International Journal of Innovative Environmental Studies Research 3(1):32-47, Jan-Mar. 2015

 www.seahipaj.org ISSN: 2354-2918

WATER QUALITY ASSESSMENT OF ARINTA AND OLUMIRIN WATERFALLS IN EKITI AND OSUN STATES, SOUTHWESTERN NIGERIA

AYODELE, Samuel Olusiji
Department of Geology
Ekiti State University, P.M.B 5363, Ado-Ekiti.
E-mail: riksam2002@yahoo.com

ABSTRACT

The study of physical, chemical and biological properties of the waters in Arinta and Olumirin waterfalls, southwestern Nigeria was carried out in order to ascertain the water quality and its suitability for human consumption.The dominant lithologies in the study area are massive quartzites, schistose quartzites and quartz schists with well defined boundaries. A total of twenty (20) water samples were collected from the study area at regular intervals(Ten samples from each locations) were analyzed to determine their physico-chemical and biological characteristics. All these parameters were determined in the laboratory. The results of the physical parameters are as follows;pH ranges from 6.9-7.3 (neutral to slightly alkaline). Temperature ranges from 27.6^{0c} – 28.3^{0c} , electrical conductivity(0.01ms/cm), turbidity (2-9 NTU), total dissolved solids (6.7mg/l – 13.4mg/l) which is interpreted to be fresh water and generally soft, total hardness (5.3-17-4mg/l). The result of the physico-chemical test showed that the water from olumirin waterfall is turbid while that of Arinta water is not; all other physical parameters such as odour, taste etc conform with the W.H.O. standard (1997) for drinking water. However, cations and anions range are as follows; Ca^{2+} (1.6-4.8mg/l), Mg^{2+} (0.4-1.2mg/l), Na^{+} (9.2-90.4mg/l), Fe^{2+} (Not detected), Cl^{-} (13.9-57.5mg/l), No_3^{-} (0.39-0.72mg/l), $S0_4^{\ 2-}$ (5.8-8.9mg/l), The bacteriological analysis for total coliform /100ml ranges from 3cfu/100ml-89cfu/100ml. This shows a high load of bacteria (Ecoli and Coliform) in the water, it also revealed that Olumirin water is contaminated and the source of contamination could be linked to the faecal contamination resulting from poor sanitary system in the environment.

Keywords: Olumirin, Arinta, Waterfall, WHO, Contaminants, lithologies.

INTRODUCTION

Water plays a vital role in the lives of virtually every living thing. A large percentage of the mass of living organisms is made up of water. The quality of water is of vital importance, whether for industrial or domestic purposes. For water to be of consumable quality, it must attain a certain degree of purity. According to Davis and De wiest (1966), drinking water standard are based on two main criteria, namely, the presence of objectionable tastes, odour and colour; and the presence of substances with adverse physiological effects. However, mineral enrichment from underlying rocks can change the chemistry of water, making it unsuitable for consumption (Ako et al. 1990). Water can also be a source of serious environmental and health problems if the design and development of such water supply systems is not coupled with appropriate sanitation measures.

It seems no work has been done in the study area but similar work has been carried out in other areas such as preliminary results on the evaluation of the chemical quality of Effon Psammite Springs, Southwestern Nigeria by Odewande et al; (2008). The results of the hydro-chemical studies of the Spring water shows that the water is mildly acidic to alkaline with the following water facies: Na – $S0_4$ – Cl, Na – HCO_3, Ca – Na – SO_4 and Ca – Mg - HCO_3 . SO_4. However, the study also revealed that about eight out of fifteen spring samples were acidic to alkaline while the remaining springs were slightly alkaline to neutral. Hydrogeochemical investigation of surface water and ground water around Ibokun, Ilesha area Southwestern Nigeria was carried out by

Elueze et al; (2004). The results of the study revealed that the water is neutral to slightly alkaline with the following water facies Ca – (Mg) - Na HCO_3, Ca – Na – Cl (SO_4) - HCO_3 Ca – (Mg) HCO_3 and Na – (K) – Cl - SO_4. The result obtained reflected the contribution and influence of bedrock types and weathering products of the underlying rocks on the surface and underground water in the area. The computed values of water hardness and Sodium absorption ratio indicate that the water is generally soft with low sodium content. Though, most of the hydro-chemical parameters show relatively higher values in the groundwater than the surface water, both satisfying the W.H.O standard for domestic agricultural and other industrial uses. Hydrochemical characterization of water resources around the semi-urban area of Ijebu Igbo Southwestern Nigeria was carried out by Abimbola et al;(2008). The results obtained from the study showed that influence of filths, unguided wastes and sewage disposal compartments around Ijebu-Igbo waters may have acted as factors controlling the water quality in the study area. The total dissolved solids (TDS) revealed the water to be from a fresh water source. The discharge of domestic waste water and refuse to the surroundings might have contributed to the elevated increase in NO_3 concentration in the water; this is reflected in the bacteriological analysis employed which showed that the study areas are contaminated with faecal coliform and E-coli especially in the water close to the sewage disposal unit, the main market, pit latrines and refuse dump sites with the highest value of 7.0 x 10^4 cfu/100ml, indicating extreme pollution of the water which is beyond the World Health Organization (WHO); 2004 bacteriological standard for drinking water. The water is unacceptable and not recommended as potable water unless treatment designs are adopted.

This study focuses on the water quality assessment by determining the physical, chemical and bacteriological properties of Arinta and Olumirin waterfalls in Ekiti and Osun States, southwestern Nigeria and its conformity with the World Health Organisation (WHO) standard for drinking water.

Location of the Study Area

The study area falls within the Basement Complex of Southwestern Nigeria. Arinta waterfall is a wonderful work of nature located at Ipole Iloro, (Figs. 3 and 5) a farming community North of Ikogosi Warm Spring in Ekiti West local government area of Ekiti State. It lies within latitudes 7^0 32' N and 7^0 36' N of the equator and longitudes 4^0 55' E and 4^0 57' E of the Greenwich meridian. Olumirin waterfall is a natural cascade coming from Ijesa hills in Ori-Ade district. It is located 2km off Erin Ijesa town in Ori Ade Local Government Area of Osun State. It lies within latitudes 7^0 31' E and 4^0 52' E and 4^0 54' E of the Greenwich meridian. (Figs. 4 and 6).The study area also lies south of Kwara and Kogi States bounded by Osun State in the south and Ondo State in the East. The neighboring towns to the study areas include Apapolu, Ikogosi, Irogbo, Erin-Oke and Erin Ijesa (Fig 1).The topography of the study area is rugged with series of highlands, lowlands and massive rocks with steep sides. The major topographic landform within the study area is the quartzite ridge systems which are usually formed by quartzite exposures that have undergone varying degrees of weathering. Trellis drainage pattern is in existence in the study areas, while majority of the rivers flow north- southwards and are structurally controlled .The rivers are found to occupy the valleys between the ridges and the gneissic terrains. The rivers found in the study area are perennial.

Local Geology of Study Area

The study area lies within the crystalline Basement Complex of south western Nigeria, and it is part of Ilesha schist belt. The dominant lithologic units in the area are the massive and schistose quartzites and the quartz schists (referred to as the Effon Psammite Formation) which are excellent structural markers that form a ridge system with migmatites as the basement rock. (Figs. 2 & 3). This environment like other areas within the Nigerian schist belt was subjected to the Pan African Orogenic event about 600 ± 150 Ma (Ajibade et al, 1988). The land mass of the study area is dominated by quartzite exposures which is very extensive to the extent that it covers about ¾ of the study area. Hubbard et al, (1968) describes the formation as a belt of quartzites, quartz schist and granulites which occurs east of Ilesha, and runs approximately 180km in a general NNE–SSW direction. The colour of the quartzites found within the study area varies from one locality to the other for instance, the schistose types are pure and white in colour, and the ferruginous ones usually exhibit a grey colouration when the samples are fresh but display brownish colouration when weathered. There are the milky ones and the coarse grained types which have a sugary appearance. The different rocks in the study area have been subjected to deformation in which folds of different styles and magnitudes distinctively develop on the different metamorphic rock types such as tight to isoclinal folds, asymmetric folds, antiforms. Other structural features that are common include fractures, foliations, dykes, veins etc, and the general trend of the folds and foliation is NNE – SSW direction G.S.N. sheet 61,(Akure).

Geology of Waterfalls

A waterfall is usually a geological formation resulting from water, often in the form of a stream flowing over erosion resistant rock formation that forms a nickpoint, or sudden break in elevation, they are the result of a specific set of conditions that allow water to maintain its vertical cascade. Waterfall develops in several ways; waterfalls can occur along glacial troughs where by a stream or river flowing into a glacier has receded or melted. The large waterfalls in Yosemite Valley are examples of this phenomenon. Most waterfalls are the result of many years of the action of water on layers of rock composed of different degrees of hardness. Hard layers are more resistant to erosion while soft layers are less resistant to erosion. Typically, a stream will flow across an area of formation and the more resistant rock strata will form shelves across the stream way, elevated above the further streambed when the less erosion resistant rock around it disappears. Over a period of years, the edges of this shelf will gradually break away and the water fall will steadily move upstream. Often, the rock strata just below the more resistant shelf will be of a softer type and will erode out to form a shallow cave like formation or plunge pool known as a rock shelter found beneath many water falls. Eventually, the outcropping more resistant cap rock will collapse under pressure to add blocks of rocks to the base of the water fall. These blocks of rocks are then broken down into smaller boulders by attrition as they collide with each other, and they also erode the base of the water falls by abrasion creating a deep plunge pool or gorge formed as a result of the kinetic energy of the water hitting the bottom (Fig. 4). Olumirin waterfalls, Arinta waterfalls, Athabasca falls and sunwapta falls are typical examples. Other waterfalls originate where a fault uplifts a mountain range or part of a range, creating a fault scarp over which streams drop steeply. Continued under cutting and erosion of the edge and of the rock bed above the falls move many water falls upstream; these ultimately diminish in size, dwindle to rapids, then disappear.

Sampling, Field and Laboratory Analyses

Samples for this study were collected from twenty locations (Arinta and Olumirin) designated as Ar1 to Ar10 and Or1 to Or10 from each locations.(Tables.1 &2). The samples were collected and stored in pre-washed 250-ml polythene bottles. The temperature of the water samples were taken with a thermometer having a calibration from 10^0C to 110^0C. All the samples were stored in a refrigerator and the temperature was kept below 20^0C prior to analyses. Field measurements taken during the study include temperature, pH, conductivity and dissolved oxygen. This was achieved using standard field equipment. Laboratory analyses of the samples were carried out at the Federal Ministry of Agric and Water Resources Regional Water Laboratory Alagbaka , Akure, Ondo State. The analyses were carried out based on various standard methods for water analysis in their laboratory.

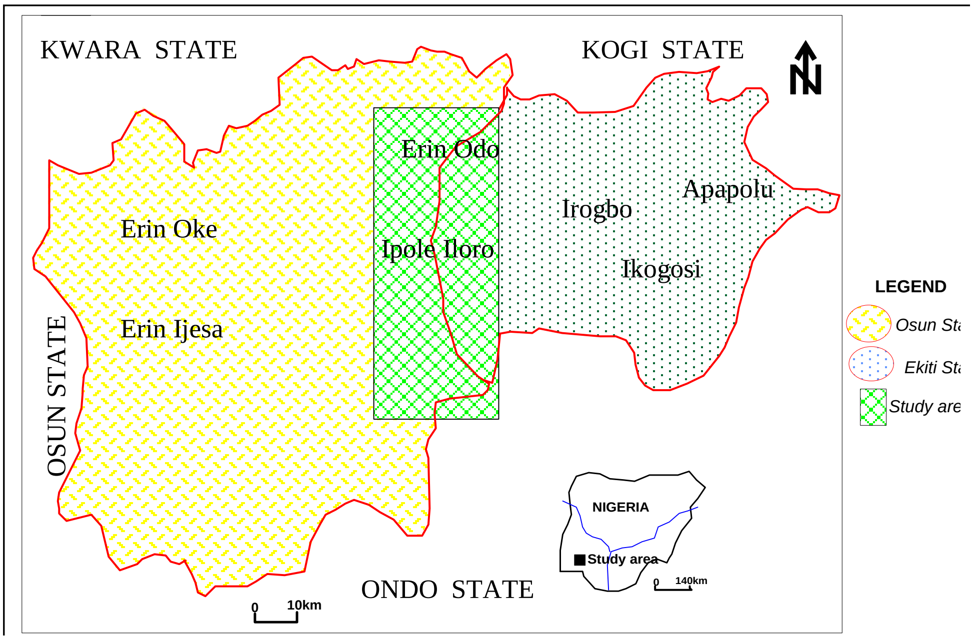

Fig.1: Map of Osun and Ekiti States showing the study area (Inset: Map of Nigeria showing the study area)

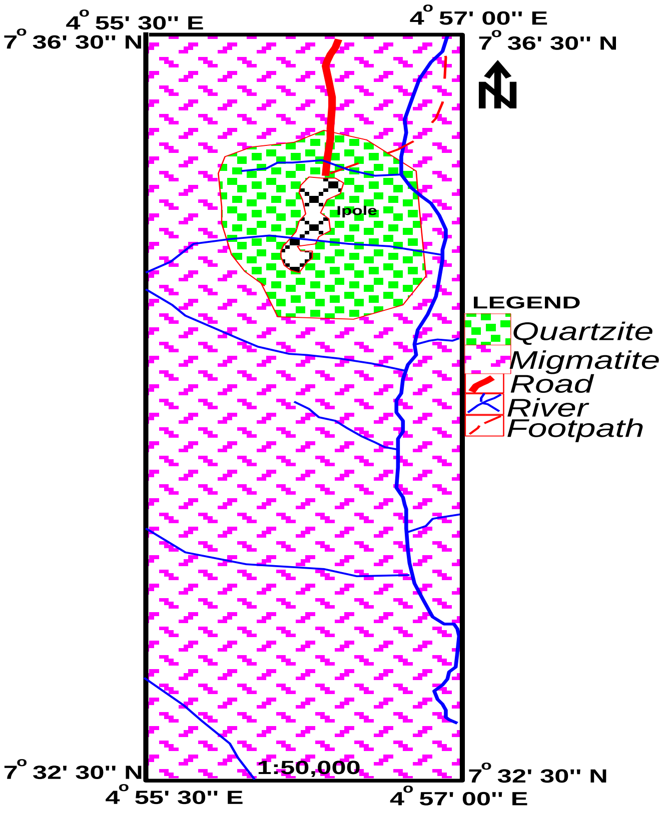

Fig.2: Geological Map of Ipole showing Arinta waterfall.

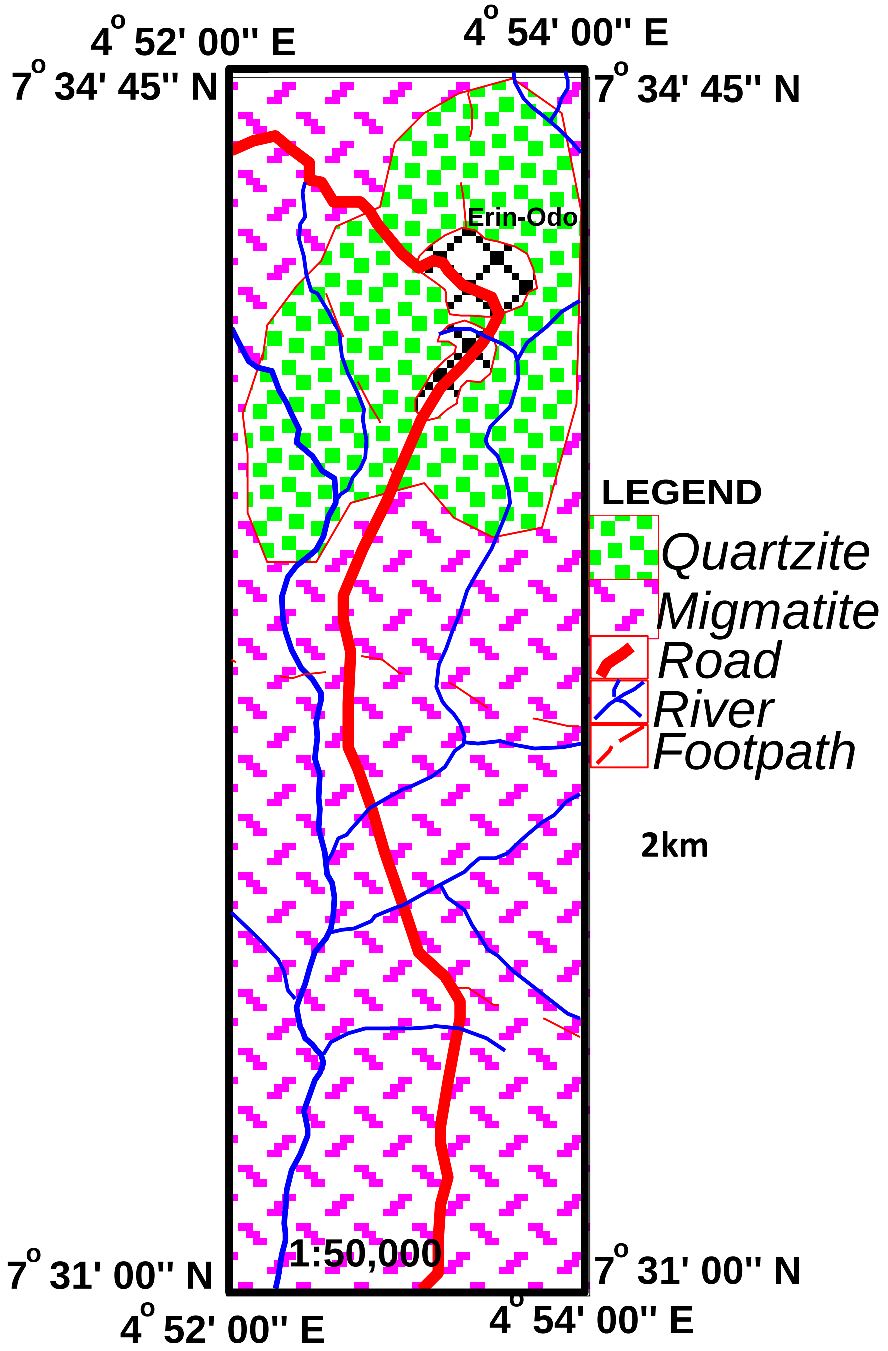

Fig.3: Geological Map of Erinodo showing Olumirin waterfall

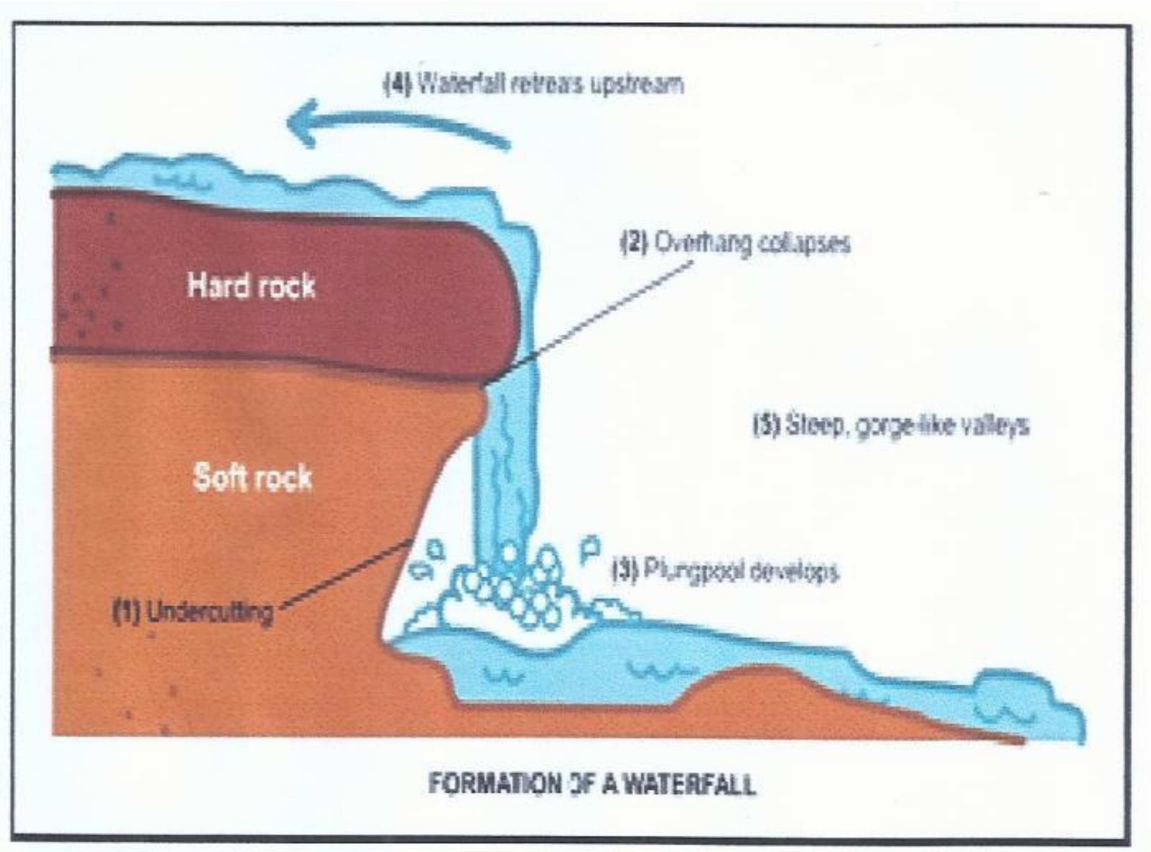

Fig.4: Schematic diagram showing different stages of formation of a waterfall (After Hem,1970)

Fig.5:Arinta Waterfall at Ipole, Ekiti State.

Fig.6: Olumirin waterfall at Erinodo, Osun State.

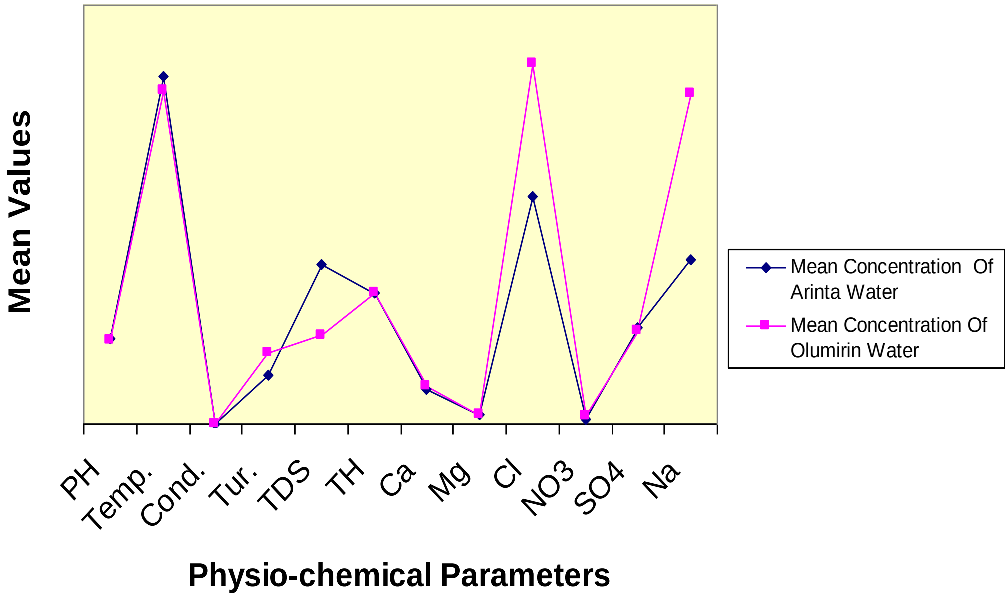

Fig.7: A graph of mean values against the physico-chemical parameters of the water samples.

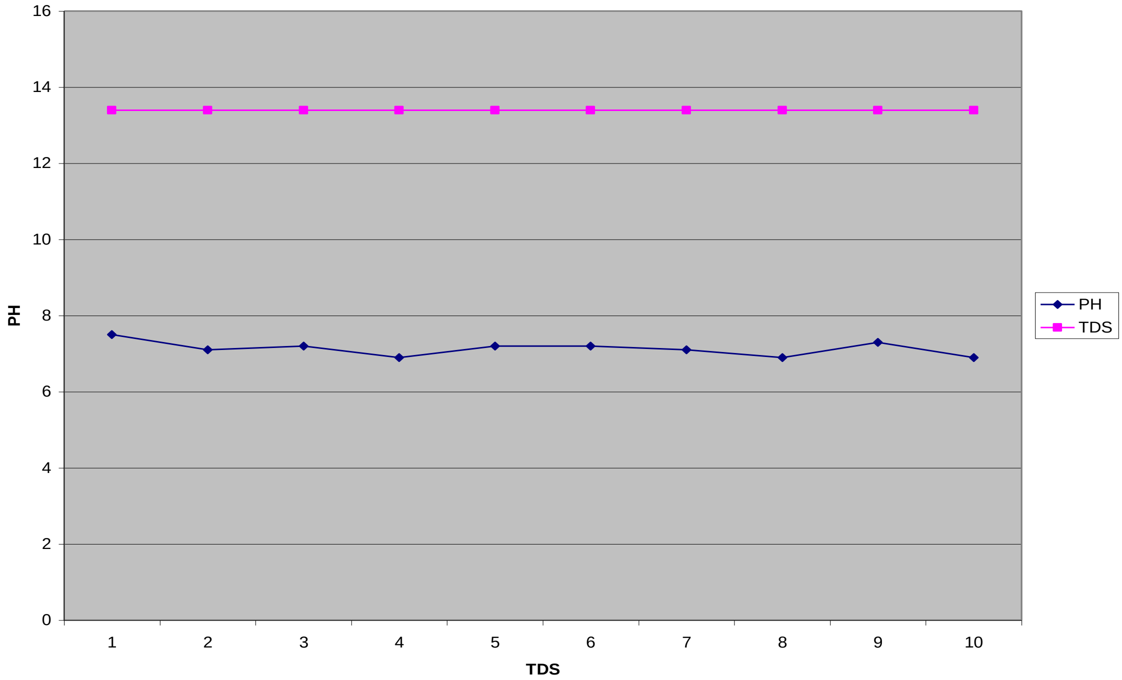

Fig.8a: Graph of pH against Total dissolved solids for Arinta Waterfall

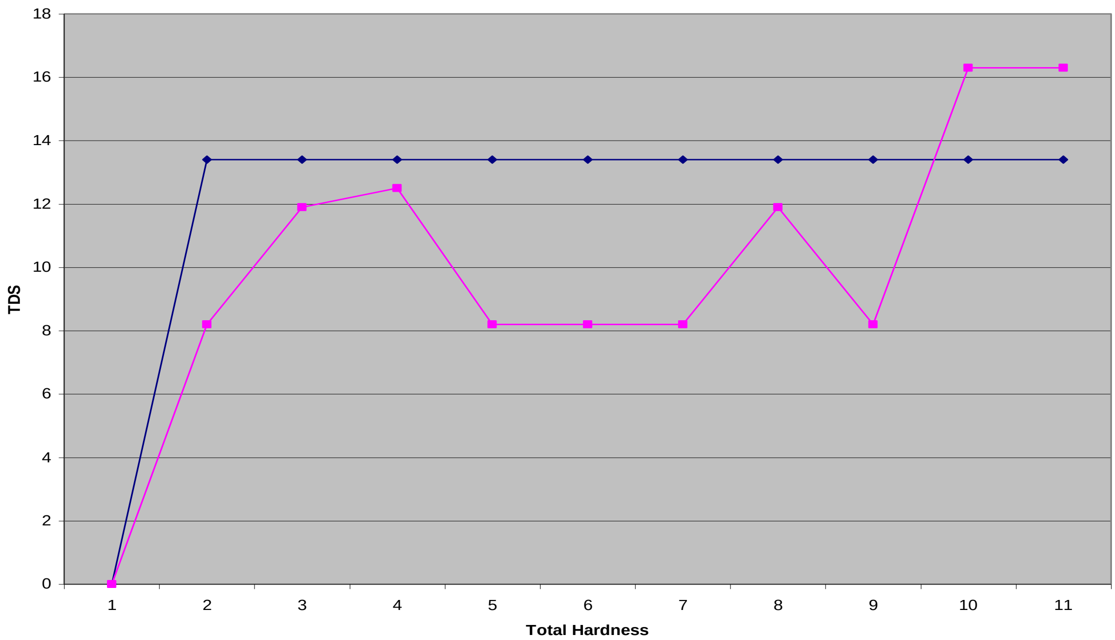

Fig.8b: The graph of Total dissolved solids against total hardness for Arinta waterfall

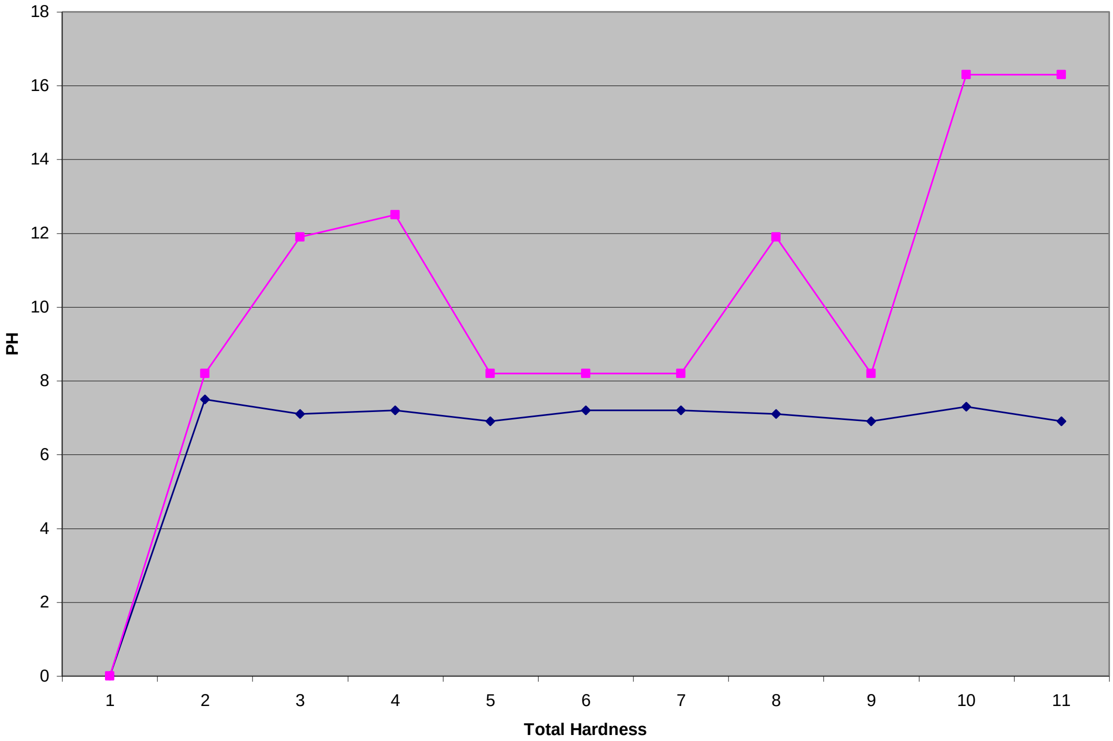

Fig.8c: Graph of pH against Total Hardness for Arinta Waterfall.

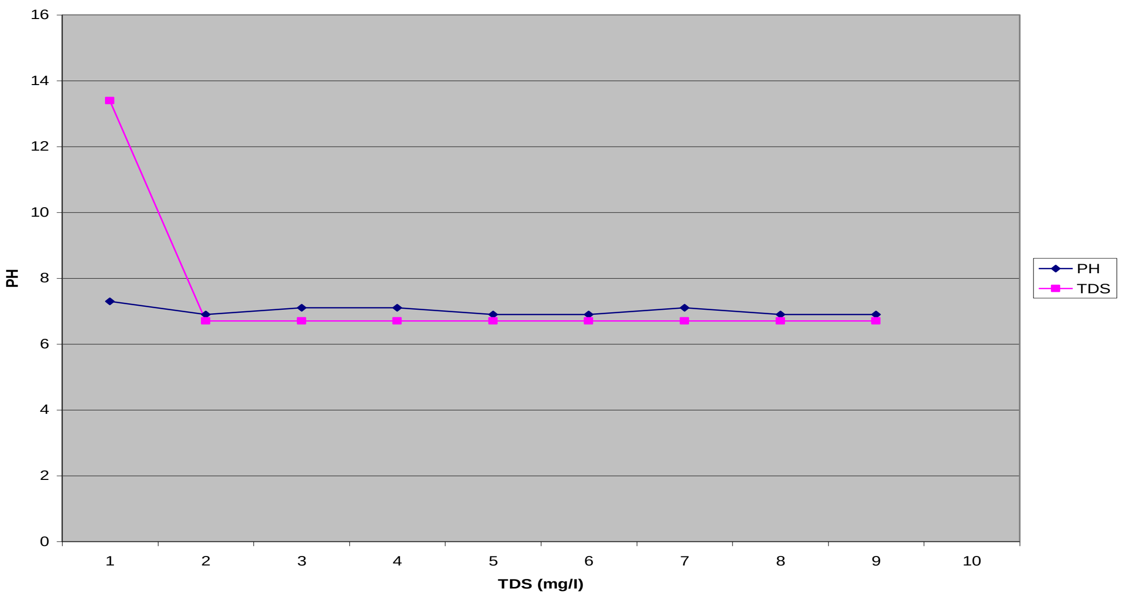

Fig.9a: Graph of pH against Total dissolved solids for Olumirin waterfall

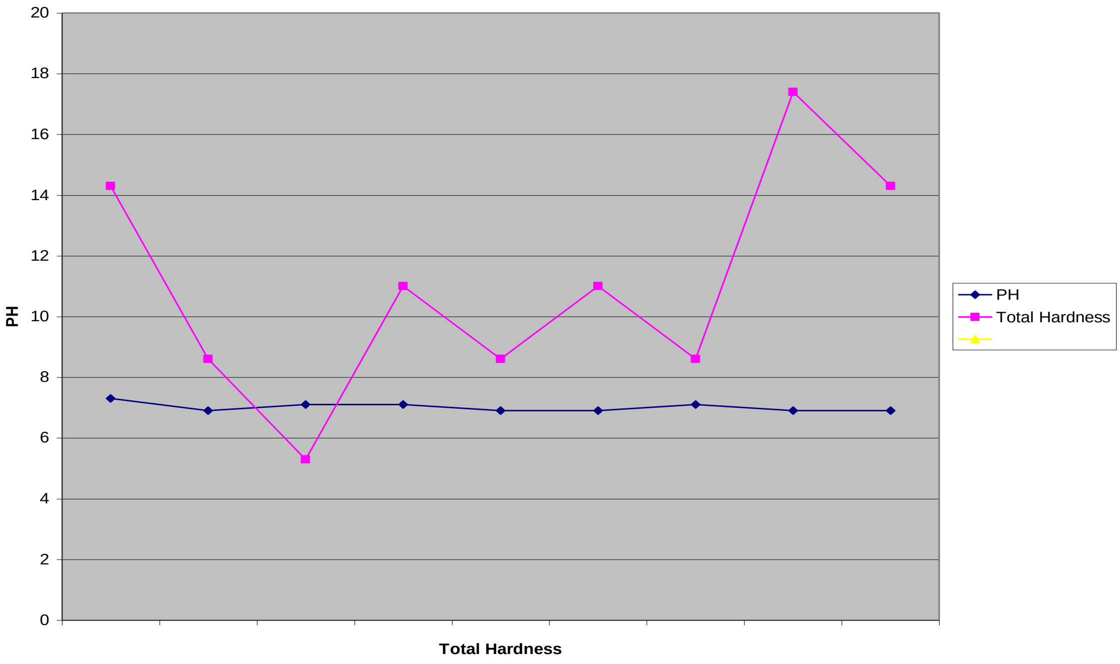

Fig.9b: Graph of pH against Total Hardness for Olumirin waterfall

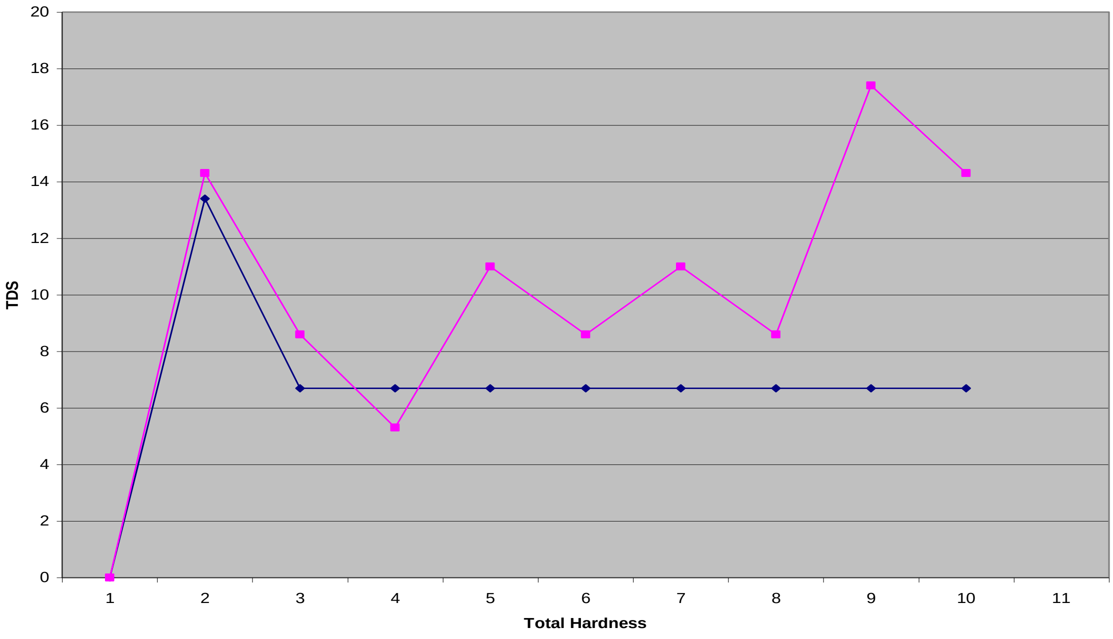

Fig.9c: The graph of Total dissolved solids against Total Hardness for Olumirin waterfall.

RESULTS AND DISCUSSION

The results obtained from different physio-chemical and bacteriological analysis carried out on the water samples collected from the study areas are presented in Tables 1,2,4and 5 . The results showed that water samples collected from Arinta water fall appears to be clear in colour while the water samples from Olumirin water fall appear to be slightly clear which indicated the presence of dissolved and colloidal matter (Tables 1 & 2). All the water samples analyzed had no taste and were odourless with respect to the sense of taste and smell. The temperature ranges from 28.3 - 29.6^{0}C in Arinta water and 27.6 - 28.2^{0}C in Olumirin water. However, the World Health Organization sets no guidelines value for temperature. The conductivity of the water samples tested ranges from 0.01µs/cm to 0.02µs/cm. All the water samples tested from both waterfalls have conductivity values which fell below the highest desirable level for drinking water. The average results of turbidity carried out on the water samples showed that samples Ar1, Ar_2, Ar_3, Ar_4, Ar_5, Ar_7, Ar_8 and Ar_9 (Table 1) sourced from Arinta waterfall are within the highest desirable limits of the World Health Organization (WHO, 1997) standard for drinking water while samples Ar6 and Ar_{10} are above the maximum permissible limits of the World Health Organization standard for drinking water (Tables 1,2 and 5). Results of water samples sourced from Olumirin waterfalls show that samples Or_2, Or_4, Or_7, Or_8 and Or_{10} (Table 2) are within the highest desirable limits of the World Health Organization standard for drinking water while samples Or_1, Or_3, Or_5 and Or_9 are above the W.H.O maximum permissible standard for drinking water (Tables 1, 2 and 5). The total dissolved solid content is also known as the total salt concentrated in water. Water is classified according to the total dissolved solid content by Hem 1970 as follows:

Fresh	< 1000mg/l
Moderately saline	3000 – 1000mg/l
Very saline	1000 – 35,000mg/l
Briny	> 35,000mg/l

From this classification the TDS concentrations for the tested water samples, which vary from 6.7mg/l to 13.4mg/l, fall under the fresh water classification. With respect to the World Health Organization standard for drinking water, all the tested samples fell below the highest desirable limit for drinking water which is 500mg/l (Table. 5). Hem (1970) classified water according to its hardness as follows:

Hardness (mg/l $CaCO_3$)	**Class**
Soft	0 – 60
Moderate	61 – 120
Hard	121 – 180
Very hard	> 180

Therefore, based on the above classification all the water samples tested can be classified as having soft hardness. The results of the total hardness of the water samples vary between 8.2mg/l to 17.4mg/l which falls below the highest desirable level for drinking water by the World Health Organization which is 100mg/l (Table 1, 2 and 5). The background values of the chemical elements in water should have some direct bearing to the geology of the environment from which it migrated. This is so where the water accumulates and remains fairly long enough to take up soluble materials in solution. At times, more materials are taken in solution at some localities than the others. Thus one may expect the concentration of a particular ion in water from similar and identical geological background to differ. The results obtained from the chemical analysis of the water samples from Arinta and Olumirin are presented in tables 4 and 5. The average result of calcium hardness in the water samples range from 1.6mg/l to 4.0mg/l which is within the highest desirable limit of the W.H.O standard for drinking water. There is no health objection to its high content in water; the main limitation is based on excessive scale formation. The magnesium concentrations of the water samples range from 0.4mg/l to 1.2mg/l which is below the highest desirable level recommended for drinking water by the World Health Organization (20mg/l). The value of chloride ion in the water samples range from 13.9mg/l -57.5mg/l which is below the highest desirable limit of the world health organization standard for drinking water (200mg/l. The nitrate content in the water samples range from 0.3mg/l to 0.72mg /l which is below the highest desirable level of the world health organization standard for drinking water (10mg/l). The average sulphate content of the water samples analyzed range from 5.8mg/l to 8.9mg/l which is also below the highest desirable limit of the world Health organization standards for drinking water (250mg/l). The average sodium concentrations in the water samples tested range from 9.2mg/l to 90.4mg/l which is below the maximum desirable level recommended for drinking water by the world Health organization (200mg/l). The summary of the various physical and chemical parameters, their mean values as compared to the values of the world Health Organisation (1971) standards for drinking water are presented in Table 5, while comparison of parameters of the water samples in the study areas is also shown (Fig.7). The result showed that the mean values of chloride, nitrate, sodium and turbidity of Olumirin water are higher than that of Arinta water. The overall mean of the turbidity values of Arinta water is 44 N.T.U while that of Olumirin water is 5.9 N.T.U. (Table. 5), the World Health Organization recommends 5.0 N.T.U for both highest desirable limit and maximum permissible level and based on this comparison, it can be conveniently said that the water samples from Olumirin have very high turbidity (Figs 9a, 9b and 9c) while the turbidity level of those from Arinta are minimal (Figs 8a, 8b and 8c).

The total bacteria count (TBC) of the water samples in the areas (Arinta and Olumirin) range from 3cfu/100ml to 93cfu/100ml respectively. This revealed a high load of bacteria in the water. The results of the biological analysis of the water samples are presented in Tables 6 & 7. The results showed that the total bacteria count of Arinta water range from 9 cfu/100ml- 98cfu/100ml and that of Olumirin water ranges from 3cfu/100ml-85 cfu/100ml with an over all mean of 41cfu/100ml and 27.4 cfu/100ml respectively (Tables 6 & 7). Arinta water has a higher percentage of contaminated water with faecal coliform and E-coil while that of Olumirin water have a lesser percentage of contamination. With respect to the World Health Organisation standard, all the water samples have a total bacteria count concentration above the desirable limit of the WHO standard with the exception of sample number Or2 sourced from Olumirin water fall which has 3 coliform per 100ml (3 cfu/100ml). However, the quality of any water is strictly based on some physical, chemical and biological parameters, some of these parameters are inherent in surface water and their sources are mainly from precipitation, leaching of soil particles during infiltration, decay of organic matter, salt water incursion, exchange of ions with surrounding rocks and human activities etc. Continuous occurrences of this processes leads to the increase in concentration and values of this parameter which in turn influences the quality of water.

The physical parameters such as colour, temperature, conductivity, PH, TDS and total hardness of the water in the study areas are satisfactory for drinking water. Except for Olumirin water which is turbid with an average value of 5.9 N.T.U which is higher than the W.H.O recommended value of 5.0 N.T.U. Water becomes turbid when substances like silt, clay, colloidal and organic matters are present. These usually occur in surface waters during rainy season.

Table 1: Result of Physical Characteristics of Water in Arinta Waterfall At Ipole Ekiti, Ekiti State

Sample No	PH	Temp °C	Cond ms/cm	Tur NTU	Appearance Colour mg/l	TDS Mg/l	Total
Ar1	7.5	28.3	0.02	2	Clear	13.4	8.2
Ar2	7.1	29.1	0.02	5	Clear	13.4	11.9
Ar3	7.2	29.3	0.02	5	Clear	13.4	12.5
Ar4	6.9	29.0	0.02	5	Clear	13.4	8.2
Ar5	7.2	28.7	0.02	3	Clear	13.4	8.2
Ar6	7.2	28.6	0.02	7	Clear	13.4	8.2
Ar7	7.1	29.6	0.02	3	Clear	13.4	11.9
Ar8	6.9	29.4	0.02	3	Clear	13.4	8.2
Ar9	7.3	29.0	0.02	5	Clear	13.4	16.3
Ar10	6.9	29.1	0.02	6	Clear	13.4	16.3

Ar = Arinta water

Table 2: Result of Physical Characteristics of Water in Olumirin Waterfall in Erin Odo, Osun State

Sample No	PH	Temp ^0C	Cond ms/cm	Tur NTU	Appearance Colour mg/l	TDS Mg/l	Total Hardness mg/l
Or1	7.3	27.6	0.02	3	SC	13.4	14.3
Or2	6.9	28.2	0.01	9	SC	6.7	8.6
Or3	7.1	27.8	0.01	5	SC	6.7	5.3
Or4	7.1	27.8	0.01	6	SC	6.7	11.0
Or5	6.9	27.7	0.01	5	SC	6.7	8.6
Or6	6.9	28.0	0.01	4	SC	6.7	11.0
Or7	7.1	27.7	0.01	8	SC	6.7	11.0
Or8	6.9	28.1	0.01	7	SC	6.7	8.6
Or9	6.9	27.8	0.01	5	SC	6.7	17.4
Or10	6.9	28.0	0.01	7	SC	6.7	14.3

SC = Slightly Clear Or = Olumirin Water

Table3: Result of Chemical Characteristics of Arinta Water Fall in Ipole Ekiti, Ekiti State

Sample No	Ca^{2+} mg/l	Mg^{2+} mg/l	Cl^- mg/l	N03 mg/l	Fe mg/l	S04 mg/l	Na mg/l
Ar1	2.4	0.5	16.7	0.46	ND	7.4	10.9
Ar2	3.2	1.0	15.8	0.43	ND	8.2	10.3
Ar3	2.9	1.2	18.7	0.49	ND	8.2	12.2
Ar4	2.4	0.5	15.0	0.48	ND	7.6	9.8
Ar5	2.4	0.5	19.2	0.44	ND	8.1	12.5
Ar6	2.4	0.5	24.9	0.53	ND	8.1	16.2
Ar7	3.2	1.0	20.8	0.47	ND	8.1	13.5
Ar8	2.4	0.5	20.8	0.50	ND	8.1	13.5
Ar9	4.0	1.0	26.7	0.39	ND	8.1	17.4
Ar10	4.0	1.0	32.5	0.40	ND	8.1	21.1

ND = not detected ; Ar = Arinta Water

The chemical parameters of water have been presented. (Tables 3, 4 and 5).The concentration of calcium in the study areas are below the highest desirable level for drinking water recommended by the World Health Organisation. The magnesium concentrations in all the tested water samples are satisfactory for drinking. The chloride concentration in the tested water samples are below the highest desirable level of the W.H.O standards for drinking water, also nitrate concentration of the tested water samples are also below the W.H.O standards for drinking water and are satisfactory for consumption. High concentrations of nitrate result in the death of young infants as a result of metahaemoglobinaemia or blue baby disease. Since the gastric juice of young infants lack acidity, nitrate-reducing bacteria can grow in their upper intestinal tracts. When they ingest nitrates, the nitrate can be reduced to nitrite before the nitrate is completely absorbed in the bloodstream, this results in the absorption of nitrate in the bloodstream, which combines with the haemoglobin to form metahaemoglobinaemia, which is an effective oxygen carrier. This produces anoxenia which can lead to the death of infants by asphyxia. Older infants and adults can tolerate higher level because their stomach PH is too low for nitrate reducing bacteria. Sulphates, although frequently detected are usually at concentrations below 10mg/l which is acceptable within W.H.O recommended standards for drinking water. The sodium concentration in the water samples tested varies uniformly and its concentration is below the highest desirable limit recommended for drinking water by the World health Organisation. The water in the study area can be said to contain calcium, magnesium, chloride, nitrate, sulphate and sodium in concentrations that are satisfactory when compared to the W.H.O standards for drinking water, but the biological quality of the water in the study areas are so poor that total bacteria count (TBC) in the water samples are higher than the W.H.O. recommended standards for drinking water. Ecoil and coliform organisms were detected in the water. The Ecoli and coliform organism (bacteria) might have originated as a result of faecal contamination in the water by human beings and animals or they could have been deposited in sediments and migrated into the water with meteoric water. The presence of these bacteria in water results in diseases like diarrhea, cholera, typhoid, infections hepatitis, Giardiasis, Amoebiasis and dracunculiasis. If there is continuous consumption of the water from the study areas (Adapted from Bradley, D.J. London school of hygiene and tropical medicine).

Table.4: Chemical Characteristics Of Olumirin Waterfall In Erin Odo, Osun State.

Sample No	Ca^{2+} mg/l	Mg^{2+} mg/l	Cl^- mg/l	N03 mg/l	Fe mg/l	S04 mg/l	Na mg/l
Or1	4.0	1.0	13.9	0.64	ND	8.4	90.4
Or2	2.4	0.6	34.2	0.66	ND	8.0	22.2
Or3	1.6	0.4	33.3	0.63	ND	7.0	21.6
Or4	3.2	0.8	29.9	0.65	ND	8.9	19.4
Or5	2.4	0.6	23.3	0.69	ND	7.4	15.2
Or6	3.2	0.8	31.7	0.61	ND	8.9	20.6
Or7	3.2	0.8	29.2	0.72	ND	8.4	19.0
Or8	2.4	0.6	14.2	0.66	ND	7.8	9.2
Or9	4.8	1.2	33.3	0.64	ND	7.4	21.6
Or10	4.0	1.0	57.5	0.70	ND	5.8	37.4

ND = not detected ; Or = Olumirin water

Table.5: Physical and chemical characteristics and WHO (1997) standards for drinking water

S/No	Measured Parameter	Range		Overall Mean		WHO Standard	
		Ar	Or	Ar	Or	Highest Desirable	Maximum Permissible
1.	PH	6.9-7.5	6.9-7.3	7.13	7.0	7.0-8.9	6.5-9.5
2.	Temp ^{0}C	28.3-29.6	27.6-28.2	29.01	27.87	-	-
3.	Cond ms/cm	0.02	0.01-0.02	0.02	0.01	900(us/cm^{-1})	1200(us/cm^{-1})
4.	Tur NTU	2-7	3-9	4.4	5.9	5.0 NTU	5.0 NTU
5.	Appearance colour mg/l	Clear	SC	Clear	SC	3.0 TCU	15.0 TCU
6.	TDS mg/l	13.4	6.7-13.4	13.4	7.37	500mg/l	1500mg/l
7.	Total Hardness mg/l	8.2-16.3	5.3-17.4	10.99	11.01	100mg/l	500mg/l
8.	Ca^{2+}mg/l	2.4-4.0	1.6-4.8	2.93	3.12	NS	NS
9.	Mg^{2+}mg/l	0.5-1.2	0.4-1.2	077	0.78	20mg/l	20mg/l
10.	CL^-mg/l	15.0-32.5	13.9-57.5	21.11	30.05	200mg/l	250mg/l
11.	No3mg/l	0.39-0.53	0.61-0.72	0.46	0.66	10mg/l	50mg/l
12.	Fe mg/l	ND	ND	ND	ND	1mg/l	3mg/l
13.	So4 mg/l	7.4-8.2	5.8-8.9	8.0	7.8	250mg/l	500mg/l
14.	Na mg/l	9.8-21.1	9.2-90.4	13.74	27.66	200mg/l	200mg/l

SC = slightly clear; NS = not seen
ND = not detected ; Ar = Arinta water
Or = Olumirin water

Table.6: Biological Characteristics of Arinta Waterfall in Ipole Ekiti, Ekiti State

Sample No	TBC cfu/ml
Ar1	13
Ar2	24
Ar3	93
Ar4	33
Ar5	9
Ar6	44
Ar7	11
Ar8	98
Ar9	75
Ar10	10

Ar = Arinta water
Range: 9 cfu/100ml – 98 cfu/100ml
Overall Mean = 41 cfu/100ml

Table.7: Biological Characteristics of Olumirin waterfall in Erin Odo, Osun State
Location: Erin Odo, Osun State

Sample No	TBC cfu/ml
Or1	11
Or2	3
Or3	19
Or4	5
Or5	85
Or6	28
Or7	30
Or8	3
Or9	63
Or10	27

Or = Olumirin water
Range: 3cfu/100ml – 85 cfu/100ml
Overall Mean = 27.4 cfu/100ml

CONCLUSION

The implications of water standards on health are enormous. Every parameter of water has a safety implication. Therefore, consumption of water of poor quality can lead to serious health problems. Some health effects may be immediate; others may be more devastating due to cumulating toxic chemicals. Ignorance or poverty cannot prevent morbidity or mortality associated with unsafe water only enlightenment does. Monitoring, surveillance and control of water standards remain cardinal for ensuring optimal public health.

A comparison of the results of the physiochemical analysis and bacteriological analysis of the water samples collected from the study area showed that the water in the study areas have no permanent chemically induced colour, they are tasteless and odourless and are neutral to slightly alkaline. The low total dissolved solids (TDS) revealed the water to be from a fresh water source and that the water is generally soft with low sodium and magnesium content. All the dissolved anion generally conforms to the recommended highest desirable limit of the World Health organization. Iron was not detected in the water samples analyzed. However, the chloride and nitrate content in the samples gives an indication of faecal pollution in the water; this is reflected in the bacteriological analytical method employed which showed that the water in the study area is contaminated with faecal coliform and E-coli. It is suggested that the high load of bacteria in the water might have originated from plant debris, animal and human excreta, legumes and the atmosphere. The high bacteria load indicates very heavy pollution. This is unacceptable and not recommended as potable water unless special treatments and designs are adopted. It can be concluded that the water chemistry has been found to be dependent on the chemistry of the basement rock, leaching during infiltration of water, exchange of ion with the reservoir rock, human activities and effluent discharge on rivers. Also, it was observed that not only the geology, topography, weather climate and rocks influence water chemistry but man himself has a very strong influence. Water plays a vital role in the lives of virtually every living thing. A large percentage of the mass of living organisms is made up of water. For water to be of potable quality it must attain a certain degree of purity. Purification of water supplies is the removal or reduction in the amount of objectionable substances in water. It is practiced in order to make water safe and unobjectionable for drinking and to reduce dissolved minerals injurious to boilers and manufactured products. Since a lot of people depend on water for their day to day activities it is however recommended that further studies should include microbial investigation, isotopic compositions and heavy metals determination to further ascertain the water quality and recommend necessary treatment measures.

REFERENCES

Ajibade, A.C.,and Fitches,W.R., (1988): The Nigerian Precambrian and the Pan African Orogeny. In: Precambrian Geology of Nigeria. Geological Survey of Nigeria. pp 45-53.

Abimbola A.F., Ajibade O.M., Odewale A.A., Okunola W.O., Laniyan T.A., and Kolawole T. (2008):Hydrochemical characterization of water resources around semi urban area of Ijebu igbo southwestern Nigeria. Journal of water resources 20: 10-15.

Ajibade A.C, Woakes M. and Rahaman M.A (1988): Proterozoic Crustal Development in Pan – African regime of Nigeria, 1986 Geophysical union 59-269pp

Ako B.D, Adeniyi F.I and Adepoju J.F (1990):Statistical tests and chemical quality of shallow ground water from a metamorphic terrain, Ile-Ife/Modakeke, Southwestern Nigeria Journal of African Earth Sciences, 10:(3) 602 – 613.

Davis S.N and De-wiest R.M.J (1996):Hydrogeology by John Wiley and Sons, New York pp 459 – 463.

Elueze A.A., Omidiran J.O., and Nton M.E (2004):Geochemical studies of surface and ground water in Ibokun area,southwestern Nigeria M.Sc Dissertation. Department of geology, University of Ibadan 57 – 65pp.

Hem, J.D., (1970): Study and interpretation of the chemical characteristics of Natural water 3rd Edition United States Geological Survey Water Supply Paper 1473: 20 – 31.

Odewande A.E, Oludunjoye M.A, Olatunji A.S & Ajibade O.M (2008): Preliminary results on the evaluation of chemical quality of Effon Psammite Springs Southwestern Nigeria. Journal of Nigerian Association of Hydrogeologists 18: 3 – 9.

World Health Organization (WHO) (1997): Guidelines for drinking water Vol. 1 Recommendations Geneva Switzerland.