The Bacteriological and Physico-chemical Studies on Olumirin Waterfall, Erin- Ijesha, Osun State. Nigeria.

*Odeyemi, A.T., Fagbohun, E.D. and Akindolapo, O.R.

Department of Microbiology, University of Ado Ekiti, Ekiti State, Nigeria.
E-mail: adebowaletoba@yahoo.com

Abstract: The portability and qualities of Olumirin waterfall, Erin-Ijesha were investigated by determining the total bacteria and coliform count with antibiotic susceptibility of the isolated bacteria and physico-chemical qualities of the water samples. Total bacteria and coliform enumeration were determined using pour plating and multiple tube techniques, the antibiotic susceptibility were carried out using paper disc method, while physico-chemical and mineral studies were also carried out using standard methods. The mean total viable count of the water samples ranged 14.8 x 10^2CFU/ml - 21.3 x 10^3CFU/ml while the coliform count ranged 13 -175MPN/100ml. The identified bacteria isolates and their percentage distribution were *E.coli* (43.1%), *Klebsiella* spp (20.7%), *Proteus* spp (12.1%), *Salmonella* spp (6.99%), *Pseudomonas* spp (5.17%), *Shigella* spp (6.9%), *and Enterococcus* spp (5.17 %). Antibiotic resistance shown by bacteria isolates were exhibited as follow; Nalidixic acid (31%), Ampicillin (76%), Cotrimoxazole (60%), Gentamicin (19%), Nitrofurantoin (24%), Colitin (48%), Streptomycin (34%) and tetracycline (52%). 82.8% of the isolate exhibited multiple antibiotic resistance. The physico-chemical analysis also revealed the presence of some mineral elements in the water samples. The mineral value of the water samples include; magnesium (84.8 - 93.4) mg/L, phosphate (12.6 - 17.1) mg/L, sodium (47.8 - 87.6) mg/L, potassium (76.6 - 104.5) mg/L, chloride (59.0 - 90.2) mg/L, zinc (0.75 - 1.82) mg/L, lead (0.12 - 0.33) mg/L, iron (0.52 - 0.60) mg/L, copper (0.12 - 0.27) mg/L while nickel and arsenic were not detected in any of the water samples. Comparing the experimental results with the international water standard for natural water, the waterfall is not fit for consumption or for any domestic purpose unless being treated. Also, problems that may arise from the resistance bacteria strains can be tackled while the new antibiotics can also be developed.

[Odeyemi, A.T., Fagbohun, E.D. and Akindolapo, O.R. **Bacteriological and Physico-chemical Studies on Olumirin Waterfall, Erin- Ijesha, Osun State, Nigeria.** *Rep Opinion* 2015;7(3):51-58]. (ISSN: 1553-9873). http://www.sciencepub.net/report. 7

Key Words: Physico-chemical, Olumirin, Bacteriological, Susceptibility, Erin- Ijesha

Introduction

Waterfalls in the mountainous regions generally develop where a layer glacier has deepened a major trunk valley, leaving less-eroded branch valleys hanging; the tributary streams in this valley discharge into the main river by falls or cascades. Hanging valleys also develop where a main river deepens its channel more rapidly than its tributaries do. Such falls among the highest in the world (Encyclopedia, 2009). Examples of waterfalls that originated from hanging valleys include; Bridalvell, Ribbon and Upper and Lower Yosemite falls in Yosemite National park, Sutherland Falls (580m/1904 ft) in New Zealand and Staubbach falls in Switzerland. The town Erin Ijesha, Osun state is about 97 km from Ibadan, Oyo state, Nigeria. The water fall is 2 km from Erin-Ijesha in Osun state. When it was first discovered, the water was said to have given the appearance of a mysterious figure so that no one dared to move near it for fear of being swallowed up. Olumirin waterfall Erin-Ijesha as the name implies has five layers and few visitors who always climb beyond the second layer. The area can also serve for mountaineering exercise for visitors to enjoy the breeze at the waterfall.

The contamination of natural water with faecal material, domestic, industrial sewage, agricultural and pasture runoff may result in an increased risk of disease transmission to humans who use such water (Nogueira *et al.*, 2003). The pathogenic organisms and indicator organisms present in water samples render them unfit for human consumption, though they can be used for other purposes (Banwo, 2006). The progressive increase in antimicrobial resistance among enteric pathogens particularly *Shigella* spp*, Vibro cholerae,* Enterotoxigenic *E.coli*, is becoming critical concern of people in developing world and this is mostly related to the frequent unrestricted use of over - the - counter drugs without medical supervision (Iruka *et al.*, 2007).

The search for potable water that is fit for human consumption is important since water is one of the most indispensable needs for the survival of all living things (Fawole and Oso, 2001). Realizing that Olumirin water fall in Erin-Ijesha is widely employed in domestic household use, recreational purposes and industrial use, this findings is designed to know the portability and qualities of the water sample by determining the bacteriological quality, antibiotic susceptibility of the isolated bacteria, and physico-chemical qualities of the water samples from Olumirin water fall, Erin-Ijesha.

Materials and methods

Collection of Samples

Using aseptic techniques, 250 ml sterile sampling bottle were used to collect water samples directly from the point where the water fall and from other four different points along the flowing path (Figure 2) of the waterfall. Samples were transported to the laboratory on ice and analyzed within 4 h after collection. Water samples collected for mineral analysis were chemically preserved by the addition of 5ml concentrated HNO_3 per litre of the sample.

Microbiological Analysis and Antibiotic Susceptibility Test

The water samples were analyzed bacteriologically using methods as described by Olutiola *et al.,* (1991). Slant agar were prepared in Bijou bottles using standard plate count agar. Distinct colonies were picked on the incubated plates and subcultured on freshly prepared nutrient agar to obtain pure strains.

The antibiotics susceptibility of the isolates was determined by the disk diffusion method on Mueller-Hilton agar according to CLSI (2005). The bacterial isolates were tested against seven ABTEK disc antibiotics which comprised Fusidic acid, Tetracycline, Erythromycin, Ampicillin, Cotrimoxazone, Streptomycin, Nalidixic, Colistin, Nitrfurantoin, Gentamycin and Sulfamethoxazole. The inoculum was standardized by adjusting its density to equal the turbidity of a Barium sulphate ($BaSO_4$) (0.5 McFarland turbidity standard), and incubated at 35^{o}C for 18 hours. The diameter of the zone of inhibition (including the diameter of the disk) was measured to the nearest whole millimeter and interpreted using CLSI guideline (CLSI, 2005).

Physicochemical Analyses

The temperature of the water samples were taken at the sites of collection using a simple thermometer calibrated in °C; electrical conductivity was measured with a CDM 83 conductivity meter (Radio Meter A/S Copenhagen, Denmark). Turbidity and pH were determined at site using Water Proof Scan 3+ Double Junction (Wagtech International, UK) and HI 98311-HI 98312 (Hanna) Water Proof EC/TDS and Temperature Meters (Wagtech International, UK). The water samples were then stored in the deep freezer until analyzed. Other physicochemical characteristics determined were hardness determined by titrimetry; total dissolved solid and total suspended solid were determined by gravimetric method; acidity, alkalinity and sulphate were determined by titrimetry; both nitrate and phosphate were determined colorimetrically by Spectronic-20 (Gallenkamp, UK) as described by AOAC (2005). Metal analyses were carried out using flame atomic absorption spectrophotometer (GBC Avanta version 1.31). The instrument was set to zero by running the respective reagent blanks. Average values of three replicates were taken for each determination. The detection limits for Fe, Zn, Cu, Ni, Cr, Pb and Cd were 0.05, 0.008, 0.025, 0.04, 0.05, 0.06 and 0.009 (mg l) respectively. Manganese was determined using atomic absorption spectrophotometer (Perkin-Elmer Model 403).

Results and Discussion

The mean total bacterial count of the water samples were estimated as follows; A (21.3 x 10^2-8.25 x 10^3) CFU/ml, B (43.3 x 10^2 - 19 x 10^3) CFU/ml, C (40.2 x 10^2 - 16.5 x 10^3) CFU/ml, D (46.8 x 10^2 - 21.3 x 10^3) CFU/ml, E (14.8 x 10^2 - 6.0 x 10^3) CFU/ml (Table 1). The coliform count i.e. the Most Probable Number (MPN) of coliform count in 100ml of water samples were also estimated as; A (17-25)MPN/100ml, B (25-55) MPN/100ml, C (35-45) MPN/100ml, D (115-175)MPN/100ml, E (13-25) MPN/100ml (Table 2). The results revealed that Olumirin waterfall is contaminated and threatened by the environmental pollution traced to human activities using the waterfall as a tourist centre, and the accidental defeacation into the flowing water by the animals. The mean total bacteria and coliform counts were generally high exceeding the limit of 1.0 x 10^2CFU\ml and 2MPN\100ml respectively for a period of 30days (WHO, 2000; FAO, 2007). Due to inadequate supply of municipal tap water to Erin-Ijesha community, Olumirin waterfall is the major source of drinking water and for other domestic purposes collected at a point D where arthropogenic activities is common. At this point the flowing of the water is slower and accommodates contaminated flowing water from point B and C. This correlate with the report of Lechevalier *et al*., (1996) and Stocker and Lamka (2002). The presence of enteric pathogenic bacteria like *Salmonella typhi* and other coliforms correlate with the findings of Adeyeye *et al.,* (2010) on some microbiological characteristics of water samples from Arinta waterfalls in Ipole-Iloro Ekiti, Nigeria. The decrease in microbial loads for treated water sample (Sample E) is attributed to various purification and disinfection process which the water has passed through but this is not effective enough to bring the microbial load to the acceptable WHO Standard for drinking water which stipulated that the total coliform count in drinking water should be zero (WHO 1999). The distribution of the isolated bacteria include *E.coli* (43.1%), *Klebsiella* spp (20.7%), *Proteus* spp (12.1%), *Salmonella* spp (6.9%), *Shigella* spp (6.9%), *Enterococcus* spp (5.17%) *and Pseudomonas* spp (5.17%) (Table 3).

The isolates demonstrated high level resistance to ampicillin, cotrimoxazole, tetracycline, and colistin while gentamicin was the most effective of all the antibiotics used (Table 4). The pattern of antibiotics resistance of bacteria isolates were ampicillin (76%), cotrimoxazole (60%), gentamicin (19%), nalidixic acid (31%), nitrofurantoin (24%), colistin (48%), streptomycin (34%), tetracycline (52%) (Table5). The bacteria isolates have high percentage multiple antibiotic resistance ranging from 67%-100%. *Pseudomonas* spp have the least value of 67% followed by *E.coli* (72%), *Shigella* spp (75%), *Klebsiella* spp (92%) while the remaining isolates demonstrated 100% multiple antibiotic resistance patterns (Table 6). There were increase in the occurrence of Multiple Antibiotic Resistance (MAR), among bacteria isolates from Olumirin waterfall , only 5.1% of the isolate were resistance to single antibiotics while 82.8% were multiple antibiotic resistance (MAR). Among the resistant isolates 94% were multiple antibiotic resistant while the 6% were resistant to single antibiotics. Among the bacteria species isolated, three (3) were 100% multiple antibiotic resistant while others were 67%, 72%, 75%, 92% multiple antibiotic resistant and these were significant. This contributes to the more difficulties, complication and relapses cases encountered when treating infections caused by these resistance strains.

Antibiotic-resistant bacteria were widespread in Olumirin waterfall, although this is not surprising because the intrinsic resistance of many organisms to antibiotics is well documented (Ajayi and Akonai, 2003). Most of the isolates showed multiple antibiotic resistances which is significant health-wise and these may be related to contamination by human wastes (Ajayi and Akonai, 2003). Olayemi and Opaleye (1990) in their report on antibiotics resistance among coliform bacteria isolated from hospital and urban waste water, when the isolates were subjected to eight (8) different antibiotics, the result of the resistance pattern showed that 35% of the coliforms were resistance to single antibiotics while the other 65% were multiple resistance.

Physico-chemical parameters have values ranged as follows; conductivity (0.03-0.06)mg/L, hardness (20mg/L), alkalinity (620-740). The mineral value of the water samples include; magnesium (84.8 - 93.4) mg/L, phosphate (12.62 - 17.13) mg/L, sodium (47.8 - 87.6) mg/L, potassium (76.6 - 104.5) mg/L, chloride (59.0 - 90.2) mg/L, zinc (0.75 - 1.82) mg/L, lead (0.12 - 0.33) mg/L, iron (0.52 - 0.60) mg/L, copper (0.12 - 0.27) mg/L while nickel and arsenic were not detected in any of the water samples (Table 7). These results revealed that magnesium, phosphates, iron, lead and copper level in the water were above the WHO standard and this could lead to serious environmental and health hazard to the consumers (WHO, 2003).

Table 1: Total Bacteria count of Olumirin water samples

Water samples	Dilution factor	
	10^{-2}	10^{-3}
A_1	15	9
A_2	24	8
A_3	25	9
A_4	21	7
Mean value	**21.3**	**8.25**
B_1	19	14
B_2	55	29
B_3	45	13
B_4	56	20
Mean value	**43.3**	**19**
C_1	12	8
C_2	35	18
C_3	90	30
C_4	25	10
Mean value	**40.5**	**16.5**
D_1	28	25
D_2	66	25
D_3	45	20
D_4	48	15
Mean value	**46.8**	**21.3**
E_1	5.O	3.0
E_2	19	7.0
E_3	20	6.0
E_4	15	8.0
Mean value	**14.8**	**6.0**

KEYS: 1, 2, 3, 4- Period of collection

Olumirin waterfall could be likened to a time bomb of epidermis that may explode anytime as long as the water from the source is untreated. In as much as water is essential for life, it could at the same time prove to be a potential reservoir of pathogenic microbes that could caused discomfort/ injury to those consuming the water. This study suggests that, there is the need for public awareness of the inherent dangers that would be associated with the consumption of this water in its untreated form. Also, since the water is being used for recreational purposes, bathing, defecating or contaminating the water meant in any form since the microbiological wholesomeness of water meant for drinking, recreation and industrial uses must be made to comply with established standards of appropriate national and international legislative agencies especially in the light of recent report of World Health Organisation that 99.8% of death in developing countries are water sanitation and hygiene-related death and that 90% are death of children.

Table 2: Total coliform count of Olumirin water samples

Water samples	10ml[a]	1ml[a]	0.1ml[a]	MPN/100ml
A_1	3	4	2	20
A_2	3	5	0	25
A_3	4	0	1	17
A_4	3	2	2	20
B_1	3	5	0	25
B_2	4	5	0	40
B_3	4	5	1	50
B_4	4	5	2	55
C_1	5	1	1	45
C_2	4	3	1	35
C_3	4	5	0	40
C_4	4	5	0	40
D_1	5	2	4	150
D_2	5	3	1	140
D_3	5	1	4	115
D_4	5	3	3	175
E_1	3	2	0	14
E_2	3	3	0	17
E_3	3	0	2	13
E_4	3	4	1	25

KEYS: 1, 2, 3, 4-Period of collection
a = 5 - number of samples of each quantity tested

Furthermore, the water can be treated in a reservoir with bactericidal agent and there is need for it to be regularly analyzed to determine if the coliform level falls within acceptable limit before being supply to the people. The isolates from this water showed multiple antibiotics resistant (MAR) which is significant health-wise, therefore, the results of MAR obtained in this study should be helpful for health care personnel in proper monitoring of rural waters and suggest possible solutions to problems that may arise from these resistance strains that could invade the communities from drinking the contaminated water.

Table 3: Distribution of isolated bacteria from Olumirin waterfall Erin-Ijesa

Isolates	No isolated	Frequency (%)
E coli	25	43.1
Klebsiella spp	12	20.7
Proteus spp	7	12.1
Salmonella spp	4	6.90
Shigella spp	4	6.90
Pseudomonas spp	3	5.17
Enterococcus spp	3	5.17

Table 4: Zones of inhibition in diameter (mm) of antibiotic sensitivity pattern of the isolated bacteria

Organisms	**AMP**	**COT**	**GEN**	**NAL**	**NIT**	**COL**	**STR**	**TET**
E. coli	19.0	-	19.0	19.0	19.0	-	19.0	19.0
	19.0	17.0	19.0	18.0	19.0	17.0	19.0	19.0
	19.0	19.0	9.0	19.0	19.0	9.0	19.0	19.0
	-	-	6.0	-	19.0	6.0	19.0	19.0
	-	-	15.0	15.0	19.0	-	19.0	-
	19.0	-	19.0	19.0	6.0	12.0	8.0	12.0
	-	4.0	19.0	19.0	19.0	19.0	19.0	9.0
	19.0	19.0	19.0	19.0	19.0	9.0	19.0	19.0
	-	-	14.0	-	14.0	-	9.0	-
	18.0	19.0	19.0	19.0	19.0	8.0	19.0	19.0
	-	-	19.0	14.0	19.0	9.0	19.0	9.0
	-	-	19.0	19.0	19.0	-	19.0	6.0
	19.0	19.0	19.0	18.0	19.0	9.0	19.0	19.0
	-	-	9.0	-	9.0	-	19.0	4.0
	-	-	17.0	13.0	18.0	4.0	14.0	-
	-	-	19.0	15.0	-	8.0	19.0	17.0
	-	13.0	18.0	19.0	22.0	4.0	22.0	11.0
	-	-	-	-	-	5.0	13.0	-
	5.0	-	18.0	14.0	15.0	5.0	23.0	8.0
	26.0	-	14.0	-	8.0	7.0	8.0	7.0
	-	24.0	28.0	24.0	22.0	11.0	23.0	26.0
	-	-	23.0	19.0	21.0	12.0	28.0	9.0
	28.0	-	9.0	-	4.0	16.0	24.0	8.0
	16.0	27.0	29.0	24.0	26.0	28.0	27.0	24.0
	-	9.0	27.0	23.0	25.0	11.0	27.0	4.0
Klebsiella spp	-	-	16.0	18.0	19.0	9	14.0	-
	-	14.0	16.0	20.0	21.0	10.0	11.0	-

	-	-	14.0	-	15	7.0	-	9.0
	-	-	22.0	20.0	23.0	9.0	28.0	9.0
	-	-	18.0	11.0	16.0	4.0	24.0	5.0
	12.0	-	23.0	22.0	24.0	16.0	28.0	4.0
	-	-	12.0	14.0	18.0	7.0	20.0	8.0
	9.0	-	23.0	14.0	26.0	9.0	24.0	6.0
	-	13.0	17.0	19.0	21.0	5.0	8.0	6.0
	-	-	14.0	14.0	15.0	-	19.0	4.0
	16.0	19.0	19.0	-	19.0	9.0	19.0	18.0
	-	19.0	19.0	19.0	19.0	9.0	19.0	-
Proteus spp	-	10.0	19.0	19.0	19.0	-	19.0	17.0
	-	9.0	19.0	19.0	19.0	-	19.0	17.0
	-	-	14.0	19.0	19.0	-	19.0	-
	-	-	14.0	4.0	13.0	-	19.0	6.0
	6.0	-	24.0	17.0	23.0	7.0	19.0	12.0
	9.0	-	22.0	25.0	28.0	3.0	19.0	10.0
	11.0	-	18.0	13.0	14.0	7.0	14.0	6.0
Salmonella spp	9	-	19.0	17.0	24.0	7.0	24.0	7.0
	-	-	-	8.0	-	-	8.0	-
	4	17.0	15.0	11.0	9.0	4.0	16.0	-
	8	6.0	18.0	12.0	25.0	-	23.0	6.0
Shigella spp	19.0	19.0	19.0	19.0	18.0	17.0	17.0	16.0
	9.0	19.0	19.0	14.0	11.0	14.0	9.0	10.0
	-	-	-	6.0	19.0	-	19.0	19.0
	-	-	9.0	-	4.0	-	12.0	-
Enterococcus *spp*	-	-	24.0	21.0	18.0	4.0	-	4.0
	-	-	20.0	-	21.0	-	25.0	11.0
	18.0	-	24.0	15.0	15.0	11.0	23.0	26.0
Pseudomonas spp	30.0	29.0	25.0	22.0	21.0	10.0	25.0	25.0
	-		24.0	14.0	24.0	9.0	24.0	14.0
	-	-	8.0	9.0	-	9.0	11.0	-
Organisms	**AMP**	**COT**	**GEN**	**NAL**	**NIT**	**COL**	**STR**	**TET**

KEYS: AMP-AMPICILLIN COT-COTRIMOXAZOLE
GEN-GENTAMICIN NAL-NALIXIDIC
NIT-NITROFURANTOIN COL-COLITIN
STR-STREPTOMYCIN TET-TETRACYLINE

Table 5: Percentage incidence of Multiple Antibiotic Resistance (MAR) pattern

Isolates	Total no of isolates	Total no of resistance isolates	Total no of incidence of MAR	% Frequency of MAR isolates
E coli	25	20	20	72 %
Klebsiella spp	12	12	11	92 %
Salmonella spp	4	4	4	100 %
Shigella spp	4	3	3	75 %
Proteus spp	7	7	7	100 %
Pseudomonas spp	3	2	2	67 %
Enterococcus spp	3	3	3	100 %

Table 6: Antibiotic sensitivity pattern of the isolates, multiple resistance pattern and percentage of resistant isolates

Isolate	AMP	COT	GEN	NAL	NIT	COL	STR	TET	PHENOTYPE OF RESISTANT PATTREN
E. coli 1.	S	R	S	S	S	R	S	S	COT
2.	S	S	S	S	S	S	S	S	-
3.	S	S	R	S	S	I	S	S	GEN
4.	R	R	R	R	S	R	S	S	AMP, COT, GEN, NAL, COL
5.	R	R	S	I	S	R	S	R	AMP, COT, COL, TET
6.	S	R	S	S	R	S	R	R	COT, NIT, STR, TET
7.	R	R	S	S	S	S	S	R	AMP, COT, TET
8.	S	S	S	S	S	I	S	S	-
9.	R	R	R	R	R	R	R	R	AMP, COT, GEN, NAL, NIT, COL, STR, TET
10.	S	S	S	S	S	R	S	S	COL
11.	R	R	S	I	S	I	S	R	AMP, COT, COL, TET
12.	R	R	S	S	S	R	S	R	AMP, COT, TET
13.	S	S	S	I	S	I	S	S	-
14.	R	R	R	R	R	R	S	R	AMP,COT, GEN, NAL, NIT,COL, TET
15.	R	R	S	R	S	R	I	R	AMP, COT,NAL, COL,TET
16.	R	R	S	I	R	R	S	R	AMP,COT,NIT,COL, TET
17.	R	S	S	S	S	R	S	R	AMP, COL, TET
18.	R	R	R	R	R	R	I	R	AMP, COT, GEN, NAL, NIT, COL, TET
19.	R	R	S	I	I	R	S	R	AMP, COT, NIT, TET
20.	R	R	I	R	R	R	R	R	AMP,COT,NAL,NIT, COL, STR, TET
21.	S	S	S	S	S	S	S	S	-
22.	R	R	S	S	S	S	S	R	AMP, COT, TET
23.	R	R	R	R	R	S	S	R	AMP, COT, GEN, NAL, NIT,TET
24.	S	S	S	S	S	S	S	S	-
25	I	R	S	S	S	S	S	R	COT,TET
% of resistant	**60%**	**68%**	**24%**	**28%**	**28%**	**52%**	**12%**	**64%**	**Total of Resistant = 20**
Klesiella spp 1	R	R	S	I	S	I	I	R	AMP, COT, TET
2.	R	I	S	S	S	I	R	R	AMP, STR, TET
3.	R	R	I	R	I	R	R	R	AMP, COT, NAL, COL, STR,TET
4.	R	R	S	S	S	I	S	R	AMP, COT, TET
5.	R	R	S	R	I	R	S	R	AMP, COT, NAL, COL, TET
6.	R	R	S	S	S	S	S	R	AMP, COT, TET
7.	R	R	R	I	S	R	S	R	AMP, COT, GEN, COL, TET
8.	R	R	S	I	I	I	S	R	AMP, COT, TET
9.	R	S	S	S	S	R	R	R	AMP, COL, STR, TET
10.	R	R	I	I	I	R	S	R	AMP, COT,COL, TET
11.	I	S	S	R	S	I	S	I	NAL
12.	R	S	S	S	S	I	S	R	AMP, TET
% of resistant	**92%**	**66%**	**-**	**25%**	**100%**	**42%**	**25%**	**92%**	**Total no of resistant isolates = 12**
Proteus spp 1	R	R	S	S	S	R	S	I	AMP, COT,COL
2.	R	R	S	S	S	R	S	I	AMP, COT, COL
3.	R	R	I	S	S	R	S	R	AMP, COT, COL, TET
4.	R	R	I	R	R	R	I	R	AMP, COT, NAL, NIT, COL, TET
5.	R	R	S	I	S	R	S	R	AMP, COT, COL,TET
6.	R	R	S	S	S	R	S	R	AMP,COT,COL,TET

7.	R	R	S	R	R	R	S	R	AMP, COT, NAL, NIT, COL, TET
% of resistant	**100%**	**100%**	**-**	**29%**	**29%**	**100%**	**-**	**71%**	**Total no of resistance isolates = 7**
Salmonella spp 1	R	R	S	I	S	R	S	R	AMP,COT,COL, TET
2.	R	R	S	I	S	R	S	R	AMP, COT,COL, TET
3.	R	S	S	R	R	R	S	R	AMP, NAL, NIT, COL, TET
4.	R	R	S	R	S	R	S	R	AMP, COT, NAL, COL, TET
% of resistant isolates	**100%**	**75%**	**25%**	**75%**	**50%**	**100%**	**25%**	**100%**	**Total no of resistance isolates = 4**
Shigella spp 1	S	S	S	S	S	S	S	I	-
2.	R	S	S	I	R	S	R	R	AMP, NIT, STR, TET
3.	R	R	R	R	S	R	S	S	AMP, COT,GEN, NAL, COL
4.	R	R	R	R	R	R	I	R	AMP, COT, GEN, NAL, NIT,COL,TET
% of resistant isolates	**75%**	**50%**	**50%**	**50%**	**50%**	**50%**	**25%**	**50%**	**Total no of resistance isolate = 3**
Enterococcus 1	R	R	S	S	S	R	S	R	AMP,COT, COL, TET
2.	R	R	S	R	S	R	R	R	AMP, COT,NAL, COL, TET
3.	S	R	S	I	I	R	S	R	COT, COL, TET
% of resistant isolates	**67%**	**100%**	**-**	**33%**	**-**	**100%**	**33%**	**100%**	**Total no of resistance isolate = 3**
Pseudomonas spp 1	S	S	S	S	S	I	S	S	-
2.	R	R	S	I	S	I	S	R	AMP, COT, TET
3.	R	R	R	R	R	I	R	R	AMP, COT, GEN, NAL, NIT, STR, TET
% of resistant isolates	**67%**	**67%**	**33%**	**33%**	**33%**	**-**	**33%**	**67%**	**Total no of resistance isolate = 2**

Table 7: Physico chemical and mineral analysis of Olumirin waterfall Erin- Ijesa water samples

Parameter	A	B	C	D	E
pH	7.95	7.85	7.65	6.55	6.70
Conductivity	0.06	0.03	0.03	0.04	0.03
Total hardness(mg/L)	20.0	20.0	20.0	20.0	20.0
Total dissolve solid(mg/L)	41.5	23.0	25.0	31.0	24.0
Alkalinity	740	700	620	680	720
Turbidity	10.2	17.7	5.40	10.6	9.20
Phosphate(mg/L)	14.7	15.3	12.6	11.5	17.1
Sodium(mg/L)	47.8	60.3	64.6	54.1	87.6
Chloride(mg/L)	90.2	85.6	77.3	59.0	65.4
Magnesium(mg/L)	93.4	87.8	85.2	84.8	85.7
Potassium (mg/L)	76.5	87.4	79.6	85.3	104.5
Iron(mg/L)	0.59	0.52	0.58	0.60	0.55
Zinc(mg/L)	1.66	0.88	1.82	0.75	1.22
Lead(mg/L)	0.21	0.12	0.33	0.25	0.21
Copper(mg/L)	0.12	0.22	0.27	0.13	0.16
Nickel(mg/L)	ND	ND	ND	ND	ND
Arsenic(mg/L)	ND	ND	ND	ND	ND
Cobalt(mg/L)	ND	ND	ND	ND	ND
Calcium(mg/L)	73.3	72.4	62.5	63.4	67.8

KEYS: A, B, C, D, E -Points of sample collection
ND -Not Detected

Duncan multiple range test

Water samples	Total Bacterial count		Total Coliform count
	10^{-2}	10^{-3}	
A	21.25^{ab}	8.25^{ab}	20.5^{ab}
B	43.25^{ab}	19.00^{c}	42.5^{c}
C	40.5^{ab}	16.50^{bc}	40.0^{bc}
D	46.75^{b}	21.25^{c}	145.0^{c}
E	14.75^{a}	6.00^{a}	17.25^{a}

References

1. AOAC, (2005).Official Methods of Analysis.18th Ed Association of Official Analytical Chemists International, Gaithersburg, MD, USA, Official Method.
2. Adeyeye, E.I., Fagbohun, E.D and Odeyemi, A.T (2010). Some microbiological characteristics of water samples from Arinta waterfalls in Ipole-Iloro Ekiti, Nigeria. *Journal of Pure and Applied Microbiology*. *4*(1), 79-82.
3. Ajayi, A.O and Akonai, K.A (2003): Antibiotic profile of microorganism encountered in Lagos, *Nigeria Journal of Science; 12* (1&2): 30-35.
4. Banwo, K. (2006). Nutrient load and pollution study of some selected stations along Ogunpa River in Ibadan, Nigeria M.sc Dissertation University of Ibadan. p 107.
5. CLSI (2005). Performance standards for antimicrobial susceptibility testing; fifteenth informational supplement, Clinical and Laboratory Standard Institute Wayne, Pa. M100-S15, vol.25, no.1.
6. Encyclopedia (2009). Waterfall, Microsoft Encarta online.
7. Fawole, M.O and Oso, B.A. (2001). Laboratory manual of microbiology: Revised edition spectrum books L-d Ibadan P.127.
8. Food and Agriculture Organisation (2007). Annual report on chemical manual for food and water 5th Edition, 1; 20-26.
9. Iruka, N.O., Oladipupo, A. A., Denis K. B., Kayode, K. O, and Japheth, A. O. (2007). Growing Problem of Multidrug-Resistant Enteric Pathogens in Africa (perspective), Vol 13 (11).
10. Lechevallier, M.W. (1996). Bacterial contamination in drinking water supplies in a modern rural neighborhood. *Journal Applied and Environmental Microbiology 39*; 742
11. Nogueira, G., Nakamora, C.V., Tognim, M.C., Abrev Filtio, B.A and Dias Filho, B.P. (2003). Microbiological quality of drinking water of urban and rural communities. *Brazil Rev., Saude Publication 37*: 232-236.
12. Olayemi, A.B and Opaleye, F.I. (1990). Antibiotic resistance among coliform bacteria isolated from hospital and urban waste water work. *Journal of Microbiology 6*: 258-288.
13. Olutiola, P.O., Famurewa, O and Sonntag, H.S (2000). An introduction to General Microbiology (A practical Approach). Measurement of Microbial Growth. pp 101-111.
14. Stoker, R and Lamka, K.G. (2002). Contamination of drinking water by bacteria in rural Neighborhood. *Journal of Applied and Environmental Microbiology 39*: 739-742.
15. World Health Organization (WHO) (1999). Guidelines for drinking water quality 2nd edition, volume 1 Recommendation. World Health Organization, Geneva pp: 30-113.
16. World Health Organization (WHO) (2000). Air quality Guidelines for Europe, Regional Publication European series 6: pp 12.
17. World Health Organization (WHO) (2001). Global Strategy for containment of antibiotic resistance. Geneva: The organization p 99.

9/21/2014