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BASIC ANALYTICAL EXAMINATION OF SELECTED STREAMS AND THEIR WATER QUALITY IN ADO-EKITI (SOUTHWESTERN NIGERIA) AND ITS NEIGHBOURING VILLAGES.

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Abstract

Water samples were collected from ten (10) streams at different locations within Ado-Ekiti and its environ in Ekiti State, South Western Nigeria. The samples were evaluated for their physico-chemical properties. The samples under investigation has pH within the range 7.6 to 8.2; total hardness 8.0 mg/l to 196.0 mg/l; Calcium and Magnesium hardness 1.6 mg/l to 76.0 mg/l and 0.49 mg/l to 19.93 mg/l respectively; total solids 0.2 mg/l to 1.2 mg/l; total suspended and total dissolved solids 0.00 to 0.06 mg/l, 0.14 mg/l to 1.16 mg/l respectively; free carbondioxde 3.74×10^{-3} mg/l to 5.72×10^{-3} mg/l; phenolphthalein acidity 9.0 mg/l to 15.0 mg/l; conductivity 4.0 µScm^{-1} to 570 µScm^{-1}. The metal analysis results from atomic absorption spectroscopy (AAS) are as follows: Sodium (2.7 mg/l to 60.1 mg/l), Potassium (4.0 mg/l to 52.0 mg/l), Zinc (0.80 mg/l to 1.51 mg/l), Calcium (1.60 mg/l to 76.0 mg/l), Iron and Lead were not detected in the sample considered.

Keywords: *Physico-chemical, Atomic absorption spectroscopy, Ado-Ekiti and Nigeria*.

INTRODUCTION

Water is one of the most important substances needed by human, animals and plants for their day to day activities and survival. Dubey and Maheshwari, (2006) defined water as a very essential part of protoplasam and that it creates a state for metabolic activities to occur effortlessly; therefore, no life can exist without water. But the prevailing lack of infrastructures in the rural areas of Nigeria has made this resource material (water) from the streams and rivers the major source through which the inhabitants in these areas get water (Siyanbola *et al*., 2011, Nikoladze and Akastal, 1989; Lemo, 2002; Eze & Madumere, 2012). However, the industrialization of urban areas and the non conformity of the industries with regulatory standards for effluent discharge are hampering the portability of the streams and river sources. Due to these increasing anti-environmental human activities (e.g. discharging of effluents into municipal drains) there is a vivid posing/up-setting the natural composition of the aquatic habitats and to the individuals that consume the aquatic matter as well as drinking from such water. Figure 1 below show how aquatic habitats are killed through such activities (Onuegbu 2008, Siyanbola *et al*., 2011). Pollution of water is the major cause for the spread of many epidemics and serious diseases like cholera, tuberculosis, typhoid, diarrhea and ultimately death (Harrison 1958; Lenat and Crawford 1994; Biggs 1995; Gergel *et al*., 1999; Caraco *et al*., 2003; Donohue *et al*., 2006; Khan *et al*., 2012). Pollution itself occurs when there is a change in the physical, chemical or biological condition in the environment which would harmfully affect the quality of human life including animal and plant life (Lowel and Thompson, 1992; Okoye *et al*., 2002; Muhibbu-din *et al*., 2011). Industrial wastes such as oil spillage are known to adversely affect innate life by directly poisoning or indirectly through plummeting the quality of the water as well as that of the streambed (Ahmed and Reazuddin 2000). Urban wastes, on the other hand, cause organic enhancement and spread pathogens of devastating and serious sickness. Federal Ministry of Health gave a statistics in 1994 that only about 30% of Nigerian have access to potable water (Dada and Ntukekpo 1997; Ajala 2009) while in the same year, United Nations estimated that 1.2 billion people lacked access to potable water worldwide (Oyeku *et al*., 2001).

Fig. 1 Map showing unpolluted water (A) and polluted water (B)

(Source: www.Google maps.com)

The impact of the activities of man has been so widespread that the water bodies have lost their self-purification capability to a large extent (Sood *et al*., 2008; Anyanwu, 2012, Ranjini *et al*., 2010).

The World Health Organization therefore has recommended continuous surveillance of water supplies, which should involve monitoring of the water supplies, from public health point of view, for safety and the ability to sustain water supplies. This is to be achieved through sanitary inspection and water quality analysis (World Health Organization, 2002, *Drinking Water Guidelines; Bacteriological Parameters*. World Health Organization, Geneva 5, 2)Stream water is the main source of water supply in Ekiti State, Southwestern Nigeria, the urban and towns depend on the surface water such as streams, springs, dug well and bore hole for their daily activities. The quality and purity forms of these sources are very uncertain. The quality of natural water is generally governed by various physico-chemical and microbiological parameters. The physical and chemical characteristics of water bodies affect the species, composition, abundance, productivity and physiological conditions of aquatic organisms in it (Bagenal, 1978). It is therefore very necessary to understand the physico-chemical and bacteriological qualities of these stream water bodies. The presence of coliforms, total dissolved solids, conductivity, pH, hardness, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD) are some of the significant parameters to study the water quality (Kumar *et al*., 2012).

The objective of this study is to determine basic physico-chemical properties of selected streams in Ado-Ekiti and its environs.

MATERIAL AND METHODS

Sampling and Sample Sites

Water samples were collected in triplicate from eight (10) different streams as shown in the study location map (Figure 2). The samples were collected mid stream about five (5) meters away from the bank. The representative sample for each location was drawn out after mixing the three samples for each location together. The pH and conductivity of each sample were determined almost immediately on arrival at the laboratory. Samples collected were labeled accordingly showing the time and location.

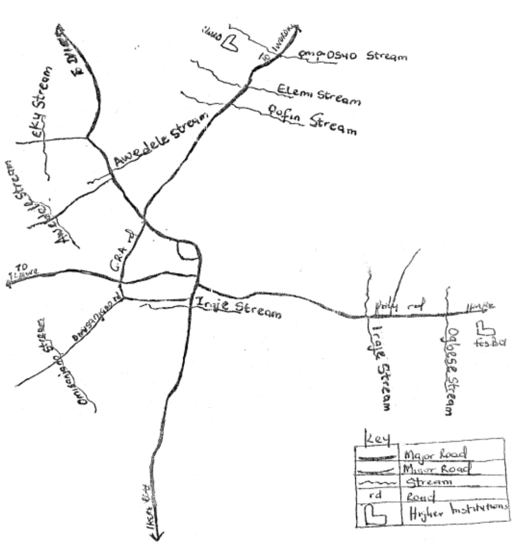

Fig. 2: Study Location Map

Table. 1: Description of Water Samples

Sample Code	Description	Location
T_1	Ogbese Stream	Federal Polytechnic Road, Ado-Ekiti
T_2	Ireje Stream	Federal Polytechnic Road, Ado-Ekiti
T_3	Ireje Stream	Bamigboye, Ado-Ekiti
T_4	Eku Stream	Bashiri, Ado-Ekiti
T_5	Awedele Stream	Bashiri, Ado-Ekiti
T_6	Elemi Stream	University of Ado, Ado-Ekiti
T_7	Ofin Stream	Adehun, Ado-Ekiti
T_8	Omisanjana Stream	Omisanjana, Ado-Ekiti
T_9	Awedele Stream	Textile, Ado-Ekiti
T_{10}	Omoosuo Stream	Iworoko Ekiti

PHYSICO-CHEMICAL ANALYSIS OF THE SAMPLES

The parameters analyzed for the determination of the quality of the stream water are: pH, odour and appearance, conductivity, free carbondioxide in the sample, acidity of the sample, total solids (TS), Total suspended solids dried (TSS), Total hardness, Calcium Hardness by EDTA, Magnesium hardness by EDTA.

pH was determined by use of a pH meter, the electrode was dipped into a beaker containing 100 mL of buffer solution of pH 9 and later pH 4 in order to calibrate the instrument. The electrode was dipped into the sample after calibration of the instrument.

Odour of the sample was determined by smelling the water samples for any foulness in the odour.

Conductivity was measured with a conductivity measuring bridge. The sample was poured into a cup-like material in the conductivity meter and the conductivity is read from the electronic meter in $\mu S cm^{-1}$.

Free carbondioxide in the water sample was determined by adding five (5) drops of phenolphthalein to 100 mL of the water sample until the appearance of a pink colour that persists for about 30 minutes after titrating with sodium carbonate. Concordant reading were taken and recorded.

The expression for calculating free CO_2 in the samples is given below:

$$\text{Free } CO_2 = \frac{A \times 22 \times 100}{50 \times 100} \text{ mg/L}$$

A = volume of the sample used.

Acidity of the water sample was determined via two methods; methyl orange acidity and phenolphthalein acidity. Methyl orange acidity was determined by pipetting 100 mL of the sample into a conical flask and adding one drop of the sodium thiosulphate solution so as to react with residual chlorine. Two drops of methyl orange

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indicator was added and titrated with N/50 sodium hydroxide until the red colour changes to yellow. Phenolphthalein acidity was done as above, but two drops of phenolphthalein indicator was added instead of methyl orange. The sample was titrated until the pink colour persisted for thirty minutes.

The Total Solid (TS) of the sample was determined by transferring aliquots of the sample to a dried and pre-weighed nickel crucible, the sample was then dried at 103˚C for one hour, cooled in a dessicator and weighed, the process of drying, cooling and re-weighing was done until the weight loss was less than 4% of the previous weight.

$$Total\ solids = \frac{W_2 - W_1}{V} \text{ x } 10^6 mg / L$$

Total suspended solid was determined by measuring 50 mL of the sample. It was sieved by using a filter paper and dried in an oven at 103˚C. The dried sample is cooled in a dessicator and reweighed. The process was repeated until the weight is constant.

$$Total\ Suspended\ Solids\ (\text{TSS}) = \frac{W_2\ -\ W_1}{V} \text{ x } 10^6\ mg / Ls$$

Total hardness was determined by pipetting 50 mL of the sample and adding two drops of indicator. This was titrated against EDTA till the wine colour changed to a pure blue colour.

$$Hardness = \frac{\text{Vol. of EDTA x titre value x m.100}}{\text{mL of sample}}$$

Calcium hardness was determined by addition of 2 mL of NaOH to 50 mL of the sample and titrating against EDTA until the colour changed from pink to purple.

$$Ca^{2+}\text{mg/L} = \frac{\text{mL of 0.01 EDTA x 1000 x 0.4008}}{\text{vol. of sample}}$$

Magnesium hardness was also determined adding 2 mL of ammonium chloride/ammonia solution; 0.1g Erichrome black T was added as the indicator. It was titrated immediately with EDTA until it turned from red to blue.

$$Mg^{2+} = \frac{\text{(Total hardness titre of 0.01M of EDTA) x 1000 x 0.243}}{\text{Volume of sample}}$$

RESULTS

Table 2: Analysis of Stream water samples for pH, Conductivity, Total Solids, Dissolved Solids, and Suspended Solids.

Sample Code	pH	Conductivity µS cm^{-1}	TS (mg/L)	TDS (mg/L)	TSS (mg/L)
T_1	7.68	210	0.4	0.36	0.04
T_2	8.21	570	0.2	0.14	0.06
T_3	7.82	260	1.2	0.16	0.04
T_4	7.55	40	0.8	0.76	0.04
T_5	7.83	300	0.2	0.14	0.06
T_6	7.68	130	0.1	0.08	0.02
T_7	7.86	310	0.2	0.16	0.04
T_8	7.81	120	0.2	0.16	0.04
T_9	7.96	270	0.4	0.40	0.00
T_{10}	7.89	280	0.4	0.16	0.04

TS: Total Solids
TDS: Total Dissolved Solids
TSS: Total Suspended Solids

Table 3: Analysis of Water Sample for Methyl Orange, Acidity, Free Carbondioxide,Phenolphalein, Acidity and Chloride Content.

Sampe Code	Methyl Orange (mg/l)	Free CO_2 (mg/l)	Phenolphthalein (mg/l)	Chloride (mg/l)
T_1	N.D	3.96	10.7	N.D
T_2	N.D	4.53	12.0	N.D
T_3	N.D	3.74	12.0	N.D
T_4	N.D	5.72	10.0	N.D
T_5	N.D	3.96	11.0	N.D
T_6	N.D	5.59	10.0	N.D
T_7	N.D	3.74	12.3	N.D
T_8	N.D	3.96	9.0	N.D
T_9	N.D	4.97	15.0	N.D
T_{10}	N.D	3.96	11.3	N.D

N.D: Not Detectable

Table. 4: Physical Properties of Water Sample

Sample Code	Appearance	Odour
T_1	Clear and Bright	N.D
T_2	Clear and Bright	N.D
T_3	Slightly Turbid	Faintly Perceived
T_4	Clear and Bright	N.D
T_5	Slightly Bright	Faintly Perceived
T_6	Clear and Bright	N.D
T_7	Clear and Bright	N.D
T_8	Clear and Bright	N.D
T_9	Clear and Bright	N.D
T_{10}	Clear and Bright	N.D

N.D: Not Detected

Table 5: Metal Analysis of Water Samples

Sample code	Na (mg/L)	K (mg/L)	Zn (mg/L)	Fe (mg/L)	Pb (mg/L)	Ca (mg/L)
T_1	12.1	13.2	1.51	N.D	N.D	24.0
T_2	60.1	52.0	0.91	N.D	N.D	76.0
T_3	13.2	6.8	0.90	N.D	N.D	6.40
T_4	2.7	4.0	0.92	N.D	N.D	1.60
T_5	11.2	7.5	0.92	N.D	N.D	60.0
T_6	8.4	7.8	1.01	N.D	N.D	13.6
T_7	10.4	6.0	0.82	N.D	N.D	8.8
T_8	6.0	8.1	0.80	N.D	N.D	40.0
T_9	11.8	9.6	0.75	N.D	N.D	24.0
T_{10}	10.6	6.4	0.85	N.D	N.D	24.0

N.D: Not Detected

TABLE 6: World Health Organization (W.H.O) Standards of Some of the Parameters(W.H.O, 2001)

Parameters	Concentration
Lead (Pb) (mg/L)	0.1
Calcium (Ca) (mg/L)	0.01
Zinc (Zn) (mg/L)	10
Iron (Fe) (mg/L)	7.5
Sodium (Na) (mg/L)	3.0
Colour / Turbidity	5 NTU
pH	6.5 – 8.5
Hardness as $CaCO_3$ (mg/L)	100
TDS (mg/L)	0.2

The physico-chemical analysis of eights streams in Ado-Ekiti showed that the highest pH of 8.21 was found in the Ireje stream around Federal Polytechnic road in Ado-Ekiti (T_2), while the lowest pH value 7.55 was found in Eku stream (T_4). The result revealed that Ireje stream (T_2) also had the highest conductivity value of 570 μScm^{-1}. The highest TS of 0.8 mg/L was found in the Eku stream (T_4)

DISCUSSION

The physico-chemical analyses of the eight streams are given in Tables 3 – 6, while the names of the streams with their acronyms are given in Table 1. Table 2 shows that pH values of the streams were within the W.H.O standards with the highest pH value being 8.21 from T_2 and the lowest pH value of 7.55 from T_4, this is because pH is determined by the amount of dissolved free carbon dioxide (CO_2) in water (Hem, 1985; Abdullah and Musta, 1999). The Total Dissolved Solid of the streams calculated was found to be below W.H.O standards. The range of Total Solid was between 0.1 mg/L (T_6) and 1.2 mg/L (T_3). The Total Suspended Solid had its range between 0.00 (T_2) and 0.06 mg/L (T_5). Table 3 shows that methyl orange acidity was not detected for any of the samples. So also, there was no chloride content detected in the samples. But when phenolphthalein was used as the indicator in determining the acidity, it was found to be in the range of 9.0 mg/L and 12.3 mg/l. The free carbondioxide was also found to be in the range of 3.74 mg/l and 5.72 mg/l.

Table 4 shows the calcium and magnesium hardness, and the total hardness of samples (T_1 - T_{10}). The tables show that 40% of the samples will not be good for domestic (disinfection or filtration) purposes because of the concentration of the total hardness of the samples. The concentration of calcium and magnesium hardness was lower than that stipulated by the W.H.O standard.

Table 5 shows the physical properties of the streams, for samples T_1, T_2, T_4, T_6, T_7, T_8, T_9 and T_{10} were clear, while T_3 and T_5 appeared to be slightly turbid. Most of the samples did not have offensive odour except for samples T_3 and T_5, which had a mild offensive odour.

The metal analysis of the samples as shown in Table 6 shows that the level of the metals ranges for the samples as follow: sodium (2.7 - 60.1 mg/L), Zinc (0.75 – 60.1 mg/L), potassium (4.0 – 52.0 mg/L), Calcium (1.60 – 76.0 mg/L). Iron and lead were not detected in the samples.

Conclusion

Due to the results obtained from the analyses of the streams in Ado-Ekiti, it is clear that the parameters measured in the water samples collected from the streams were within the confines specific limits of World Health Organization (W.H.O, 2001). Therefore most of the streams could serve for domestic purposes such as drinking, cooking, bathing, and washing. These results can be due to the fact that Ado-Ekiti and its environs have very few industries, but as the town begins to develop, the environmental condition might gradually change. It is therefore paramount that the streams under study be monitored periodically.

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