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SALINE WATER VARIABILITY IN AZARA DEVLOPMENT AREA OF NASARWA STATE

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Abstract: This study examines the variability of saline water properties under salt mining activities in Ribi, Azara and Akiri areas of Azara Development Area. A total number of Forty (40) water samples were collected and analysed for the physical, chemical and environmental impact of saline water in the three areas. The results of the chemical analysis revealed that the cation concentration are inorder of Na, $>Ca^{2+}>Mg^{2+}$ while that of anions are in the order $Cl^{-}>HCO^{3-}>SO2^{2+}>SO4^{2-.}$ In percentage, the degree of metal concentration is comparable in the two studyareas, except for some non-metals. Significant positive correlations were observed between and among the variables in the three areas. The geo-accumulation index order for brine are in these order Na >Ca> Mg>Mn> Al > Cr > Li. The major salts identified were Cl^{-}, $HCO3^{2-}$, $SO4^{2-}$, and $NO3^{2-}$. The high electrical conductivity value recorded is as a result of high concentration of brine water in the study areas.
Keywords: Physico-Chemical Properties, Oxisol, Saline water, Barite, Hydromorphic, cation, artesian springs, pond, lateritic ferruginous soil and anion.

1. Introduction

Quite number of saline water formation are known in the NE-SW sedimentary belt of Nigeria, mostly within the lower and upper Benue- Trough significantly outcrops formation or occurrences which supported local are found at Ogoja Area Benue State and Awe local government and Azara development areas in Nasarawa State. The saline water occur as artesian springs in small ponds and in dug wells and have electrical conductivity ranging from above 5,000 µs/cm to 100,000 u's/cm. the equivalent salt concentration in about 0.8% to over 8%. The higher concentration values are over two times the concentration of sea water. This makes the saline water more attractive for commercial development than sea water in Nigeria (Abiola *et al,* 2014).

The discovery of the saline water dated back to the origin of the associated settlements where saline has been the traditional source of Edible salt. Saline water is as old as Akiri, Ribi and Azara area. Some of the locals and Fulani herdsmen who were early settlers in the area have remained in these towns today due to prevalence of saline water which they tagged as been spiritual. They believe this water can cure different ailment.

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There are however over 25 documented saline springs where salts are locally processed with unknown reserve across the middle Benue valley, with sources and level of saline water concentration remain a point of argument among many workers and authors. Moreover, more than 10 known solid minerals are been mined along with saline water for example Byrites, led, zinc, limestones, coal, e.t.c currently active exploitation of these minerals resources are going on within this region, without adequate data on physical or chemical variability of the saline water quality. This study attempts to provide information about the physical and chemical variability of saline water constituent in these areas under study.

2. Material and Method

Study Area:- The three study areas are within the radios of 20km, and they are about 50-66km from Lafia town, capital of Nasarawa State, with GPS location of latitude 8^{o} 22' 21"N and longitude 009^{o} 22' 08" E for Akiri, Latitude 8^{o} 22' 21" N and longitude 008^{o} 22' 00" E for Azara 1, Latitude 8^{o} 22' 21" N and longitude 008^{o} 22' 40" E for Azara II and also latitude 008^{o} 22'13" N & longitude 009^{o} 17'33" E for Ribi study area. These areas are not linked directly to the tarred grade B road from Lafia to Awe town.

The relief consist of undulating plains, believed to be tectonic in origin, which consist of cyclically bedded grey and greenish shale, siltstones and sand stones, they are also believed to be part of the Albian to coniancian Awe formation of middle Benue. The areas are characterized by tropical sub-Humid climate with two distinct seasons of wet and dry season. The mean annual rainfall ranges between 850mm to 1200mm. the soil are of tropical lateritic ferruginous soil derived from the basement complex and old sedimentary rocks. The mean monthly temperature ranges between 24^{s}c to 36^{o}c with the hottest month being March and April, and coldest month is December.

a) Sample Collection

Field work in the study areas were undertaken at several points of saline well, ponds and spring in AkiriRibi and Azara areas. The areas were mapped and 40 samples of saline water were collected. At the field in-situ basic parameters like temperature, pH and conductivity were determined while others were determined in the laboratory. In all 17 elements and minerals were determined for the analyses. The samples were collected at the peak of dry season in the month of February. A total number of 80 water samples were collected for the physico-chemical analysis of the saline in the pond, well, and spring at the three samples areas. Samples were collected in 2litres plastic containers, which had been adequately washed and rinsed containers, which had been adequately washed and rinsed with distilled water for

the sampling. About 1 litre of each of the samples collected was filtered and the volumes were used for the analyses of anions and metals with acidified nutric acid to prevent the metal from adhering to the wall of container. For further purposes, the entire samples collected were refrigerated at 10^{oc} before eventually analysed.

b) Mineral Analysis

All the analyses were carried out in the laboratory in accordance with American public Health Association (1989) standard method for examination of water. The elemental analysis was done in the water samples using Perkin Elmer and Oak brown, atomic spectrophotometer. The instrument setting was as described by Abiola *et al* (2010) and Aremu *et al* (2008). Sodium and Potassium are determined by using a flame photometer (Model 405, Corning, UK) as described by Abiola *et al* (2014).

c) Physico-Chemical Analysis

Temperatures were measured using mercury thermometer while pH was done using a BNC pH meter. Conductivity measurement was done using conductivity meter model NATOP PBS while alkalinity and total hardness were done by titremetry (APHA, 1995). Chloride was measured by chloride ion water (model KRK Cl-Sc Japan). Phosphate (molybdophosphoric blue colour method in H_2SO_4 system) and nitrate were estimated using a PVE UNICAM visible spectrophotometer in private lab in Lagos. Total dissolved solids were determined by gravimetry method and chemical oxygen Demand (COD) by APHA method (APHA, 1995).

3. RESULT AND DISCUSSION

The temperature of saline water varies from 28.90^{o}c to 40.70^{o}c with Akiri area having the highest temperature of 40.70^{o}c and Ribi with 28.90^{o}c (Table 1).

The mean pH of the salt water rise because of high electrical conductivity of the saline, with decreases from Akiri (7.40) down to Azara I (6.39) and shown the nature of weak acid. The values are not within the range stipulated by world Health Organization standard value for drinking water. Electric conductivity was very high with Azara I (34, 080) having the highest with Akiri having the lowest value of 10, 300 due the inter-calation of the saline water parent materials with the Byrites Vein formation.

Generally the amount of Na at the different saline sites was relatively high with ranges from 2191.00 in Akiri to 6982.40 in Azara I (Table I). like Na, K amount in the saline water is relatively high too, because of it's high electro-positivity. Calcium is a divalent element which forms part of the salt in the saline body (Aremu and Inajoh, 2007). The highest amount is observed at Azara II (506.00), then the lowest at the Akirisaline pond (Table 1). The

alteration of Ca may affect the skin ligament, which can further lead to skin pigment. Magnesium like calcium is a divalent element which forms the salt of the "Alum" and it is needed in a small quantity for good quality of water (Aremu *et al* 2008). Azara II area had the proportional amount of 94.30 followed by Azara I (91.42), then Ribi Area (78.33) and the least was recorded at Akiri which was 18.92. Manganese content generally was law in water with highest amount recorded in Ribi (1.21) and the lowest at Azara II (0.00). The amount of Iron in the saline water is relatively high. The highest amount can be found at saline pond at Azara II (5.99), while the lowest was recorded at Akiri saline pond (3.78). The level of iron is above the WHO (2008) maximum allowable amount in surface water (Table 1).

The hardness of water is determined by the amount of CO_3^{2-} or HCO^- in the water, and this called "Alum". Akiri has the highest HCO^- ion with mean amount of 471.13, followed by Azara I (440.98) and the least was Azara II (300.12). generally, however the amount of chloride ion in the saline water is very high with Azara II recorded the highest amount of 12, 700.00 followed by Ribi saline spring (12, 148), then Azara I with 11, 700 and the least is Akiri Area, 3098. The amount of sulphate ion is negligible in all the study area, with all of them recorded traceable amount (0.00). Nitrate ions is relatively high in Azara I (33.25) and followed byAkiri (12.05), however, Ribi and Azara II recorded traceable amount 0.00 concentration of lithium Berylium and Chromium exceeded the maximum allowable WHO 2008 limit in Ribi and Azara I, while Azara II and Akiri has lowest or traceable amount of the elements.

Table 1 Mean average of element and Compound in the Study Areas.

	Akiri Pond		**Ribi Spring**		**Azara 1 Spring**		**Azara II Pond**		**WHO 2009**
Mineral	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Standard
temp^{o}c	40.7	2.58	28.90	2.09	30.70	1.89	29.80	1.77	<40
pH	7.40	0.20	6.92	0.11	06.39	0.23	06.58	0.27	6.90
µsc/ EC	10300:00	516.07	28170	239.43	34080	354.98	32800	265.01	1000
Ca	101.36	2.26	426.13	3.49	465.12	3.93	506	5.92	<1
Mg	18.92	3.35	78.33	7.90	91.42	6.62	94.30	6.07	<1
Na	2191	244.01	6534.67	414.32	6982.40	403.62	7388	382.16	200
K	74.70	16.07	228.93	38.60	252.62	35.50	281.90	11.86	<1
Fe	3.78	0.27	5.74	0.35	5.49	0.33	5.99	0.46	<1
Mn	0.18	0.58	1.21	0.16	0.30	0.23	0.00	0.00	<1
Li	1.20	4.33	6.97	3.26	7.83	2.48	0.00	0.00	<1
Ba	18.01	3.11	74.73	2.41	63.68	1.32	74.50	2.04	<1
Cr	6.07	0.04	42.23	0.12	44.61	0.18	45.38	0.183	<1
Br	2.40	0.13	6.50	0.93	6.00	0.34	5.40	0.33	<1
HCO_3^-	471.13	3.62	414.84	3.18	440.98	3.74	300.12	3.82	50
Cl	3098.50	34.53	12148	507	11700	510	12700	491	600
SO_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	250
NO_3^-	12.05	1.62	0.00	0.00	33.25	2.16	0.00	0.00	20

Table 2: Summary the Pearson Moment Product Correlation for Akiri,Ribi, Azara I and Azara II study Area

	AkiriRibiAzara I		Azara II		
Akiri	STD	1.00 XX	0.702X	0.974 XX	0.945 XX
	Error	-----	.000	.000	.000
	Number	17	17	17	17
Ribi	STD	0.702X	1.000 XX	0.863X	0.901 XX
	Error	.000	------	.000	.000
	Number	17	17	17	17
Azara I	STD	0.974 XX	0.863X	1.000 XX	0.866X
	Error	.000	.000	------	.000
	Number	17	17	17	17
Azara II	STD	0.945X	0.901 XX	0.866X	1.000 XX
	Error	.000	.000	.000	------
	Number	17	17	17	17

XSignificant at one tail; STD: Standard Deviation; Error: Standard Error and Number: Number of variables analysed

XXSignificant at twotail

4. CONCLUSION

In conclusion the Pearson Moment Product Correlation was used to confirm the level of variation between the elemental parameters and among the study areas, the result show that there is a level of significant at either two-tail or one-tail among the study area (Table 2). However, there is no much significant variation in the presence or the amount of mineral available in saline water of the study areas in Nasarawa State.

The study has presented data on the concentration of some parameter and metals of saline water samples from Akiri, Ribi, Azara I and II Area of Nasarawa State, Nigeria. This being most comprehensive study in the areas and water from the saline pond or spring showed that physic-chemical examined from the four sources are relatively not within the world Health Organization standard limit.

Lastly, mineral mining has left a scare of countless and complex environmental and environmental related problem being experienced today by Nigerian state. The environmental related problems range from pollution of various form as well as land degradation of national dimension.

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