Quality Evaluation of Acid Radicals of Some Selected Boreholes in Edda, Ebonyi State

Ibiam J.A. [*1, 2], Afiukwa J.N.[1], Ugbo, U.I.[2], Ezem, S.N.[2] and Ehiri, R.C.[3]

1. Department of Industrial Chemistry, Ebonyi State University, P.M.B 053, Abakaliki, Nigeria

2. Department of Science Laboratory Technology, Akanu Ibiam Federal Polytechnic, Unwana, P.M.B. 1007 Afikpo, Ebonyi State Nigeria.

3. Department of Chemistry/Biochemistry/Molecular Biology, Federal University, Ndufu-Alike, Ikwo, Nigeria

* Corresponding Author: amahibiam2002@yahoo.com **;** Phone number: 2348063803459

ABSTRACT: The Acid Radicals of some boreholes in Edda of Ebonyi State were evaluated. Composite samples drawn from 8 borehole water sources were collected for dry and rainy seasons and analyzed for acid radicals The Ammonia, Nitrate, nitrite of the water samples were determined using UV Spectrophotometer model HACH DR 2400 (Phenate Method) at wavelengths of 636, 470 and 520 nm. The Phosphorus of the water samples was determined at wavelength 882nm using UV Spectrophotometer (Ascorbic Acid Method) while sulphate was determined at wavelength 420 nm using UV Spectrophotometer model SM 7525. The Chloride of the water samples was determined Mohr's Method. The results of the samples were compared with WHO standard for drinking water and the Control. The results obtained during dry and rainy seasons showed that NH3-N (0.1 - 1.73 and 0.07 - 1.73, 0.38 - 1.24 and 0.53 - 3.35 mg/l), NO3- (1.14 - 18.82 and 2.66 - 3.40, 1.37 - 2.58 and 2.84 - 4.51 mg/l), NO2- (0.06 - 0.43 and bdl - 0.24, 0.11 - 0.35 and 0.02 - 0.18 mg/l), Cl- (106.50 - 177.50 and 40.00 - 146.00, 71.00 - 1047.00 and 40.00 - 746.00 mg/l), SO42- (19.68 - 68.53 and 6.90 - 11.64, 53.07 - 129.53 and bdl - 57.33 mg/l), PO43- (0.09 - 2.16 and 0.08 - 9.16, 0.09 - 15.76 and 0.09 - 1.85 mg/l). The results revealed that apart from NH3 and NO2- every other acid radical was within the permissible limit of WHO. The water sources require sufficient treatment to overcome the identified acid radical flaws and in other to make it suitable for drinking. This work has been able to provide data for the level of contamination in boreholes in the locality as well as increase the awareness that no source of water is immune to pollution due to human activities.

Key Words: boreholes, spectrophotometer, season and contamination

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Introduction Potable water is generally considered as one of the main factors that contribute for human well-being. The demand for this potable water in most developing nations of the world particularly, Nigeria far outweighs the supply as one can see long queues of people with their containers at the public water supplies. Groundwater is usually the most important component of the earth crust and it constitutes about two-thirds of the freshwater resources of the world [1]. It accounts for nearly all usable freshwater and it mostly originated from rain or snowmelt infiltration through soil into subsurface aquifers [2]. Groundwater remains the largest reservoir of drinkable water and due to the natural filtration process through soils and rocks, is thought to be less contaminated when compared to surface and thus considered a good quality water source for human use and consumption [3, 4]. The nature, quality and mobility of groundwater are all strongly dependent upon the rock formations in which the water is held [5]. Several decades ago, groundwater quality has emerged as one of the important and confronting environmental issues [6]. Boreholes contaminations have generated a lot of worries and controversies as many urban and rural dwellers depend on them. Attention has been given to water contamination and its management because of the impact on human health [7, 8]. Boreholes are polluted by domestic and industrial wastes, acid rain, fertilizers and pesticides, refuse dump and landfill leachates which percolate into the aquifer and contaminate the water [9]. The study will evaluate the acid radicals in some boreholes of Edda, Ebonyi State with the view of establishing the quality of the boreholes.

The Study Area The study area is Edda in Ebonyi State of Nigeria. Geographically, Edda is situated between 70.45 and 50.58 latitudes north of the equator. It lies about 90 miles (144.873 km) north of Atlantic coast. Her surface land area is about 86.14 square miles (223.1 square kilometers). Edda has boundaries on the North with Ohaozara; on the South by Arochukwu/Ohafia; on the East by Unwana/Afikpo and by the West with Akaeze/Nkporo. Edda occupies about 378 square kilometers and with population of about 240,000 according to the 2006 national demography. The main occupation of the people is largely agriculture. Edda is richly blessed with large mineral deposits such as: lead, zinc, copper, gypsum, coal, crude oil and gas, kaolin, laterite, igneous rocks [10].

Sample collection Samples were collected in Oso and Owutu autonomous communities of Edda. A total of 8 sample stations (Figure 1) were mapped out in the locality. The samples were coded Amaukabi (AB), Nde Okpo (BB), Nde Obasi (CB), Amaosonta (DB), Oso Tech (EB), Okporojo Secondary School (FB), Ogiri (GB) and Ameta (HB). Electronic Hand-held GPS equipment was used to record the co-ordinates of each sampling point.

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Sampling Procedure The containers and glass wares were soaked in 0.1 M HNO_3 for 24 hours. Thereafter, the containers were thoroughly washed with detergent, rinsed with distilled water to remove any contaminant which may remain in the containers. Composite samples were collected in 1-litre plastic containers and prior to collection as part of the quality control measures, all the bottles were rinsed three times with the sample water at the point of collection. Standard procedures were followed in the preservation of the samples. The containers were labeled using masking tape and a permanent marker. The locations were indicated on the tapes using sample codes for easy identification.

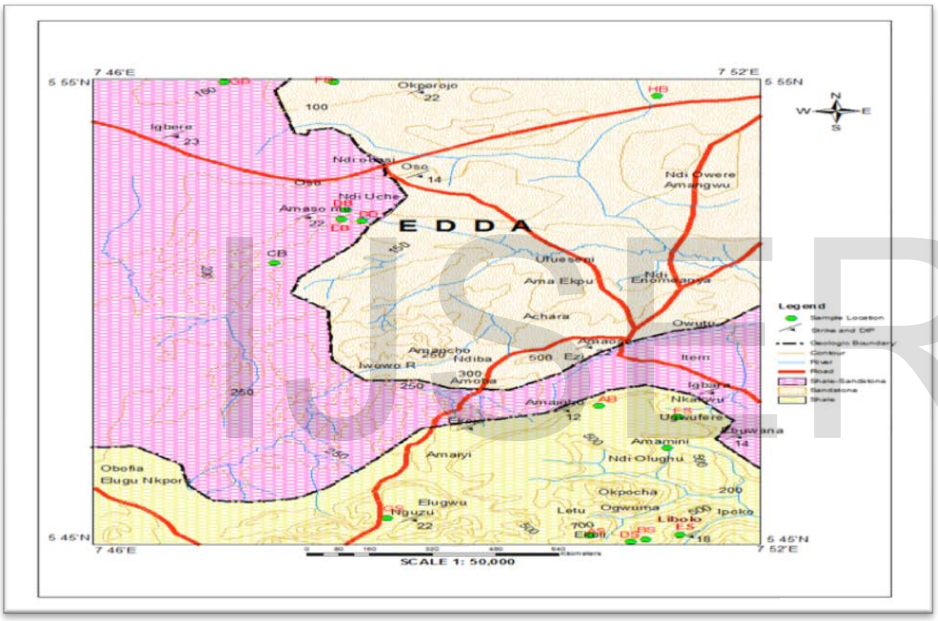

Fig 1: Map of Afikpo South LGA Showing the Sample Locations [11]

Sample Analysis The Ammonia, nitrate and nitrite of the water samples were determined using UV Spectrophotometer model HACH DR 2400 (Phenate Method) at a wavelength of 636, 470 and 520 nm according to the method described by [12]. The Phosphorus of the water samples was determined at wavelength 882nm using UV Spectrophotometer (Ascorbic Acid Method) according to the method described by [13]. The sulphate of the water samples was determined at wavelength 420 nm using UV Spectrophotometer model SM 7525, Serial Number 752509044, according to the method described by [14]. The Chloride of the water

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samples was determined, using Silver Nitrate with Chromate Indicator (Mohr's Method) as described in International Standard ISO 9297.

Results and Discussion Table 1, Figures 2 and 3 showed the concentrations of $\mathbf{NH_3}$ in the borehole water during dry and rainy seasons as 0.38 - 1.24 and 0.53 - 3.35 with mean concentrations of 0.69 and 1.62 mg/l, respectively. Ammonia is a useful indicator of organic pollution.

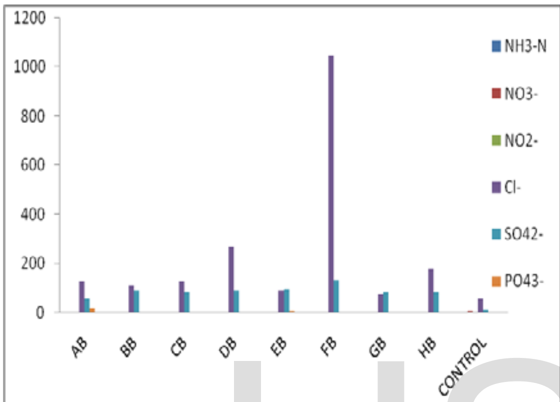

Fig 2: Concentrations of Acid Radicals of Borehole at the Dry Season

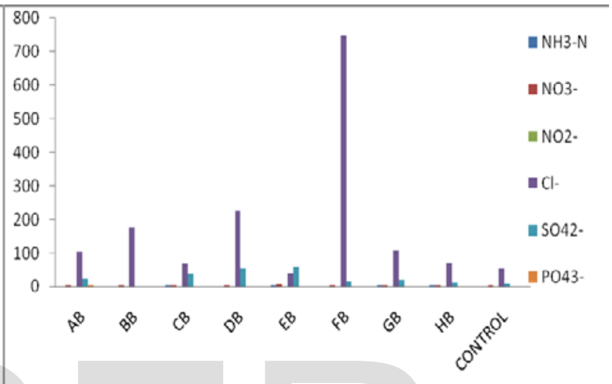

Fig 3: Concentrations of Acid Radicals of Borehole at the Rainy Season

Table 1, Figures 2 and 3 showed that the $\mathbf{NO_3^-}$ content in the borehole water during dry season and rainy ranged 1.37 ± 0.03 - 2.69 ± 0.05 and 2.84 ± 0.01 - 4.51 ± 0.00 mg/l with mean concentrations of 1.94 and 3.44 mg/l, respectively. The results of the samples analyzed were below both the Control (3.41 ± 0.00 and the permissible limit of [15] which recommended 50 mg/l as the threshold limit. This low level is an indication that there is low infiltration of nitrate into the groundwater body and the results were in accord to the findings of [16, 17, 18] in the literature. It was reported that NO_3^- level above the WHO limit was dangerous to children below the age of 6 and pregnant women as it has the potential of causing metheglobenamia. Methemoglobinemia is actually an excess of methemogobin in the blood and it can cause cyanosis (blue skin) of limbs, weakness and rapid heart rate. Table 1, Figures 2 and 3 showed that the value of $\mathbf{NO_2^-}$ in borehole water during dry and rainy seasons ranged 0.11 ± 0.01 - 0.35 ± 0.00 and 0.02 ± 0.00 - 0.18 ± 0.01, with mean concentrations of 0.21 and 0.10 mg/l, respectively. The results of the analysis were within the

Control (0.10 ± 0.00) apart from locations FB and GB which were higher than the Control. However, the concentrations were above the maximum permissible limit of WHO which recommended 0.003 mg/l as the threshold limit. This high level is an indication that there is infiltration of nitrite into the groundwater body and the results were in accord to the findings of [17, 18] in the literature. Just like nitrate, excessive nitrite exposure can result in acute acquired methemoglobinemia, a serious health condition that afflict mostly children. The results of the analysis revealed that concentrations of **Cl^-** in the borehole water samples as shown in Table 1, and Figures 2 and 3 during dry and rainy seasons ranged 71.00 ± 0.82 – 1047.00 ± 0.25 and 40.00 ± 0.47 – 746 ± 2.49 mg/l with mean concentrations of 250.63 and 191.00 mg/l, respectively. Apart from location EB, the other locations have concentrations higher than the Control (53 ± 0.47 mg/l); similarly, locations DB and FB with mean concentrations of 266.25 ± 0.118 and 1047.30 ± 0.245 mg/l, respectively, have values that are below WHO 250 mg/l threshold of drinking water. High concentration of Cl^- gives an undesirable taste to water and beverages. Taste thresholds for the chloride ion depends on the associated cation and are in the range of 200-300 mg/l for sodium, potassium and calcium chlorides [19]. According to literature [20] any groundwater samples with concentration greater than 100 mg/l may be dominated by halite and contain mixtures that indicated pollution from sewage or animal waste. No health-based guideline value is proposed for chloride in drinking water. That notwithstanding, chloride concentrations in excess of about 250 mg/l can give rise to detectable taste in water and laxative effect in human beings [21]. Table 1, Figures 2 and 3 showed that the **SO_4^{2-}** concentrations of the analysis of the borehole water samples during dry and rainy seasons varies 53.07 - 129.53 and bdl - 57.33 ± 0.009 mg/l with mean concentrations of 86.03 and 30.76 mg/l, respectively. The results of the analysis showed that apart from location BB (bdl) every other locations were above the Control (8.08 ± 0.005 mg/l). Though various levels of concentration of SO_4^{2-} were found in

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the analyzed water samples but the levels were below the [15] 500 mg/l limit of drinking water standard. Ingesting of 8 g of sodium sulphate and 7 g of magnesium sulphate causes catharsis in adult males [22]. Table 1, Figures 2 and 3 showed that the **PO_4^{3-}** concentrations in the borehole water during dry and rainy seasons ranged 0.09 ± 0.005 - 15.76 ± 0.028 and 0.09 ± 0.001 - 1.85 ± 0.00, respectively with mean concentrations of 2.70 and 0.39 mg/l, respectively. Apart from locations FB and GB whose concentrations were below the Control (0.10 mg/l) every other location were above the control. However, location AB with a mean concentration of 15.76 ± 0.028 exceeded the WHO stipulated tolerance level of 5.0 mg/l for potable water; other locations were within the WHO threshold of drinking water standard. PO_4^{-3} at 0.1 mg/l in water has deleterious effect on water quality by promoting the development of slimes and algal growth. It was reported that the presence of phosphate in the groundwater body emanates from sources such as sewage, detergents, industrial effluents and agricultural drainage [23].

Table 1: Mean concentration of Acid Radicals of Borehole water Samples at the Dry Season

Samples	Season	NH_3-N	NO_3^-	NO_2^-	Cl^-	SO_4^{2-}	PO_4^{3-}
AB	Dry	0.38 ± 0.01	1.58 ± 0.05	0.11 ± 0.01	124.25 ± 0.20	53.07 ± 0.39	1.58 ± 0.03
	Rainy	1.13 ± 0.01	2.85 ± 0.01	0.02 ± 0.00	102.00 ± 0.47	23.06 ± 0.03	1.85 ± 0.00
BB	Dry	0.38 ± 0.01	1.49 ± 0.04	0.26 ± 0.01	106.50 ± 0.24	87.40 ± 0.09	0.96 ± 0.03
	Rainy	1.32 ± 0.00	4.13 ± 0.01	0.07 ± 0.01	176.00 ± 1.25	bdl	0.16 ± 0.00
B	Dry	0.59 ± 0.01	2.58 ± 0.07	0.18 ± 0.01	124.25 ± 0.12	80.33 ± 0.20	0.78 ± 0.01
	Rainy	1.96 ± 0.00	3.54 ± 0.02	0.14 ± 0.01	66.00 ± 0.47	37.07 ± 0.01	0.44 ± 0.00
DB	Dry	0.83 ± 0.01	1.83 ± 0.02	0.20 ± 0.01	88.75 ± 0.48	88.43 ± 0.13	0.61 ± 0.01
	Rainy	0.81 ± 0.00	2.84 ± 0.01	0.11 ± 0.01	226.00 ± 0.94	53.23 ± 0.14	0.12 ± 0.00
EB	Dry	0.83 ± 0.01	1.83 ± 0.02	0.19 ± 0.01	88.75 ± 0.48	90.50 ± 0.07	2.33 ± 0.02
	Rainy	3.35 ± 0.00	4.51 ± 0.00	0.09 ± 0.01	40.00 ± 0.47	57.33 ± 0.01	0.24 ± 0.00
FB	Dry	1.24 ± 0.05	1.37 ± 0.03	0.35 ± 0.02	1047.30 ± 0.25	129.53 ± 0.47	0.70 ± 0.00
	Rainy	0.53 ± 0.00	3.59 ± 0.01	0.18 ± 0.01	746.00 ± 2.49	14.22 ± 0.01	0.10 ± 0.00
GB	Dry	0.95 ± 0.04	1.58 ± 0.05	0.24 ± 0.02	71.00 ± 0.82	80.60 ± 0.62	0.09 ± 0.01
	Rainy	2.19 ± 0.00	2.91 ± 0.00	0.12 ± 0.01	106.00 ± 0.47	19.83 ± 0.01	0.11 ± 0.00
HB	Dry	0.55 ± 0.02	2.36 ± 0.23	0.18 ± 0.01	177.50 ± 0.24	78.37 ± 0.19	0.35 ± 0.02
	Rainy	1.69 ± 0.00	3.17 ± 0.30	0.07 ± 0.01	70.00 ± 1.25	10.56 ± 0.28	
							0.09 ± 0.00

Control	0.22 ± 0.00	3.41 ± 0.00	0.10 ± 0.00	53.00 ± 0.47	8.08 ± 0.01	0.10 ± 0.00
WHO (2011)	0.50 mg/l	50	0.003	250	500	10

Conclusion The study has shown that the concentration of NO_2^- exceeded the WHO guideline value. The result also showed that the chloride concentrations in location FB was outrageous and could pose serious danger to the inhabitants, especially the school children who use it as the only source of drinking water. Generally the boreholes in the area of study should be given comprehensive treatment so as to make the water potable to people.

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