NS NSUK Journal of Science & Technology, Vol. 7(2): pp. 26-31, 2020 Print: ISSN: 2756-696X
On-line: ISSN 2756-6951
Website: www.nsukjst.org.ng

ASSESSMENT OF WATER QUALITY INDEX OF PORTABLE WATER SOURCES IN THE FEDERAL CAPITAL TERRITORY METROPOLIS ABUJA

Madu, P. C., *Shuaibu, B. S. and Onyejere, C. C.

Department of Chemistry, Nasarawa State University, Keffi.

Corresponding Author: bathiyashuaibu@gmail.com

ABSTRACT

Water quality from drinking sources in Abuja metropolis has been assessed in this work with regards to its Water Quality Index. Water quality index reports in a unit term the suitability of water for domestic purposes. This study was carried out to ascertain the water quality index to know the efficacy of water for household use from different water sources namely: tap, borehole, sachet and bottled in Abuja metropolis for domestic usage. Water samples (100) were obtained and each was analysed for 15 parameters. In the study, WQI was determined through the aid of various Physico-chemical parameters like colour, pH, turbidity, total alkalinity, chlorides, sulphates, nitrates, total hardness, electrical conductivity, total dissolved solids, phosphates and nitrites. Bottled water was seen to have water quality index of 24.3, tap water 27.4 and sachet water 31.4 which made them have an excellent and good water quality status. However, borehole water was found to have a water quality index level of 54.5 which made it to be poorly graded. The results of all the water tested shows that bottled, tap and sachet water were safe for human consumption while that of borehole needs treatment before consumption. Appropriate regulatory agencies should carry out a quality assessment of the existing boreholes to ascertain the quality level of the water before allowing for public utilization.

Keywords*: water quality index, physico-chemical parameters, suitable, drinking, water, acceptance*

INTRODUCTION

Over the last twenty years, the Federal Capital Territory F.C.T has witnessed a dramatic increase in the human population which has extended so much pressure on surface and ground sources of potable water. Abuja municipal water supplies are produced 650 mega litres of water which is lower compared to the demand of 1400 mega litres per day. This has caused a shortage of potable water in the city' (Ephraim*et al*., 2010). This decrease in the supply of potable water in Abuja has made its resident think of alternative sources of water, which includes sachet water, bottle water from different water supply plants and boreholes. In addition to meeting water demands, there are concerns about the safety of water from these municipal supplies. Borehole and bottled water are preferred compared to municipal water since they are consideredto be of higher quality (Ephraim *et al*., 2010). Low water quality affects the lives of its consumers; also, poor water quality contains pathogens which tend to cause communicable diseases such as cholera and typhoid. Poor quality water can contain hazardous chemicals that are harmful to humans. Bottled water and borehole are treated using standardized purification processes as such are free of contaminations. All bottled water companies are mandated to register for quality assessment, as they may be counterfeits and/or competitors with unregistered brands in the market that could cause a threat on human health (Onweluzo and Akuagbabazie 2010). Anthropogenic activities such as farming (fertilizer and pesticides applications),improper disposal of household and industrial wastes such as detergents, batteries, paints could cause groundwater contamination and affect the quality of borehole water(Ilaboya*et al*.,2014). Improper maintenance of the sewage system and bush toilets usage can likewise contribute to groundwater pollution in Abuja metropolis. It is thus, unexpected that the quality of potable water obtained from this area remains unchanged.

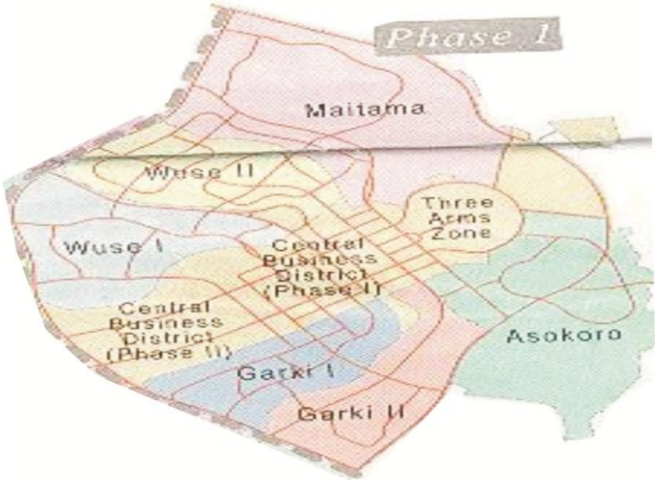
Water Quality Index gives a single number that explains the status water quality of a given location, K. Yogendra and E.T Puttaiah (2008).

In this research work, water quality index method was used to ascertain the quality of selected water samples obtained in Abuja Municipal Metropolis.

MATERIALS AND METHOD

Study area

The Abuja metropolis is located between latitude 9^0 '2' 7' and 9^0 '7' '7N and longitude 19^0 '27' '14' and 19^0 '32' '14 E. The metropolis is bound in the East by Karu and Nyanya towns. In the north by Katampe and Mabushi and Mpape districts which could be regarded as urban slums. In the west by Utako and Wuye districts, in the south by Durumi, Gudu districts. This study area has witnessed a remarkable population growth for the past two decades following the movement of the federal capital of Nigeria to Abuja from Lagos in 1991. The Metropolis' population grew from 226,949 in 1991 to 403,000 in 1999; then from 778,567 in 2006 to 2,514,313 in 2012. Nigerian Population Commission, National Bureau of Statistics (2006). According to official speculation, Abuja has been growing at 9.3% per year. (U.N.F.P.A.2015).



The materials used in the research work include water from borehole, tap, bottle and sachet.

Sample Collection

The samples used were borehole, bottled, tap and sachet water collected between August to December 2016 at each of the sampling sites. Borehole water was collected from five boreholes of each of the district. Tap water was likewise collected from five domestic tap water in each distinct. Packaged water such as bottled water and sachet water were taken from shops in the city centre.

Sample Preparation

The sample was used directly for measurement after collection. It was collected with a one-litre container then stored in a cooler and taken to the laboratory for analysis within 24 hours.

Determination of Physico-chemical Properties

The physico-chemical parameters which are the pH values, total dissolved solids (TDS), turbidity, colour, total alkalinity, total hardness, chloride ion, sulphates, phosphates, nitrates, nitrites, iron and manganese of the water samples were checked by the use of standard procedures.

For theWater Quality Index (WQI),the fifteen parameters were used to determine the quality of these water samples. The WQI is calculated by the use of standards for water quality recommended by the World Health Organization (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ). The weighted Arithmetic indexed method was employed for the calculation of WQI in this research. Also, the quality rating was calculated using the following expression.

qn = 100 [Vn – Vio]/ [Sn – Vio] (K. Yogendra *et al*.,2008)

(Let there be *n*water quality parameters and quality rating (qn) corresponding to n^{th} parameter is a number reflecting the relative value of these parameters in the polluted water to its standard permissible value)

qn = Quality rating for the n^{th} water quality parameter

Vn = Estimated value of the n^{th} parameter at a given water sampling station

Sn = Standard permissible value of the n^{th} parameter

Vio = Ideal value of nth parameter in pure water (i,e,. 0 for all other parameters except the parameters pH and Dissolve oxygen [7,0 and 14,6 mg/L respectively].

The unit weight was calculated by a value inversely proportional to the recommended standard value Sn of the corresponding parameter.

$Wn = k/Sn$

Where Wn= unit weight for nth parameter

Sn= Standard permissible value for nth parameter

K = Proportionality constant.

The overall WQI was calculated using the equation.

$WQI = \Sigma qnWn/\Sigma^{W}$

RESULTS AND DISCUSSION

The values (mean) of all the various parameters were computed from the raw data gotten from the field. These mean values were presented in tabular forms and presented in tables 1-4.

Table 5 shows that the Cl^- concentration in all the four sources of drinking tested was within the WHO guideline acceptable value of 250mg/L. The Cl^- concentration for all the four sources varied between 23.0 to 33.1 The lowest concentration was recorded in bottle water (23.0mg/L) followed by tap water(27.7mg/L), (30.2mg/L) sachet water and the highest chloride ion level was found in Borehole (33.1mg/L). The level of total iron concentration in the four sources of drinking water ranged from 0.07 to 0.2mg/L. The lowest concentration level was obtained in bottled water, followed by sachet water(0.1mg/L), and the highest being borehole(0.2mg/L).All the concentration level were within the WHO guideline level of 0.3mg/L. Also, SO_4^{2-} content value recorded range between 1.1to 15.6mg/L. All the four sources of water in Abuja metropolis had acceptable levels of SO_4^{2-} as prescribed by the WHO guideline (250 mg/L). The lowest level was found in bottled water with a concentration of 1.1mg/L followed by tap water [7.3 mg/L), sachet water (12.34mg/L). The highest level was found in Borehole water (15.6.mg/L) as seen in Table 3.The lowest value for total alkalinity was found in bottled water (31.3mg/L), followed by sachet water (44.0mg/L, tap water (45.7 mg/L), the highest level was found in Borehole(63.1mg/L). Total Alkalinity, however, ranged from 31.3-63.1mg/Lwhich is still within the WHO limit of 120mg/L.

The WQI of the separate potable water samples is presented in tables 6-9, the summary of these results compared to the water quality status is seen in table 10. From this table, it could be seen that the bottled water had an excellent water quality status (24.3). Tap and sachet water has a good water quality index water (27.4 and 31.4) respectively. The borehole water had a poor water quality of 54.5. Table 11 shows the water quality index and the quality of water suitable for drinking.

CONCLUSION

All parameters determined were found, Water Quality Index of portable water sources, namely sachet, bottle, borehole and tap in Abuja metropolis were assessed to evaluate the portability of the water sources. The WQI level of bottled water was 24.3 which revealed that the bottled water has excellent water quality status. For tap water was 27.14 while that of the borehole was 31.4 showing that they have good water quality status. The borehole water was found to have poor water quality status of 54.5, due to low pH. The pH (6.2) of the borehole is below the WHO standard limit of 6.5 – 8.5. The low pH may be attributed to the discharge of acidic water into the ground by agricultural and domestic activities.

ACKNOWLEDGEMENT

The authors do acknowledge the staff of Chemistry Department Nasarawa State University, Keffi and Federal Capital Territory Water Board Lower Usman Dam Bwari for the assistance rendered during this research work

REFERENCES

Ashwani Kumar and AnishDua (2009). Water quality index for assessment of water quality ofriver Ravi at Madhopur, India. *Global Journal of Environmental Sciences*, 8(1): 49-57

Municipality.*Water Research Institute, Council for Scientific And Industrial Research, Ghana, Annual Report 2005*.

Ephraim A. DanladiEtai(2010). Urbanization and water Insecurity in Nigeria, a study of Abuja metropolis Nigeria *International Journal of Modern Chemistry*, 1(3): 102-108.

Ilaboya, I. R., Oti, E. O., Ekoh, G. O., Umukoro, L. O. and Enamuotor B.O. (2014). Assessment of water quality index of some selected boreholes around dumpsites in Nigeria. *Inter. Journal of Environment Monitoring and Protection* 1(2): 47-55.

Yogendra, K. and Puttaiah, E. T. (2008). Determination of Water Quality Index and Suitability of an Urban Watebody in Shimoga Town, Karnataka.Proceedings of Taal2007: the 12^{th} World Lke Conference: 342-346.

Onweluzo, J. C. and Akuagbabazie, C. A. (2010). Assessment of the quality of bottled and sachet water sold in Nsukka ton. Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension Volume 9 Number 2, Pp. 104110b.

WHO/UNEP/UNESCO/WMO, (1988**).** *Global Environmental Monitoring System (GEMS)/Water operational Guide*, ETS/78.8 Rev. 1, pp. 50-52.).

World Health Organization, (2009*).Potassium in Drinking-water; Background document for development of WHO Guidelines for Drinking-water Quality***.**20 Avenue Appia, 1211 Geneva 27, Switzerland.

Table 1: Levels of physicochemical parameters in sachet water from five districts

Parameters	Asokoro	Central Area	Garki	Maitama	Wuse	Mean
Total Alkalinity mg/L	41.6	48.2	66	33	31.4	44.0
Total Hardness mg/L	52.8	53	126.8	154.8	44	86.3
Chloride ion mg/L	26.13	24.66	36.92	36.7	26.4	30.2
Colorpt/co	8	14.6	24	2.8	7.8	11.4
Turbidity NTU	1.80	1.4	1.25	1.3	1.19	1.4
Conductivity us/cm^3	192.5	100.9	350	325.5	187.7	231.3
Total dissolved solids mg/L	141.5	186.9	130.14	134.6	83.0	135.0
Ph	6.3	6.2	7.0	7.0	6.7	6.6
Temperature ^oC	30.6	29.0	28.9	29.6	28.9	29.4
Manganese ion m/L	0.36	0.61	0.3	0.4	0.4	0.4
Iron mg/L	0.35	0.08	0.14	0.02	0.03	0.1
Phosphate mg/L	0.49	3.97	0.29	0.35	0.36	1.1
Sulphate mg/L	21	20.4	2.8	2.5	14.8	12.3
Nitrate mg/L	0.50	2.04	4.6	4.6	0.86	2.5
Nitrite mg/L	0.004	0.004	0.28	0.28	0.003	0.1

Table 2: Levels of physicochemical parameters in bore-hole water samples from the five districts

Parameters	Asokoro	Central Area	Garki	Maitama	Wuse	Mean
Total Alkalinity mg/L	72.8	78.4	76	576	30.8	63.1
Total Hardness mg/L	84.4	92	64.4	59.2	55.6	71.2
Chloride Ion mg/L	37.78	30.9	45.3	25.0	26.4	33.1
Colorpt/co	13.8	26	14.6	21	7.6	16.6
Turbidity NTU	1.19	1.18	1.74	2.4	1.19	1.5
Conductivity us/cm^3	367.3	340.16	232.3	194	187.7	264.7
Total dissolved solid mg/L	140.9	202.8	98.3	95.8	103.4	128.2
Ph	6.4	6.3	6.2	6.04	5.97	6.2
Temperature ^oC	30.8	29.5	30.1	28.8	31.9	30.2
Manganese ion mg/L	0.3	0.2	0.72	0.78	0.36	0.5
Iron mg/L	0.5	0.28	0.14	0.03	0.02	0.2
Phosphate mg/L	0.76	0.99	0.29	0.22	0.39	0.5
Sulphate mg/L	9	4.8	27.4	22	14.8	15.6
Nitrate mg/L	0.5	0.3	0.78	0.6	0.06	0.6
Nitrite mg/L	0.003	0.002	0.004	0.002	0.003	0.003

Table 3: Levels of Physicochemical Parameters in Tap Water Samples from the five districts

Parameters	Asokoro	Central Area	Garki	Maitama	Wuse	Mean
Total Alkalinity mg/L	56	57.6	17.6	31.2	66	45.68
Total Hardness mg/L	55.6	58.8	40.6	87.6	126.8	73.88
Chloride Ion mg/L	24.18	25.04	26.38	25.98	36.9	27.69
Colorpt/co	14.16	13.6	8.8	8.8	24	13.9
Turbidity NTU	1.74	1.26	3.74	3.26	1.25	2.25
Conductivity us/cm^3	99.2	101.9	215.4	289.4	350	211
Total dissolved solids mg/L	192.4	186	199.0	182.2	130.1	178
Ph	6.6	6.2	6.76	6.84	7.0	6.7
Temperature ^oC	29.1	29.0	28.9	28.9	28.9	28.9
Manganese ion mg/L	0.7	0.61	0.4	0.5	0.3	0.5
Iron mg/L	0.06	0.08	0.004	0.15	0.02	0.07
Phosphate mg/L	0.23	3.97	0.06	0.11	0.29	0.93
Sulphate mg/L	10	20.4	1.1	2.6	2.7	7.36
Nitrate mg/L	10	2.04	7.38	7.86	4.6	6.38
Nitrite mg/L	0.04	0.004	0.3	0.19	0.28	0.16

Table 4: Levels of Physicochemical Parameters in Bottled Water Samples

Parameters	Asokoro	Central Area	Garki	Maitama	Wuse	Mean
Total Alkalinity mg/L	29.6	33.4	30	33.2	30.4	31.3
Total Hardness mg/L	25.2	24.8	23.2	25.6	20.8	23.9
Chloride Ion mg/L	18.74	21.90	24.26	25.02	25.2	23.0
Colorpt/co	14.8	5.6	16	5.6	13.4	11.0
Turbidity NTU	1.51	1.63	1.67	167	2.5	1.8
Conductivity us/cm^3	72.9	74.5	72.4	75.1	73.2	73.6
Total dissolved solid mg/L	40.4	41.4	40.86	38.9	58.1	43.9
Ph	7.2	7.18	6.8	7.34	6.9	7.1
Temperature ^oC	29.6	29.7	29.8	29.9	29.0	29.6
Manganese ion mg/L	0.3	0.2	0.38	0.4	0.13	0.3
Iron mg/L	2.3	2.1	0.02	0.02	0.29	0.9
Phosphate mg/L	2.3	2.1	1.99	2.04	2.0	2.1
Sulphate mg/L	0.25	0.05	1.2	1.2	3.02	1.1
Nitrate mg/L	0.5	0.6	0.15	1.0	2.4	0.9
Nitrite mg/L	0.008	0.05	0.002	0.003	0.005	0.005

Table 5: Drinking water standards recommended agencies and unit weights (All values except pH and Electrical Conductivity, colour, turbidity are in mg/L)

Parameters	Standards	Recommended agency	Unit weight
Total Alkalinity	120	WHO	0.0083
Total Hardness	300	WHO	0.0033
Chloride Ion	250	WHO	0.004
Color	15	WHO	0.066
Turbidity	5	WHO	0.2
Conductivity	300	WHO	0.0033
Total dissolved solid mg/L	500	WHO	0.002
pH	6.5-8.5	WHO	0.1428
Manganese ion	10	WHO	0.1
Iron	0.3	WHO	3.333
Phosphate	10	WHO	0.1
Sulphate	150	WHO	0.0066
Nitrate	45	WHO	0.0222
Nitrite	1.5	WHO	0.666
Temperature	23.5	WHO	0.042

Table 6: Value of Water Quality Index for Sachet Water.

Parameters	Observed values	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	Wn Qn.
Total Alkalinity	44.0	120	0.0083	36.7	0.3
Total Hardness	86.3	300	0.0033	28.8	0.09
Chloride Ion	30.2	250	0.004	12.1	0.04
Color	11.4	15	0.066	76	5.0
Turbidity	1.4	5	0.2	28	5.6
Conductivity	231.3	300	0.0033	77.1	0.25
Total dissolved solids mg/L	135.0	500	0.002	27	0.05
pH	6.6	6.5-8.5	0.1428	94.3	13.5
Manganese ion	0.4	1.0	0.1	4	0.4
Iron	0.1	0.3	3.333	33.3	111.1
Phosphate	1.1	1.0	0.1	11	1.1
Sulphate	12.3	150	0.0066	8.2	0.05
Nitrate	2.5	45	0.0222	5.5	0.12
Nitrite	0.1	1.5	0.666	6.7	4.4
Temperature	29.4	23.5	0.042	125.1	5.3
			ΣWn = 4.69	Σqn =573.8	ΣWnqn =147.3

Water Quality index = ΣqnWn/ΣWn =31.41

Table 7: Value of Water Quality Index for Bore Hole Water

Parameters	Observed Values	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wn qn.
Total Alkalinity	63.1	120	0.0083	52.6	0.44
Total Hardness	71.2	300	0.0033	23.7	0.08
Chloride Ion	33.1	250	0.004	13.2	0.05
Color	16.6	15	0.066	110.6	7.3
Turbidity	1.5	5	0.2	30	6
Conductivity	264.7	300	0.0033	88.2	0.3
Total dissolved solids mg/L	128.2	500	0.002	25.6	0.05
Ph	6.2	6.5-8.5	0.1428	88.6	12.9
Manganese ion	0.5	10	0.1	5	0.5
Iron	0.2	0.3	3.333	66.7	222.2
Phosphate	0.5	10	0.1	5	0.5
Sulphate	15.6	150	0.0066	10.4	0.07
Nitrate	0.6	45	0.0222	1.3	0.03
Nitrite	0.003	1.5	0.666	0.2	0.13
Temperature	30.2	23.5	0.042	128.5	5.4
			ΣWn = 4.69	Σqn =649.9	ΣWnqn =255.8

Water Quality index = ΣqnWn/ΣWn =54.5

Table 8: Value of Water Quality Index for Tap Water

Parameters	Observed values	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	WN Qn.
Total Alkalinity	45.7	120	0.0083	38.1	0.3
Total Hardness	73.8	300	0.0033	24.6	0.08
Chloride Ion	27.7	250	0.004	11.1	0.04
Color	13.9	15	0.066	92.7	6.1
Turbidity	2.3	5	0.2	46	9.2
Conductivity	211	300	0.0033	70.3	0.23
Total dissolved solids mg/L	178	500	0.002	356	0.07
Ph	6.7	6.5-8.5	0.1428	95.7	13.6
Manganese ion	0.5	10	0.1	5	0.5
Iron	0.07	0.3	3.333	23.3	77.7
Phosphate	0.9	10	0.1	9	0.9
Sulphate	7.3	150	0.0066	4.9	0.03
Nitrate	6.4	45	0.0222	142	3.1
Nitrite	0.2	1.5	0.666	13.3	8.9
Temperature	28.9	23.5	0.042	122.9	5.2
			ΣWn = 4.69	Σqn =606.7	ΣWnqn =126.31

Water Quality index= ΣqnWn/ΣWn =27.4

Table 9: Value of Water Quality Index for Bottled Water

Parameters	Observed Values	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	Wn Qn.
Total Alkalinity	31.3	120	0.0083	26.08	0.22
Total Hardness	23.9	300	0.0033	7.96	0.03
Chloride Ion	23.0	250	0.004	9.2	0.04
Color	11.0	15	0.066	73.3	4.84
Turbidity	1.8	5	0.2	36	7.2
Conductivity	73.6	300	0.0033	24.5	0.08
Total dissolved solid	43.9	500	0.002	8.8	0.02
pH	7.1	6.5-8.5	0.1428	101.4	14.48
Manganese ion	0.3	10	0.1	3	0.3
Iron	0.9	0.3	3.333	23.3	77.8
Phosphate	2.1	10	0.1	21	2.1
Sulphate	1.1	150	0.0066	0.73	0.005
Nitrate	0.9	45	0.0222	2	0.04
Nitrite	0.05	1.5	0.666	0.33	0.22
Temperature	29.6	23.5	0.042	125.9	5.3
			ΣWn = 4.69	Σqn =463.5	ΣWnqn =112.7

Water Quality index = ΣqnWn/ΣWn =24.3

Table 10: Summary of water quality index for thepotable water sources

Water source	**Water quality index level**	**Water quality status**
Bottled water	24.3	Excellent Water quality
Tap water	27.4	Good water quality
Sachet water	31.4	Good water quality
Borehole water	54.5	Poor water quality