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Physico-Chemical Analysis Of Some Groundwater Samples In Aba Metropolis

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ABSTRACT
Physicochemical analyses of groundwater samples from 8 boreholes situated in different locations in Aba metropolis, Abia State have been done. The study was carried out to assess the groundwater quality and their suitability for domestic purposes, using standard methods. Among the parameters investigated were pH, Temperature, Electrical conductivity (EC), Total hardness, Total dissolved solids (TDS), Total suspended solids (TSS) and Alkalinity. Others include Acidity, Turbidity, Salinity, chloride, Calcium ion, Nitrate, and Magnesium ion. Comparison with two approved water standards, the WHO standard and the Nigerian Standard for Drinking Water Quality (NSDWQ) show that the parameters analyzed were within the permissive limits recommended by the standards. Electrical Conductivity ranged from 23µs/cm – 145 µs/cm, TDS (10mg/l – 67 mg/l), TSS (14.2mg/l – 137mg/l) whereas an average pH of 6.5 was recorded across the points. Copper and Iron concentrations were (0.04 mg/l– 0.14mg/l) and (0.02 mg/l– 0.09mg/l) respectively. A mean value of 0.15mg/l of magnesium was detected whereas Phosphate and Zinc ranged from 0.04mg/l – 0.7mg/l and 0.29mg/l – 0.34mg/l respectively. The range of Calcium hardness recorded across the sample points (2.13mg/l - 3.72mg/l) indicates that the groundwater within this area is soft. Moreover, heavy metals such as Lead, Arsenic, Mercury, Barium and Manganese were not detected. Therefore, the groundwater samples were found to be safe from chemical pollution and fit for household consumption.
Keywords: WHO Standard, Physiochemical Analysis, Aba, Groundwater quality, water pollution.

INTRODUCTION
Water is directly linked to human and animal health as well as the economy of any nation. The presence of adequate supply of quality water for human consumption is essential for sustainable development program of any society. Nevertheless, the quality and suitability of water are of great concern to the society because of the much water borne diseases ravaging human health (Alam *et al.*, 2017). The quality of water depends on its composition. Chemical composition of water is a measure of its suitability for human consumption and also for industrial and agricultural purposes. The suitability depends on the characteristic physical and chemical composition of the geological formations that the water passes through during its course as well as the anthropogenic activities going on within its environment (Venu and Rishi, (2011). Indiscriminate disposal of municipal solid waste into open dumps and surface water bodies constitutes a source of hazardous materials in water bodies.
Aba is a densely populated commercial city in Abia State, South Eastern Nigeria. It is located within the coordinates 5° 07`N and 7° 22' E. Its inhabitants are mainly traders, artisans and the local farmers. Presently, there is a profound dependence of the inhabitants of Aba metropolis on groundwater resource owning to the increase in population and also government's inability to meet the increasing water need of

the people. More so, there is a decrease in the quality of fresh water due to pollution caused by poor waste treatment practices, exploration, agricultural and artisans' activities in the city. Aba has been associated with abundant groundwater resource (Ogoko and Kelle, 2016). This is evident in the number of boreholes drilled in the city. However, the suitability of the borehole water for human consumption may not be ascertained. Therefore, this study seeks to determine the suitability of the available groundwater resource for drinking and other household use. It focuses on the Physiochemical analyses of the borehole water consumed in Aba metropolis. This will be beneficial to the public health of the people.

Studies on the physiochemical analyses of groundwater have been carried out in different parts of the globe, Nigeria not being exempted. Mazel *et al*. (2022); Matini *et al*., (2011); Zhang *et al*., (2019); Nkpaa *et al*., (2018) ; Cobbina *et al*., (2015); Okereke *et al*., (2014); Yadav *et al*., (2012) and Nwachukwu and Ume, (2013) all investigated groundwater properties of different area using physicochemical analyses. Consistent in their findings show that most groundwater pollutants stem from physical processes and anthropogenic activities. They noted that hazardous materials which are disposed off with municipal solid waste into open dumps and surface water bodies, contaminates groundwater resources through leaching. Leachate from old buried waste pit, from boreholes sited close to septic tanks and storm runoff laden with particle pollutants sometimes infiltrates into aquifers with shallow depths thereby polluting and affecting groundwater quality (Obot and Edi, (2013).

MATERIALS AND METHOD

The physiochemical analyses were done using standard procedures in accordance with Adindu *et al.,*(2012) and Okereke *et al.,* (2014). Water samples were collected at random from eight different boreholes in the city. Each sample was collected using a clean plastic container. The temperatures and pH of the water samples were determined using a thermometer and a pH meter respectively. Total dissolved solids were determined using Dissolved Solid meter (HACH). TDS, Salinity and Conductivity were analyzed using conductivity meter. Turbidity, Total Suspended Solids, Phosphate, Nitrate, Sulphate, Calcium, Zinc, Chloride, Copper and Iron, were analyzed using Spectrophotometer. Gravity method was used to determine the Total acidity of the water samples.

RESULTS

The results are presented in Table 1, Figure 1 and Figure 2 as shown below.

Table 1: Results of the physiochemical analyses of some groundwater samples in the area.

Parameter	SP1 East	SP 2 Mosque	SP 3 Park	SP 4 Okpulo Umubo	SP 5 World Bank	SP 6 Umueze	SP 7 Faulks Road	SP 8 Eziama	WHO Standard (2011)	NSDWQ Standard (2015)
PH	6.7	6.7	6.9	6.20	6.5	6.7	6.4	6.2	6.5 – 8.5	6.5 – 8.5
Temp (^{0}C)	26.8	26.7	26.8	25.0	25.2	25.9	26.0	26.2	32	30 -32
Conductivity (μs/cm)	36.9	46.1	40.7	56.0	63.0	23.0	145.0	137.0	1000	1000
Turbidity (NTU)	2.1	2.0	2.1	5.20	5.0	5.1	5.0	5.3	5.0	5.0
TSS (mg/l)	16.2	14.2	16.0	7.50	71.0	90.0	133.0	137.0	-	-
TDS (mg/l)	20.2	25.5	23.5	25.0	29.0	10.0	67.0	63.0	1000	1000
Nitrate (mg/l)	0.9	0.9	1.0	8.60	9.8	8.26	12.37	10.5	50	50
Calcium (mg/l)	1.5	2.2	2.2	2.13	3.19	1.72	3.06	3.72	75	75
Sulphate (mg/l)	2.4	3.3	3.0	-	-	-	-	-	100	100
Phosphate (mg/l)	0.1	0.1	0.1	-0.70	0.04	0.04	0.47	0.52	2.5	-
Chloride (mg/l)	9.8	8.2	10.2	12.0	14.0	11.0	22.0	18.0	250	250
Copper (mg/l)	0.02	0.01	0.01	0.10	0.11	0.04	0.14	0.12	2.0	100.0
Iron (mg/l)	0.02	0.02	0.02	0.04	0.03	0.04	0.09	0.08	0.3	0.3
Zinc (mg/l)	0.10	0.13	0.1	0.31	0.32	0.29	0.34	0.31	3.0	3.0
Magnesium (mg/l)	-	-	-	0.15	0.11	0.14	0.16	0.16	50	20
Alkalinity	-	-	-	60.0	65	50.0	45.0	40.0	50	200
Total Acidity	-	-	-	35	36	32.5	27.0	26.4	100	-
Total Hardness				6.0	15.0	5.0	12.0	15.0	500	150.0

Sources: Okereke *et al.*, (2014) and Adindu *et al.*, (2012).

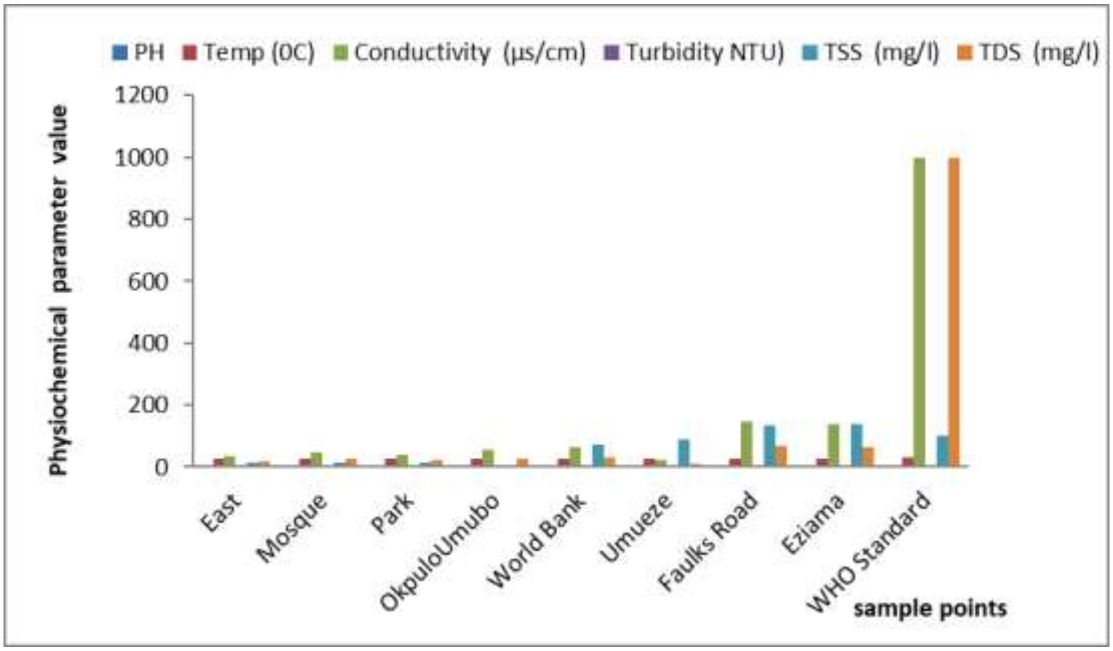

Fig.1: Physiochemical parameter values of the groundwater samples compared with WHO limits.

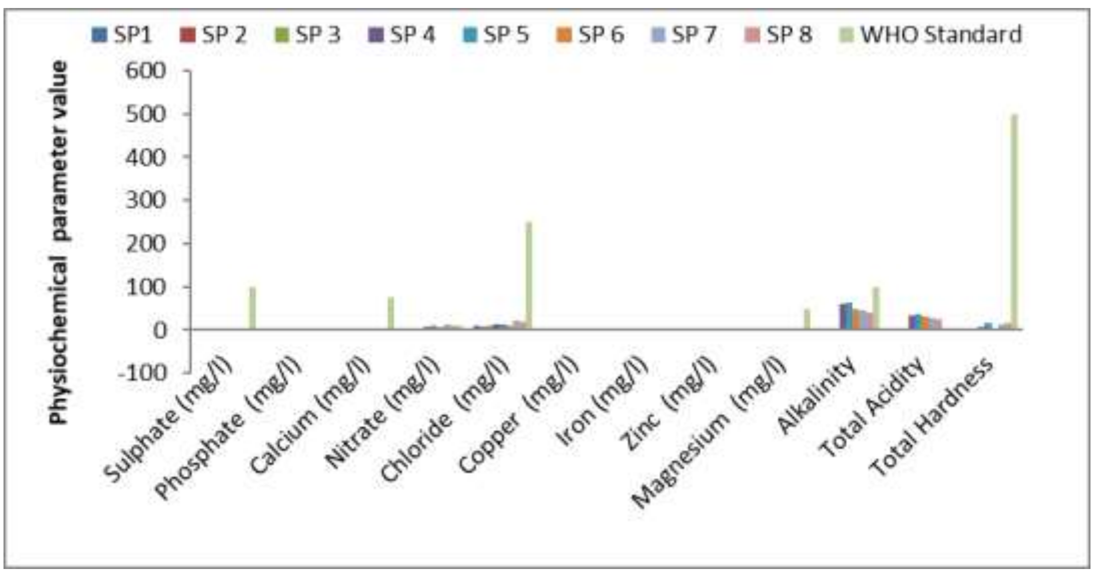

Fig. 2: Results of the physiochemical analyses of the groundwater samples in the area.

DISCUSSIONS

pH and Alkalinity

The capability of water to neutralize acids is quantified as its Alkalinity. pH quantifies the intensity of acidity or alkalinity of a solution. Alkalinity in water depends on the availability of bicarbonate ion, carbonate ion and hydroxide ion.. The measured pH and Alkalinity values across the sample points indicated values ranging from 6.2 mg/l (Eziama) to 6.9 mg/l (Park) and 40 mg/l (Eziama) - 65 mg/l in World Bank respectively (Table 1). In comparison with the WHO maximum permissible limit of pH (6.5

to 8.5) and Alkalinity (100 mg/l), the obtained values were found to pose no health risk to the consumers of the sampled borehole waters in the study area.

Electrical Conductivity (EC)

EC is an indicator of water quality and soil salinity, hence the relatively high values observed in some water samples showed high salinity; thus the waters might not be very suitable for domestic use (Onwughara *et al*., 2013).`Conductivity expresses the capacity of an aqueous solution to convey electrical current. It is a function of the total concentration and mobility of cations and anions such as magnesium, calcium, sodium and sulphates in water. It also signifies the total number of dissolved acids (Shrinivasa and Venkateswaralu, 2000). Its value in this study ranged from 23.0µs/cm (Umueze) to 145µs/cm (Faulks Rd). These values fall within the recommended WHO and NSDWQ limits, however its significant rise from below 65µs/cm to 135µs/cm in Eziama and 145µs/cm in Faulks Road respectively signifies high salinity or high mineral content in the aquifer materials in contact with the groundwater in these two locations (Fig. 1).

Turbidity

Turbidity of water is due to the presence of colloidal and fine dispersions present in the water. In this area, its value is in the range of 2.0 NTU and 5.3 NTU. The water samples from Okpuloumubo, Umueze and Eziama slightly exceeded the WHO limit of 5.0 NTU for drinking water. There is therefore the possibility of decomposed vegetation, colloidal substances and suspended vegetation in the water affecting the appearance of the water.

Total Dissolved Solids (TDS)

TDS is indicative of the salinity of water. TDS values between 20mg/l and 1000mg/l, signifies fresh water, values greater than 1000mg/L is considered brackish and also not suitable for drinking and household purposes (Adindu *et al.*, 2012). In this study, the analyses of the samples show TDS values ranging from 10.0mg/l and 67mg/l. This result indicates low impurities in the borehole water of the area. It could be noted that increasing values of TDS in SP 7 and SP 8 correlates with increasing values of conductivity in the same sample points. Yadav *et al*., (2012) noted that Total Dissolved Solids is closely related to conductivity. This increase could be attributed to interaction of the groundwater with increased amount of ions present in the geo-materials of the locations.

Total Hardness

Water hardness is an important criterion for determining the usability of water for domestic, drinking and various industrial applications. It is due to the concentration of dissolved minerals, usually total concentration of cations of calcium , magnesium, iron and manganese in water (Tank and Singh, (2010); Alam *et al.*, (2017). The concentrations of these ions react with a sodium soap to precipitate an insoluble residue. Hardness is also the property of water which increases its boiling points. Total hardness values across the sample points SP4 to SP8 ranged from 6 mg/l to 15 mg/l while it was not detectable in SP1, SP2 and SP3, probably due to the low values of calcium and Iron in the groundwater of these sample points. It could also be attributed to the absence of manganese and magnesium in these locations.

Total hardness in the sampled groundwater of this area indicates softness in accordance with the classification of the World Health Organization International Standard for Drinking Water WHO, (2017) and NSDWQ, (2015) standards, which classified water with a total hardness, < 50 mg/l as soft water, hardness > 50 - 150 mg/l as moderately hard water and values greater than 150 mg/l as hard water. Hardness in water could cause gastro-intestinal irritation. The groundwater of Aba metropolis is therefore implied to be soft and suitable for drinking and household use.

Calcium /Iron/ Magnesium

Calcium has been associated with low risk of delivery of low birth weight babies in women. A study conducted on the relationship between the levels of calcium in drinking-water and the risk of delivering babies with very low birth weights in Taiwan, China reported that there is significant protective effect of calcium intake from drinking-water on the risk of delivering a baby with very low birth weight. Chronic iron overload results primarily from a genetic disorder (hemochromatosis) characterized by increased iron absorption whereas, magnesium supplementation can reduce smooth muscle contractibility and tone resulting from a reduction in blood pressure (Alam *et al.*, 2017).

The concentrations of Iron and Magnesium in the groundwater samples are very low ranging from 0.02 mg/l – 0.08 mg/l and 0.11mg/l – 0.16 mg/l respectively. That of Magnesium from SP4 to SP8 values fall within the standard limits while its below detectable limits in SP1, SP2 and SP3. These two ions may have made no significant contribution to the total hardness of the water samples (Fig. 3).

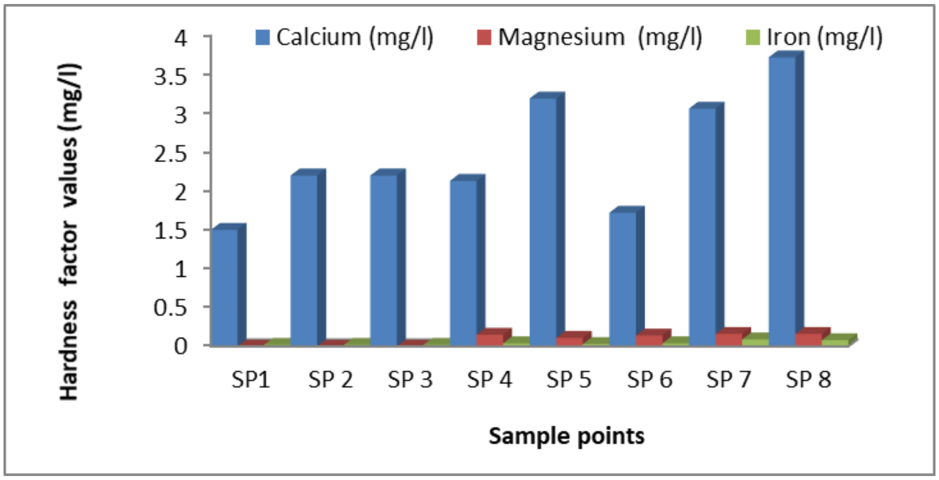

Fig 3: Distribution of Calcium, Iron and Magnesium in the water samples.

Chloride and Sulphates

Sources of chloride in water are mainly resulting from agricultural runoff, inorganic fertilizers, industrial and septic tank effluents, animal feed stocks among others. Chloride is not harmful to human at low concentration but could alter the taste of water at concentrations above 250 mg/l However, Its high concentrations have been reported to have increased the rate of corrosion of metals in a water distribution system, depending on the alkalinity of the water (Mazel *et al.*, (2022); Matini *et al.*, (2011). Low chloride values (8.2 – 22.0)mg/l were obtained in this study. These values fall within the permissible recommended WHO limits.

CONCLUSION

The concentrations of the physiochemical parameters of the sampled groundwater selected at random in Aba metropolis were found to fall within the permissible limits of both WHO and NSDWQ for drinking water. Based on the hardness concentration, it could be inferred that the groundwater of this area is soft and poses no serious health concern for the citizenry.

However, routine monitoring by the regulatory bodies is required to ensure that the turbidity does not exceed the present values and also to monitor the state of the groundwater system in this area in order to ensure the health of the people.

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