the three sources were within the WHO permissible limits for drinking water. Phosphate may occur in groundwater as a result of domestic sewage, detergents and agricultural effluents with fertilizers (Murhekar, 2011). Normally, groundwater contains only a minimum phosphorus level because of the low solubility of native phosphate minerals and the ability of soils to retain phosphate (Devendra *et al.*, 2014). Phosphates are not toxic to people or animals however, it can lead to digestive problem when ingested in very high level (Kumar and Puri, 2012).

A comparison of mean physicochemical parameters of the three water sources (borehole, well and town supply) alongside the WHO permissible limit is presented in Figures 1 and 2. The distribution shows compliance to permissible levels with respect to conductivity, TDS, total hardness, COD, chloride, sulphates, pH and phosphates. However, all the water sources were not in compliance with respect to nitrate levels. For turbidity, only the well water source was out of the acceptable range while for dissolved oxygen, the ≥ 5 mg/L recommended level was only recorded for borehole and well water samples. Overall our findings show 100% compliance for borehole water, 81% for well water and 91% for town water supply.

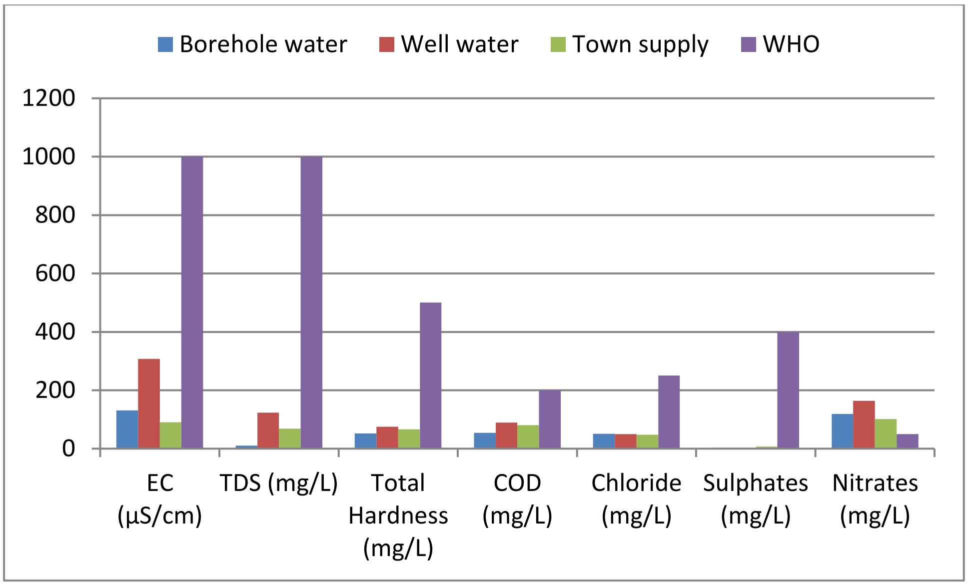

Figure 1 Comparison of physicochemical parameters in drinking water samples from Wukari with WHO standards

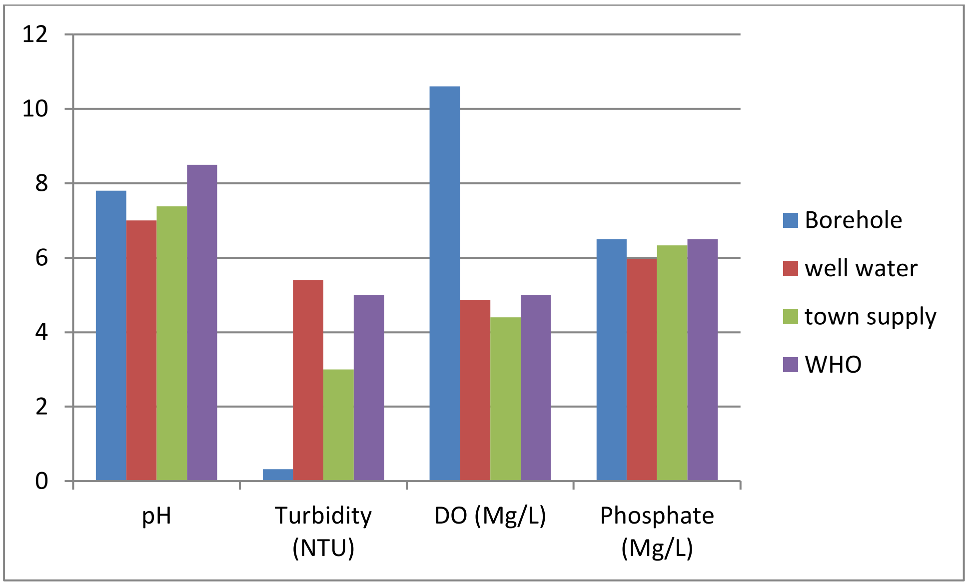

Figure 2 Comparison of physicochemical parameters in drinking water samples from Wukari with WHO standards

Tables 2, 3 and 4 present Water quality index (WQI) evaluation of the three water sources investigated. WQI provides a single number that expresses the overall quality of water at a certain location and time, based on several water quality parameters. The objective of WQI is to turn complex water quality data into information that is understandable and usable by the public. In this study, WQI values obtained by means of the weighted arithmetic method [7] were 39.40, 61.60 and 88.04 for borehole, town supply and well water samples respectively. A classification of water quality based on the weighted arithmetic water quality index (WQI) method is presented in Table 5. In the classification, a WQI ranging between 0 and 25 is rated excellent water quality and graded as A, whereas an index greater than 100 is considered unsuitable for drinking purpose and is graded as E. The WQI values in this study indicate that the borehole water scored 'B' (good water quality), the town supply samples scored 'C' (poor water quality) while the score for well water sample was 'D' (very poor water quality).

Table 2 Water Quality Evaluation of Borehole water samples from wukari, Nigeria

parameter	Experimental Value	Standard Value (Sn)	Wn (1/Sn)	Quality rating (Qn)	QnWn
pH	7.8	8.5	0.118	53.33	6.29
EC (µS/cm)	131	1000	0.001	13.1	0.013
Turbidity (NTU)	0.32	5	0.2	6.4	1.28
TDS (mg/L)	10.34	500	0.002	2.068	0.004
TH (mg/L)	52	500	0.002	10.4	0.02
COD (mg/L)	54	200	0.005	27	0.135
DO (mg/L)	10.6	5	0.2	41.66	8.33
Chloride (mg/L)	50.8	250	0.004	20.32	0.081
Sulphates (mg/L)	3.06	400	0.0025	0.78	0.002
Nitrates (mg/L)	119.19	50	0.02	238.38	4.8
Phosphate (mg/L)	6.5	6.5	0.015	100	1.5
			ΣWn = 0.57		ΣQnWn = 22.46

WQI (ΣQnWn/ ΣWn) = 39.40

Table 3 Water Quality Evaluation of Well water samples from Wukari, Nigeria

parameter	Experimental Value	Standard value(Sn)	Wn (1/Sn)	Quality rating (Qn)	QnWn
pH	7.0	8.5	0.118	0	0
EC (µS/cm)	307.8	1000	0.001	30.78	0.03
Turbidity (NTU)	5.4	5	0.2	108	21.6
TDS (mg/L)	123.4	500	0.001	2.34	0.002
TH (mg/L)	74.9	500	0.002	14.98	0.029
COD (mg/L)	89	200	0.005	44.5	0.22
DO (mg/L)	4.86	5	0.2	101.45	20.29
Chloride (mg/L)	49.4	250	0.004	19.76	0.079
Sulphates (mg/L)	2.12	400	0.0025	0.53	0.0013
Nitrates (mg/L)	163.76	50	0.02	327.52	6.55
Phosphate (mg/L)	5.97	6.5	0.015	91.85	1.38
			ΣWn = 0.57		ΣQnWn = 50.18

WQI (ΣQnWn/ ΣQn) = 88.04

Table 4 Water Quality Evaluation of town water supply Samples from Wukari, Nigeria

parameter	Experimental Value	Standard value(Sn)	1/Sn (Wn)	Quality rating (Qn)	QnWn
pH	7.38	8.5	0.118	0.23	0.028
EC (µS/cm)	90	1000	0.001	9	0.009
Turbidity (NTU)	2	5	0.2	40	8
TDS (mg/L)	68.2	1000	0.001	6.82	0.007
TH (mg/L)	66	500	0.002	13.2	0.026
COD (mg/L)	80	200	0.005	40	0.2
DO (mg/L)	4.4	5	0.2	106.25	21.25
Chloride (mg/L)	48	250	0.004	19.2	0.077
Sulphates (mg/L)	7.07	400	0.0025	1.77	0.004
Nitrates (mg/L)	101.2	50	0.02	202.4	4.05
Phosphate (mg/L)	6.33	6.5	0.015	97.38	1.46
			ΣWn = 0.57		ΣQnWn = 35.11

WQI (ΣQnWn/ ΣQn) = 61.60

Table 5 Classification of Water Quality based on Weighted Arithmetic WQI

WQI value	Water quality rating	Grading
0 -25	Excellent water quality	A
26 - 50	Good water quality	B
51 - 75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking	E

Source: (Boah *et al.*, 2015)

4. CONCLUSION

Physicochemical assessment of water samples from borehole, well and town supply and from Wukari, Nigeria was carried out in this study. Our findings show that most of the physicochemical parameters were within the WHO recommended standards for drinking water with exception of turbidity, DO and nitrates where the levels fell short of expectations in some cases. Despite the finding that most of the tested parameters fell within permissible limits of the WHO standards, the calculated Water Quality Index indicated that only the borehole source was of good quality; the well and town water supply showed poor and very poor water quality respectively This could be a consequence of the few parameters that fell outside the recommended limits. We recommend routine water quality monitoring by regulatory bodies in order to safeguard public health. Improved government interventions in the area of the supply of clean and safe water to the public is also highly recommended

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