



## Quality assessment of water supply at Nsukka town in Enugu State, Nigeria

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### Abstract

The different freshwater sample collections took place at different locations of water supply at Nsukka town (New University road, Ugwuoye and Isiakpu). The samples were analytically assessed for their physio-chemical and bacteriological characteristics. The nature of work carried out involved samples collection preparation and analysis of the sample. Results obtained from various analyses were compared to standards set by the WHO and NAFDAC. It was inferred that the physical parameters fell within the standards except for colour which was high in borehole. The general results showed that the sources are not chemically polluted since the concentration of inorganic parameters are not higher than the WHO and NAFDAC drinking water standards. The analytical results also showed bacteriological contamination of well water, this means ensuring proper treatment before consumption. This implies that the *E.coli* that has polluted the well water might have come from sewage waste, livestock or agricultural waste. In a nut shell, the analytical result showed a pH of 6.6 for well water, 6.8 for borehole and 7.2 for tap water. *E.coli* was found to be absent in both tap water and borehole but detected in well water.

**Keywords:** Bacteriological analyses, chemical parameters, physical parameters, sample collection, water pollution.

### Introduction

Water is the medium from which life originated and existed. It means that living things cannot survive without water. The importance of water to life cannot be over-emphasized as more than 60% of human activities involve the utilization of water<sup>1</sup>. Water is the most abundant single compound on earth. It occupies two-thirds of the earth mass. Water is associated with some health hazards and mishaps<sup>2</sup>. WHO report have clearly shown that 80% of illnesses today are water related and improper use of water can lead to illness or even death<sup>3</sup>. Some of the diseases caused by water contamination include dysentery, typhoid fever, cholera and hemosiderosis. There is no pure water in nature because being a universal solvent, it tends to react with or dissolve to varying degree substances which it comes in contact with. Therefore, water quality depends on physico-chemical and bacteriological characteristics<sup>4</sup>. Quality can be pronounced when judged with a defined standards. The quality of water suitable for a particular aim depends on the standard acceptable for that use. NAFDAC and WHO have both set standards for drinking quality water. Water is considered polluted when it comes in contact with and dissolves unwanted substances called pollutants that alter the quality of the water. The kind and extent of pollution to be expected of particular water depends on the source of pollutant<sup>5</sup>.

### Material and methods

**Sample Collection:** Samples were collected from three different locations at Nsukka town of Enugu state. These samples locations include New University road, Ugwuoye and

Isiakpu. The water sources that were being examined are tap, borehole and well respectively. The different samples were collected using labelled water containers. The water from tap was collected directly, that from borehole was also collected directly while that from well was collected using a small plastic bucket tied to a string. A total of nine samples were being examined and approximately one from each source.

**Procedures:** Water samples collected were analysed for Physical, chemical and bacteriological characteristics. These include pH, turbidity, odour, total hardness, calcium and magnesium hardness, cations like  $Zn^{2+}$ , anions like  $Cl^-$  and  $SO_4^{2-}$  and coliform organism.

**Determination of pH:** 10ml of the sample water were measured using the sample cell. Two drops of bromothymol blue indicator was added to each sample. The sample was stopped using the finger-thumb and shaken properly. After this, the cells were placed inside the lovibond colour comparator, the disc was rotated while viewing the colour match and the corresponding pH values were determined and recorded respectively.

**Determination of Turbidity:** 25ml cells were used to measure equal volumes of water samples. The stored program number for turbidity was entered by pressing 750 and the Read/enter key was also pressed. The wavelength dial was rotated until the display showed 450nm and the spectrophotometer automatically conditions itself to FTU by pressing the enter key again. The distilled water was first inserted in the cell holder as a control and the shield light was closed. The key of zero was then pressed and 0.00 FTU was displayed, which served as the

control experiment. These were repeated for the other water samples and the results obtained were recorded.

**Determination of Odour:** The conical flask was rinsed both internally and externally using 4M HCl solution until it was completely odourless. The flask was finally rinsed with distilled water. The flask was now half-filled with tap water, stopped and shaken for 3 -5 seconds. The stopper was removed and the odour of the water was quickly noted by putting the nostrils near the mouth of the flask. The same procedures were repeated for both well and borehole waters.

**Determination of Total Hardness:** The water sample to be tested was emptied into a mixing bottle. Then buffer solution was added dropwise and swirling was done simultaneously. A drop of hardness indicator, Manver was added as well. A dropwise of EDTA titrant was added too, and a colour of pink appeared which later change to blue. The number of drops added was multiplied by 20 to arrive at the total hardness in mg/L. The value now gives the total hardness of the water sample.

**Determination of Hardness of Calcium:** The water sample to be tested was emptied into a mixing bottle. Then two drops of 8N KOH solution and two pillow of calcium indicator powder were dropped to the mixing bottle. A drop wise of EDTA titrant was added too, and a colour of pink appeared which later change to blue. The number of drops added was multiplied by 20 to arrive at the calcium hardness in mg/L.

**Determination of Zinc ( $Zn^{2+}$ ):** Zircover reagent was dissolved in 25 ml of the samples of water in every cell tubes. The cell tubes were inserted into the DR. 2000 spectrophotometer at different time and the wavelength of 620nm and program number of 180 was entered. The light shield was closed, zero was pressed and later Enter key was also pressed for reading.

**Determination of  $SO_4^{2-}$ :** The water samples were poured into different cell tubes. Then sulfaver reagent was added and shaken for proper dissolution. The cell tubes on different occasions were inserted into the DR 2000 spectrophotometer and the light shield closed. A program number of 450nm was entered and a wavelength of 680nm was dialled as well, after which zero was pressed and later enter key pressed. The results obtained were recorded.

**Determination of Coliform Bacteria:** 35g of MacConkey broth was weighed in 100ml of distilled water. It was the properly mixed with the aid of a sterile. The new syringe, the bottles were sterilized and the surrounding of the experiment. Hands was also disinfected with the use of Dettol. The resulting mixture was then autoclaved for 15 minutes at 121°C (this is mainly to sterilize the agar). In other words, 10ml of the agar was then transferred into 15 samples bottles with the aid of a syringe ( that is each bottle contains 10 ml of the agar) inverted Durham tubes were then inserted into each of the 15 sample

cells. To the first 5 bottle cells, 10 ml of the water sample was introduced using a different syringe. To the next 5 cells, 1 ml was introduced and to the last 5 cells, 0.1 ml was introduced. The bottles were incubated at 37°C for about 24 hours (during this period, bacteria feed, grow and respire). The presence of bacteria in the sample was indicated by a colour change from purple to yellow and gas collected in the Durham's tube (this is known as presumptive test). For other water samples that were used for this analysis, if no significant colour change was being observed, the incubation is allowed for another 24 hours that is 48 hours (confirmative test).

## Results and discussion

The average of the analytical results of the physico-chemical parameters were compared with the standards of both World Health Organization (WHO) and National Agency for Food and Drug Administration and Control (NAFDAC). The colour parameter in PtCo for the tap water ranges from 3.6 -4.6, with an average of 4.0 which falls within the standard range of 6-50, that of borehole ranges from 96-107 with an average of 101 which negate the standard range, while that of well water ranges from 13-20 with average of 17 which also falls within the standard. Colour and taste for the samples were all unobjectionable. The average turbidity in FTU (Formazin Turbidity Unit) for tap water, borehole and well water were 2, 5 and 28 respectively. But the standard ranges from 5-25 which means that the turbidity of the well water was above standard. The average total hardness of tap water, borehole and well water were 100, 220 and 260mg/L respectively which falls also within WHO and NAFDAC standards of 500-1500. The tap water has average pH of 7.2 that of borehole was 6.8 while that of well water was 6.6 which are all within standards of 6.8-8.5. The bacteriological *E.Coli* were both undetectable in both tap water and borehole but was detectable in well water which makes it significantly unfit for human consumption without treatment.

**Physical Parameters:** Parameters such as colour, taste, odour and total dissolved solids (TDS) fell within this category. Taste and odour of the water samples have unobjectionable quality with NAFDAC and WHO laid standards. The colour of water samples from tap water had a bright appearance while that from boreholes and wells appeared dull and coloured due to high amount of solid dissolved in it. The values for total dissolved solids for tap water, well and borehole were in line with set standards.

**Chemical Parameter:** The total hardness of well water ranges from 250-260mg/L as magnesium and calcium carbonate which confirms that most of the well waters were dug on rocks. Boreholes contained 200-220mg/L and tap water with 100 mg/L. This is simply below the WHO and NAFDAC standard range of 500-1500mg/L. Turbidity results showed that both borehole and tap water are within the range except for well water that is above the set standard. Also pH for borehole was within 6.7-6.8 and that of tap water was 7.2. This depicts that

the water is fit for human consumption since it is in line with NAFDAC and WHO drink water standard of 6.8-8.5 while that of well water of 6.6 is below the range. Zinc was noticed to be present in tap water with a value of 0.005 mg/L, it is also found in trace amount in boreholes and wells with values of 0.97mg/L and 0.12mg/L respectively. The zinc has a threshold taste at approximately 5mg/L and can cause opalescence above this value.

**Bacteriological Analysis:** In this analysis, both the borehole and tap water shows absence of *Escherichia coli*. This may be due to the treatment process of tap water and the disinfection of the borehole. In well water, the presence of *E.coli* means the water was polluted in the relative extent of pollution expressed in the relative abundance of *Escherichia coli* bacteria per 100 ml of the sample. As a result of this, well water from these selected areas from Nsukka town is not fit for human consumption due to its situation suspected to be close to sewage discharge, livestock waste and agricultural waste.

**Table-1:** WHO and NAFDAC Guidelines for potable water (2004).

parameters	unit	WHO standards for drinking water maximum allowable	NAFDAC standards for drinking water.
Taste		unobjectionable	Unobjectionable
colour	PtCo	5.0	6.0
pH range		7.0 -8.5	6.8-8.5
Turbidity	FTU	5.0	
Cyanide	mg/L	0.01	0.05
Odour		unobjectionable	unobjectionable
Sulphide	mg/L	200-400	150-350
Chlorine	mg/L	0.4-1.0	1.0
Iron	mg/L	0.05 -0.3	0.05 -0.3
Sulphate	mg/L	200 -600	200 -500
Magnesium hardness	mg/L	50	30
Calcium hardness	mg/L	75-200	50-200
Total Dissolved Solids	mg/L	500-1500	400-1400
Electrical Conductivity	µs	1.2-1.4	1.2-1.4
Lead	mg/L	0.1	0.03
Nitrate	mg/L	45	43
phenol	mg/L	0.01-0.02	0.02
Zinc	mg/L	0.05-1.5	0.04-1.6
Bacteriological <i>E.coli</i>		Undetectable	Undetectable

**Table-1:** shows that for water to be fit for consumption, it must be in conformity with the standards.

**Table-2:** Results of the Analyses of water samples obtained from three locations in Nsukka Town.

Zone	New University Road			Ugwuoye			Isiakpu			
Sample location		Tap water A	Borehole D	Well G	Tap water B	Borehole E	Well H	Tap water C	Borehole F	Well water I
Physical parameters	Unit									
Colour	PtCo	4.6	102	18	3.4	96	20	4.0	107	13
Odour		-	-	-	-	-	-	-	-	-
Taste		-	-	-	-	-	-	-	-	-
Turbidity	FTU	2	5	26	3	6	28	1.0	4	30
Chemical Parameters										
Total Hardness	mg/L	100	220	260	100	220	260	100	220	260
Calcium Hardness	mg/L	80	200	180	80	200	180	80	200	180
Magnesium Hardness	mg/L	20	20	80	20	20	80	20	20	80
Chlorine	mg/L	0.11	0.1	0.1	0.1	0.1	0.1	0.11	0.1	0.1
TDS	mg/L	0.02	0.04	0.13	0.002	0.04	0.14	0.002	0.32	0.13
Sulphate	mg/L	0.00	0.17	8	0.00	0.16	10	0.00	0.15	6
Zinc (Zn <sup>2+</sup> )	mg/L	0.05	0.98	0.12	0.06	0.96	0.12	0.04	0.98	0.14
pH		7.2	6.8	6.6	7.1	6.9	6.7	7.0	6.7	6.6
Bacteriological Coliform										
Presumptive Test		-ve	-ve	+ve	-ve	-ve	+ve	-ve	-ve	+ve
Confirmatory test.		-ve	-ve	+ve	-ve	-ve	+ve	-ve	-ve	+ve

**Table-3:** Comparison of Average water quality Data with NAFDAC and WHO Standards.

Parameters	Units	Tap water ABC	Borehole DEF	Well GHI	WHO and NAFDAC Standards
Colour	Pt Co	4.0	101	17	6-50
Odour		Unobjectionable	unobjectionable	Unobjectionable	unobjectionable
Taste		Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Turbidity	FTU	2	5	28	5-25
Chemical parameters					
Total Hardness	mg/L	100	220	260	500-1500
Calcium Hardness	mg/L	80	200	180	75-200
Magnesium Hardness	mg/L	20	20	80	30-50
Chlorine	mg/L	0.11	0.01	0.01	0.4=1.0
TDS	mg/L	0.002	0.04	0.13	5-1500
Sulphate	mg/L	0.00	0.16	8	200-600
Zinc	mg/L	0.05	0.97	0.12	0.05-1.5
pH		7.2	6.8	6.6	6.8-8.5
Bacteriological Coliform		undetectable	undetectable	Detectable	undetectable

ABC, DEF and GHI are the average value of Tap, Well and Borehole waters respectively.

## Conclusion

As a matter of fact, the results obtained after the water samples have been analysed showed that the water sources did not suffer pollution from chemicals. The values of most parameters examined concurred within WHO and NAFDAC stipulated standards for portable water. The water quality examined varied from source to source. It was inferred from the analysis that the same parameters investigated for all water samples turned out to give different results from one another. Some parameters like  $P^H$  values of well water which negate the WHO and NAFDAC standard can further be treated by the help of a slaked lime ( $Ca(OH)_2$ ) called liming. Coliform bacteria were found to be absent in pipe borne water and borehole which makes it suitable for human consumption. But it was found to be present in well water due to exposure to sewage waste, livestock waste, domestic and agricultural waste. Illnesses like typhoid fever, dysentery and cholera can affect the consumer of this well water if not properly treated.

**Recommendation:** i. Water analysis should be done both in rainy season and dry season to get the exact quality of water. ii. Proper attention should be given to well water treatment make it fit for human consumption. iii. Government should intensify effort to ensure that water treatment plants are properly equipped with relevant water treatment materials. iv. Periodical water analysis is vital to ascertain the quality of existing water sources and changes in values of some parameters so that precautionary measures can be taken.

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