Australian Journal of Basic and Applied Sciences, 8(17) November 2014, Pages: 137-141

AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Physiochemical Parameters and Trace elements of Soil Samples Collected from Ogun State, Nigeria

Mojisola Usikalu and Justina Achuka

Department of Physics, Covenant University, P.M.B. 1023, Ota, Ogun State, Nigeria

ARTICLE INFO

Article history:
Received 19 August 2014
Received in revised form
19 September 2014
Accepted 29 September 2014
Available online 8 November 2014

Keywords:
pH, electrical conductivity, trace elements, atomic absorption spectrometer, soil samples, Ogun State

ABSTRACT

Background: It is very important to characterize our environment, such as soil or body of water by measuring its pH and electrical conductivity (EC). **Objective:** To measure the pH, electrical conductivity and trace elements of soil samples collected from selected locations in Ogun State, Southwestern, Nigeria using pH meter, electrical conductivity meter and atomic absorption spectrometer (AAS) respectively. **Results:** The pH measured range between 6.51 and 9.66 with a mean of 7.95 while the electrical conductivity ranges between 2.07 μSm^{-1} and 37.70 μSm^{-1} with a mean of 11.04 μSm^{-1}. Elements detected are Fe, Ca, Mn, Cr, Cu, Zn and Ni with mean values 164.00, 44.39, 3.00, 0.29, 0.20, 2.58 and 0.0005 mg l^{-1} respectively. **Conclusion:** The concentrations of Fe in the soil samples were high when compared to the world reference level. The study concluded that the soil samples were considered alkaline, non-saline and has low concentration of Ni.

To Cite This Article: Mojisola Usikalu and Justina Achuka, Physiochemical Parameters and Trace elements of Soil Samples Collected from Ogun State, Nigeria. ***Aust. J. Basic & Appl. Sci.,*** *8(17): 137-141, 2014*

INTRODUCTION

Trace elements are released into the environment from the natural weathering of rocks and their minerals and from various human activities (Haluschak *et al*., 1998). Soil is a product of rock weathering and during this process, rock minerals are completely broken and relevant chemical elements in them are adsorbed in the soil (Vandana *et al*., 2011). Minerals, organic matter, water and air are the major components of the soil and it acts as a home for plants, by providing them with stability and essential nutrients. The primary trace elements are relatively stable and immobile in the soil, they are found mainly to a soil depth that corresponds to the depth of cultivation, tilling, or disturbance. While some of these trace elements are essential for plants and animal growth, some are very harmful even to very minute amount. Human activities such as urbanization, industrialization, mining, farming, mineral processing etc are known to influence the concentration of these elements in our environment (Lar, 2013; Vardana *et al*., 2011; Iyaka and Kakulu, 2011). Trace elements found their way into the human body through ingestion and inhalation. The lack or excess of these elements in the body poses health risks to the populace and as such requires attention. Knowledge about the concentration of trace elements is a concern because of their importance in some human endeavor such as human and animal nutrition, human health and disease, geochemistry and environmental pollution (Okoya *et al*., 2011). Studies have shown that the top soil horizons overlying most parts of the Nigerian basement terrains contain high levels of potentially harmful elements (Lar, 2013). He reported the prevalence of goiter due to iodine deficiency in areas underlain by metamorphic basement and younger granite rocks, dental fluorosis resulting from the excessive ingestion of fluoride in both children and adults living in the crystalline and sedimentary terrains of Nigeria.

It is usually needful to measure the physiochemical parameters (such as pH and electrical conductivity) of the soil in order to determine the salinity and the variation in the physical properties of the soil. Having a good knowledge of the soil will enhance its optimal usage and the adoption of remedial measures where necessary since it serves as a platform for plants and animal life. Soil pH is considered a master variable in soil because it determines the availability of plant nutrient by controlling the chemical forms of the nutrient in the soil. It also influences the activity of soil microorganisms, thereby affecting nutrient cycling and disease risk. Soil electrical conductivity (EC) has been used as a surrogate measure for soil properties such as, salinity, moisture content, topsoil depth (TD), and clay content (Sudduth *et al*., 2001). It has served as a mapping tool for quick and economic method of indicating soil productivity (McBride *et al*., 1990). The healthier the soil, the more likely a

Corresponding Author: Mojisola Usikalu, Department of Physics, Covenant University, P.M.B. 1023, Ota, Ogun State, Nigeria E-mail: moji.usikalu@covenantuniversity.edu.ng

plant will thrive and grow. Therefore, this work assessed the physiochemical properties and trace elements of soils collected from Ogun State Nigeria so as to check whether these quantities are within the recommended limit.

The Study Area:

Ogun State is located within latitude $7^0$00N and longitude $3^0$58E. It covers a total area of 16,762 km^2 land mass with twenty Local Government areas and population of about 3.7 million. It borders Lagos State to the South, Oyo and Osun States to the North, Ondo State to the East and Republic of Benin to the West. The major occupation of the people is Farming. The vegetation and the soil type is suitable for the cultivation of tree and food crops like oil palm, kola-nut, cocoa, rubber, citrus, rice, maize, cassava, cocoyam, vegetables etc. The state is known for its extensive limestone deposits. Other mineral resources available include chalk, phosphate, high quality stones and gravels. Soils in the State are varied according to the geological history and soil formation processes in the different localities. The natural resources, manpower and geographical location (Figure 1) of this State have made it a potential industrial zone in Nigeria.

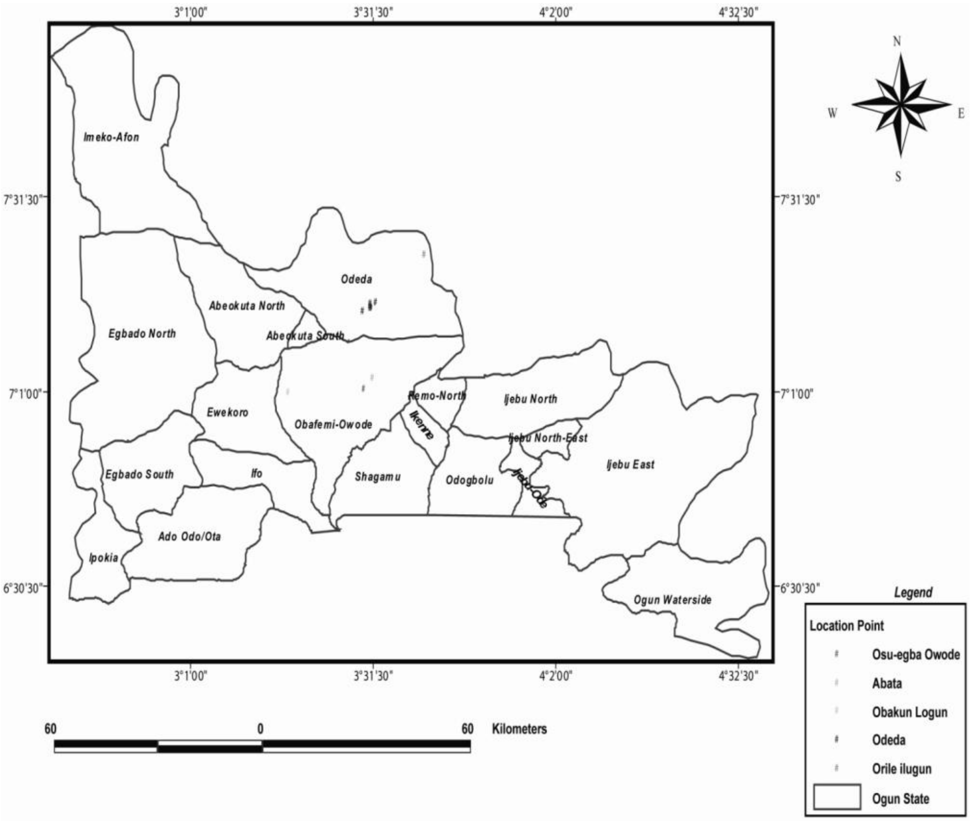

Fig. 1: Geological map of Ogun State.

MATERIALS AND METHODS

Sample Preparation and Analysis:

Samples were collected by digging the ground to at least 3cm so as to take samples free from debris and vegetation. Five (5) soil samples were taken from different points at each location for better sampling, kept in Ziploc bags and labeled accordingly making a total of one hundred (100) soil samples from all the locations. The soil samples were air dried, grinded, homogenized, and passed through a 2mm sieve for composite sample method. Ten (10) g of the prepared sample was added to 10 ml of distilled water (using measuring cylinder) inside a beaker thoroughly stirred and allow to stand for 30 minutes. The glass electrode (probe) was inserted into the mixture and left for about 30 seconds so as to obtain a stable reading. The samples were digested by placing one gram each of air-dried soil sample in 10 ml of concentrated HNO_3 (1:1) in an agate mortar. The mixture was evaporated to near dryness on a hot plate and then cooled. This procedure was repeated with a 15 ml solution of 1:1 concentrated HCl. The extracted samples were filtered and made up to 100 ml volume with 2% HNO_3. Solutions of the sample and blanks were run using Atomic Absorption Spectrometer (AAS) (200A Model). The pH meter was used to measure the pH of each solution and the electrical conductivity was measured using conductivity meter EBB/10 model properly calibrated using the standard solutions using a standard solution of known conductivity. All the apparatus was thoroughly washed and dried before measurement.

RESULTS AND DISCUSSION

Table 1 presented the measured pH in the soil samples which vary from 6.51 to 9.66 with a mean value of 7.95. The location with highest pH value is Ewekoro and the lowest value was obtained from sample collected from Ijebu East. Soil samples $S_{2,}$ $S_{9,}$ and S_{14}, were found to have the normal recommended pH limit of 6.5-7.0. Study has shown that the optimum pH range for most plants is 5.5-7.0, but plants have been known to survive outside this range (Leonard, 2012). As soil pH influences the availability of plant nutrient, it is inherent that most plants that will be found in this region will be those who can thrive in alkaline soil. The pH values of these soil samples fall within the range classified as moderately and strongly alkaline (USDA, 2012). Agriculturist in this environment will benefit more by growing plants that are adaptable to such alkaline soil. However, having this knowledge will help them to implement adequate measures that boost the acidity of soil in order to grow plants that require acidic soil.

The alkaline nature of these soil samples may be as a result of large deposit of limestone and quarry in Ogun State. Limestone being a major constituent of cement is highly alkaline and this might have led to the increased alkalinity of the soil. None of the soil sample was found to be highly acidic (pH 1.0-5.5), which can prevent plant from accessing the nutrients from such soil.

Electrical conductivity (EC) is a measure of soil salinity and is indicative of the ability of an aqueous solution to carry electric current. The EC measured is presented in Table 1 and range from 2.07 μSm^{-1} to 37.70 $\mu Sm^{-1}$with a mean value of 11.04 μSm^{-1}. The highest EC value was obtained in Ifo and the lowest obtained from sample from Owode Obafemi. According to Smith and Doran (1996), the soil of these locations is considered non-saline (0-2 mSm^{-1}). This may be due to the absence of clay soil in the study area that can retain soluble salts due to its non-porous nature. Areas with high amount of rainfall and those classified as well drained soil have also been identified to be non-saline (USDA, 2012).

Table 1: pH and Electrical Conductivity (EC) of Soil Samples

Code	Locations	pH	EC (μsm^{-1})
S_1	Imeko	8.39	14.74
S_2	Ogun Waterside	6.84	2.98
S_3	Abeokuta South	8.56	3.77
S_4	Yewa North	8.17	10.34
S_5	Abeokuta North	8.53	16.37
S_6	Ikenne	7.64	2.89
S_7	Ewekoro	9.66	4.04
S_8	Remo	7.82	13.1
S_9	Ijebu East	6.51	3.91
S_{10}	Odeda	7.78	2.81
S_{11}	Odogbolu	8.38	15.12
S_{12}	Ijebu North East	7.92	2.88
S_{13}	Ifo	7.65	37.7
S_{14}	Ijebu North	6.92	28.2
S_{15}	Ado-Ota	7.28	5.35
S_{16}	Ipokia	8.19	2.86
S_{17}	Shagamu	8.36	2.34
S_{18}	Yewa South	7.88	33.4
S_{19}	Obafemi Owode	8.35	2.07
S_{20}	Ijebu Ode	8.21	16.01
MEAN		7.952	11.044
RANGE		6.51-9.66	2.07-37.7

The elemental composition of the study area is presented in Table 2. The result revealed high concentration of Iron in almost all the samples. Fe concentrations vary between 36.04 mg l^{-1} and 521.08 mg l^{-1} with a mean value 164.00 mg l^{-1}. This is due to the fact that iron exists in various forms in the soil and out of this high value only a small amount is soluble and accessible to plants (Haluschak *et al*., 1998). Haluschak *et al*., (1998) reported that defficiency of iron in plants is generally caused by unavailability of soil iron rather than a low iron content in soil. Its concentration increases in soils which are well aerated, calcareous, alkaline or high in Manganese. Grazing animals requires an iron concentration from 50 to 100 ppm (dry weight) in forage while the maximum allowable content in water for human consumption was set at 0.3 ppm based on aesthetic, rather than health concerns (CCREM, 1995; Haluschak *et al*., 1998).The concentration of Calcium was also significant with a value that range from 0.61-321.05 mg l^{-1} and a mean value of 44.39 mg l^{-1}. Nickel was only detected in sample S_{20} having a value of 0.01 mg l^{-1}. The deficiency of Nickel in the soil can be ascribed to the finding by Nriagu (1990) that Nickel pollution is mainly due to burning of fossil fuel. Haluschak (1998) also reported that Nickel bioavailability decreases as soil pH increases and its mobility is lowered in soils with high cation exchange capacity. Hence, the deficiency of Nickel in this research is mainly due to the alkaline nature of the soil. The concentrations of copper, Chromium, manganese and Zinc are very low when compared with that from other countries as presented in Table 2. No correlation exists between the trace elements and the physiochemical parameters.

Table 2: Trace Element Concentration (mg l^{-1})

Location	Ca	Mn	Fe	Cu	Zn	Cr	Ni
S1	6.82	0.72	36.04	0.05	1.6	0.2	0
S2	1.64	1.63	241.52	0.38	1.74	0.43	0
S3	65.21	3.74	347.52	0.1	1.04	0.37	0
S4	3.01	5.95	86.57	0.16	2.53	0.18	0
S5	32.35	1.57	70.36	0.22	2.36	0.15	0
S6	55.67	2.01	145.56	0.2	7.02	0.32	0
S7	321.05	1.83	168.09	0.28	1.39	0.33	0
S8	42.74	3.64	107.48	0.26	4.95	0.32	0
S9	0.61	1.47	521.08	0.17	1.15	0.35	0
S10	33.04	2.83	223.52	0.25	1.22	0.31	0
S11	2.11	1.64	94.68	0.14	1.84	0.28	0
S12	223.01	3.34	65.36	0.19	2.53	0.1	0
S13	6.34	5.26	201.57	0.33	3.02	0.28	0
S14	0.82	7.72	184.07	0.19	7.56	0.19	0
S15	1.83	1.01	52.67	0.11	2.21	0.24	0
S16	2.56	2.76	149.06	0.13	2.02	0.42	0
S17	38.51	5.78	323.01	0.26	2.36	0.39	0
S18	44.25	4.41	81.82	0.41	2.94	0.25	0
S19	4.65	1.42	97.62	0.11	0.59	0.35	0
S20	1.58	1.2	82.43	0.09	1.61	0.3	0.01
MEAN	44.39	2.9965	164.002	0.2015	2.584	0.288	0.0005

Table 2: Reference limits of Trace Elements (mg/kg) from other Countries.

Countries	Ca	Fe	Mn	Cu	Zn	Cr	Ni
Canada	-	-	-	50	100	75	50
Brazil	-	-	-	35	60	40	13
Netherland	-	-	-	36	140	100	-
EPA	-	49.5	1773	42.8	112.5	79.4	-
Spain	-	80.3	7400	-	406	1107	-

Source: Yebra and Cancela, 2005

Conclusion:

This work determined the pH, electrical conductivity as well as the trace elements of soil samples from selected locations in Ogun State. The pH of most soil samples was found to be highly alkaline with sample S_7 having the highest pH of 9.66. This is attributed to the presence of large deposits of limestone used for cement production in this location. It was found that the concentration of iron was high when compared to other elements present in the soil and the world reference value. Most locations were lacking in some essential nutrients needed for plant growth. This implied that the plants grown in these areas would lack a healthy amount of these essential nutrients and consequently, the people and animals inhabiting these places would also lack these nutrients in their dietary. To enhance optimal crop production, the soil in the study areas needs to be treated appropriately.

REFERENCES

Aderonke Okoya, A., I. Olabode Asubiojo and A. Adeagbo Amusan, 2011. Trace element concentrations of soils of Ife-Ijesa area Southwestern Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 3(7): 173-179.

Akanni, C.O., 1992. Climate. In: Ogun State in Maps, Onakomaya, S.O., K. Oyesiku and J. Jegede (Eds.). Rex Charles Publisher, Ibadan, pp: 187.

Barber, S.A., 1984. Soil nutrient bioavailability. John Wiley & Sons, Inc., New York.

Grisso, R.B., A.W.G. Mark, D. Holshouser and W. Thomason, 2007. Precision Farming Tools: Soil Electrical Conductivity. Virginia Cooperative Extension, pp: 442-508.

Haluschak, P., R.G. Eilers, G.F. Mills and S. Grift, 1998. Status of Selected Trace Elements in Agricultural Soils of Southern Manitoba. Technical Report 1998-6E Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada.

Iloeje, N.P., 1981. A New Geography of Nigeria. Longman, Nigeria, pp: 201.

Australian Journal of Basic and Applied Sciences, 8(17) November 2014, Pages: 137-141

Iyaka, Y.A. and S.E. Kakulu, 2012. Heavy Metal Concentrations in Top Agricultural Soils around Ceramic and Pharmaceutical Industrial Sites in Niger State, Nigeria. Research Journal of Environmental and Earth Sciences, 4(2): 171-176.

Lar, Uriah, 2013. Trace elements and health: an environmental risk in Nigeria. Earth Science; 2(3): 66-72.

Leonard Perry, 2012. pH for the Garden. University of Vermont Extension, Department of Plant and Soil Science. http://pss.uvm.edu/ppp/pubs/oh34.htm.

McBride, R.A, A.M. Gordon, and S.C. Shrive, 1990. Estimating forest soil quality from terrain measurements of apparent electrical conductivity. Soil Science Society of American Journal, 54: 255-260.

Nriagu, J.O., 1990. Global Metal Pollution Poisoning the Biosphere? Environ, 32: 7-32.

Spectrum Analytic Inc, 1087. Jamison Rd NW Washington Court House, OH 43160 (800): 321-1562.

Sudduth, K.A., S.T. Drummond and N.R. Kitchen, 2001. Accuracy issues in electromagnetic induction sensing of soil electrical conductivity for precision agriculture. Computers and Electronics in Agriculture, 31: 239–264.

Terry and Abadia, 1986. Ecological Soil Screening Level for Iron Interim Final OSWER Directive, 9285: 7-69.

U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460.

United States Department of Agriculture (USDA), 2011. Soil Electrical Conductivity; USDA-NRCS, pp: 1.

Vandana Partha, N.N. Murthya and Praveen Raj Saxena, 2011. Assessment of heavy metal contamination in soil around hazardous waste disposal sites in Hyderabad city (India): natural and anthropogenic implications; Journal of Environmental Research and sssssssManagement, 2(2): 27-34.

Vidal-V´azquez, V., R. Caridad-Cancela, M.M. Taboada-Castro, A. Paz-Gonz´alez and C. parecida De Abreu, 2005. Trace elements extracted by DTPA and Mehlich-3 from agricultural soils with and without compost additions, Communications in Soil Science and Plant Analysis, 36(4–6): 717–727.

Yebra M.C and Cancela S 2005. Continuous ultrasound-assisted extraction of cadmium from atomic spectrometric system, International Journal of Environmental Analytical Chemistry, 85:305