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Quality Assessment of Drinking Water Sources in Igbinedion University Okada and its Environs

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Abstract: *Drinking water is one the essential natural liquid needed for mankind and its continuous monitoring is very paramount for human health in order to avert health risks and threat associated with drinking polluted water. The physico-chemical and biological qualities of drinking water sources in Igbinedion University Okada and its environs were carried out in this research to ascertain its suitability for human consumption using recommended standard by World Health Organization. The physico-chemical parameters analyzed were pH, Electrical conductivity, Salinity, Total Dissolve Solids, Dissolved Oxygen. Biochemical Oxygen Demand, Chemical Oxygen Demand, Bicarbonate, Sodium, Potassium , Calcium , Magnesium, Chloride, Phosphorus , Ammonium, Nitrite, Nitrate Sulphate, Iron, Manganese, Zinc , Copper, Color, Turbidity, Total suspended solid , Chromium, Cadmium , Nickel, Lead, and Vanadium . The microbiological parameters analyzed were total coliforms counts, faecal coliforms counts, and total viable aerobic count for heterotrophic bacteria and heterotrophic fungi. The bacteria isolated include Bacillus cereus, Pseudomonas aeroginos, Bacillius subtils, Micrococcus varians, Escherichian coli, Enterobacter aerogenes, Proteus vulgaris, Klebsiella, Shigella sp, Staphylococcus aureus and the fungal isolated include, Rhizopus sp, Aspergillus niger, Penicllium sp, Geotrichium sp. The laboratory result of physic-chemical qualities of the drinking water sources when compared with the WHO standard revealed pH, DO, BOD, Iron, Magnesium, Manganese and Cadmium did not meet the recommended standard in some of the drinking water sources while that of biological parameters revealed that all the sources are highly polluted and contaminated and hence pose health threat for the people if continued to consume without treatment.*

Key words: *Drinking water, Sources, Physic-chemical, Biological qualities*

INTRODUCTION

The adequacy and availability of water in quantity as well as in quality to satisfy the existence of human life, animals and plants is very essential. Water and its quality cannot be overemphasized especially when it has to be for drinking purposes. Water quality encompasses the physical, chemical and biological characteristic of water. Suitability of water for drinking purpose is only satisfied when the physical, chemical and biological parameters are within the recommended value set by standard regulatory bodies e.g., World Health Organization etc. Due to increase in industrial activities, urbanization, agricultural activities, indiscriminate disposal of waste, etc., water bodies are becoming increasing polluted, thus posing greater harm, danger and risk especially to human life. With this pollution of water bodies, there is a greater need to provide potable water for mankind. According to Narsimha *et al.,* 2013, management of water quality for drinking purposes is a backbone for control and prevention of water related diseases and also maintains a sustainable economy and environment. Most of these diseases and epidemics affecting our health are through consumption of contaminated water and food. Contaminated or untreated water supplies are associated with communicable diseases (Agunwaba, 2000). Most of these diseases are caused by pathogenic organisms that live in water. In 1992, the World Health Organization (WHO) reported that there were 461,783 reported cases of cholera and 8072 deaths attributed to diseases associated with water in 68 countries. This menace encounter in water supplied for human consumption has to be prevented and control. Assessment of drinking water quality in Igbinedion University Okada and its environs was carried out to evaluate the suitability of the sources for human consumption.

MATERIALS AND METHODS

Background of Study Area

Okada Town is the administrative headquarters of Ovia North East Local Government Area of Edo State. It is a semi-urban area hosting Igbinedion University Okada, (IUO), Edo state NYSC orientation camp, banks and other governmental offices and establishments. All these developments attract all kinds of businesses, commercial activities and people to Okada, thus, increasing the population and improving standard of living of the people in this area. Population count in year 2006 was estimated at 20,000 inhabitants (National Population Commission, 2006). Rain water, Groundwater (borehole) and surface water (river) are the most natural sources of water in Okada both for domestic and commercial use.

Materials Used

The equipment and materials used in this research work include vehicle, bucket, reagent winker A and B for titration of the water samples on the site, ice coolers for storing of water samples collected, 1 litre container, small white bottles for microbial analysis and BOD black bottles shown in **Fig. 1**; Garmin GPS 72 receiver shown in **Fig. 2** was used for determination of geo-reference locations of sampled sources.

Fig. 1: Water samples in cooler

Fig. 2: Garmin GPS 72 receiver

Methodology

This study was carried out by estimating, the total number and sources of drinking water in Okada town including the three campuses of Igbinedion University Okada. During the course of the research, all drinking sources were identified and samples were collected for analysis to ascertain its quality and health position as well as its conformity to the drinking water standard set by WHO based on health issues. Thirteen (13) drinking water sources, excluding water that are packaged and distributed by corporation companies were identified both inside the school and within the town. Three of the sources were not in use currently. The remaining ten samples were collected for analysis. The address of the water sources are given in **Table 1** with geographical location. The GPS locations of all the viable drinking sources analyzed were determined for geo-referencing using GPS- 72 series system.

Table 1: Drinking water sources in Okada town

S/N	LABELING	SOURCES	LOCATIONS	GPS Location
1.	A	Borehole	Galaxy hotel Okada	N 06 44′ 127′′, E 005 23′ 985′′
2	B	Borehole	Mighty hotel Okada	N 06 44′ 129′′, E 005 23′ 771′′
3	C	Borehole	Redeemed Church ground, Okada	N 06 43′ 763′′, E 005 23′ 123′′
4	D	Borehole	IUO Teaching hospital	N 06 43′ 379′′ E 005 22′ 800′′
5	E	Borehole	Old girls Hostel, IUO	N 06 43′ 927′′, E 005 23′ 379′′
6	F	Borehole	Opp. IUO permanent site gate	N 06 44′ 398′′ E 005 24′ 741′′
7	G	Borehole	New boys private Hostel, IUO	N 06 43′ 240′′ E 005 23′ 500′′
8	H	Artesian well	Located beside Old boy's Hostel, IUO	N 06 43′ 284′′ E 005 23′ 599′′
9	I	River	Non flowing river water at Okada	N 06 44′ 011′′ E 005 23′ 082′′
10	J	Spring Water	Spring flowing water, Along Maternity Rd, Okada	N 06 44′ 620′′ E 005 24′ 741′′

The laboratory used for the water quality analysis is MacGill Engineering and Technical Services located at No 234 Murtala Mohammed Way, Benin City. In collecting water samples extra care was taken to make sure samples collected were representative of the source being evaluated. Secondly, the sampling equipment, techniques, procedures, handling and transportation were done such that the constituents analyzed did not change between the time the samples were collected and the time they were analyzed. At any point of collection, the bottle was rinsed with the water sample thoroughly. Three sets of samples were collected at each source location. The black bottles were air tightened and covered with black paper nylon bags for the analysis of BOD after five days, to prevent photosynthetic oxygen generation. The white bottles were titrated with Winkler A and B for Dissolved Oxygen (DO) and the remaining one(1) litre of samples each were collected for the physico-chemical analysis while small bottles were for microbiological analysis. They were stored in ice cooled containers and transported to the laboratory immediately for analysis. The techniques, preparation of reagents and procedures employed in the laboratory for the analysis and determination of all water quality parameters of groundwater samples collected followed the standard methods for examination of water and wastewater recommended by APHA, (1999).

RESULTS AND DISCUSSION

The physico-chemical parameters analyzed were pH, Electrical conductivity (EC), Salinity, Total Dissolve Solids (TDS), Dissolved Oxygen (DO). Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Bicarbonate (HCO_3), Sodium (Na), Potassium(K), Calcium (Ca), Magnesium (Mg), Chloride(Cl^-), Phosphorus (P), Ammonium(NH_4), Nitrite (NO_2), Nitrate (NO_3), Sulphate (SO_4), Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Color, Turbidity, Total suspended solid (TSS), Chromium (Cr), Cadmium (Cd), Nickel (Ni), Lead (Pb), and Vanadium (V). The microbiological parameters analyzed were total coliforms counts, faecal coliforms counts, and total viable aerobic count for heterotrophic bacteria and heterotrophic fungi. The bacteria isolated include Bacillus cereus, Pseudomonas aeroginos, Bacillius subtils, Micrococcus varians, Escherichian coli, Enterobacter aerogenes, Proteus vulgaris, Klebsiella, Shigella sp, Staphylococcus aureus and the fungal isolated include, Rhizopus sp, Aspergillus niger, Penicllium sp, Geotrichium sp. The results of the physio-chemical and microbiological analyses obtained from the sample sources were presented in **Table 2** and compared with WHO standards.

Table 2: Laboratory result of Physico-chemical parameter for drinking water sources sampled and its comparison with WHO standard limit

S/N	Physio-chemical Pollutants (mg/l)	A	B	C	D	E	F	G	H	I	J	WHO value	Remark
1	pH	7.1	6.0	4.7	5.5	5.8	6.1	6.1	7.1	6.4	6.2	6.5-8.5	Acidic except sample A and
2	(EC) µs/cm	200	120	160	160	100	110	80	70	60	40	400	Very okay
3	Salinity	0.09	0.05	0.07	0.07	0.05	0.06	0.04	0.03	0.03	0.02	-	
4	Colour color unit	0	1	0	0	1	0	1	2	2	0	15	Okay
5	Turbidity(NTU)	0	1	0	0	1	0	1	3	2	0	5	Okay
6	T.S.S(mg/l)	0	2	0	1	3	0	2	7	5	0	30	okay
7	T.D.S(mg/l)	100	60	80	80	50	55	40	35	30	20	500	okay
8	DO(mg/l)	10.6	12.0	7.0	6.2	9.8	6.1	8.5	5.1	9.0	7.2	5	Above the limit
9	BOD_5(mg/l)	6.1	8.2	3.5	2.0	5.7	3.0	5.3	1.4	5.0	3.4	5	Samples A, B,E,G,I were above limit
10	COD(mg/l)	10.4	1.60	8.80	8.00	3.20	11.2	8.80	16.8	2.4	1.6	40	okay
11	Total alkalinity(mg/l)	6.10	12.20	18.30	36.60	12.20	12.20	6.10	12.20	12.20	6.10	100	okay
12	Calcium(mg/l)	0.63	0.63	3.70	11.19	1.24	0.25	0.16	0.66	0.43	0.21	75	okay
13	Sodium(mg/l)	2.75	2.67	5.10	2.12	3.28	3.23	2.60	4.93	1.62	1.84	-	
14	Magnesium(mg/l)	5.65	4.40	10.70	22.41	4.97	3.04	2.55	3.26	0.73	0.61	30	okay
15	Potassium(mg/l)	0.55	0.49	1.91	0.17	0.47	0.16	0.14	0.72	0.04	0.03	-	
16	Chlorine (mg/l)	17.22	17.22	12.92	14.64	12.92	15.50	17.22	17.00	17.22	10.33	250	okay
17	Phosphate(mg/l)	0.035	0.050	0.084	0.035	0.035	0.025	0.020	0.064	0.020	0.015	5	okay
18	Ammonia (mg/l)	0.045	0.035	0.045	0.035	0.015	0.030	0.040	0.060	0.045	0.040	-	
19	Nitrate (mg/l)	0.62	0.73	1.11	0.67	1.04	0.78	0.84	0.81	0.87	0.79	50.0	okay
20	Sulphate(mg/l)	0.050	0.072	0.072	0.124	0.131	0.159	0.074	0.089	0.060	0.050	400	okay
21	Iron(mg/l)	0.42	0.46	0.44	0.29	0.47	0.83	0.92	0.47	0.30	0.20	0.1	Above limit

22	Manganese(mg/l)	0.15	0.12	0.22	0.09	0.09	0.06	0.03	0.11	0.02	0.01	0.05	Above limit except G and J
23	Zinc (mg/l)	0.02	0.05	0.10	0.10	0.13	0.16	0.18	0.20	0.03	0.04	5	Okay
24	Copper (mg/l)	0.01	0.02	0.02	0.04	0.04	0.04	0.06	0.05	0.05	0.02	2	Okay
25	Chromium(mg/l)	0.041	0.050	0.020	0.042	0.023	0.010	0.004	0.010	0.010	ND	0.05	Okay
26	Cadmium (mg/l)	0.001	0.002	0.001	0.003	0.003	0.002	0.001	0.006	0.003	ND	0.003	Okay except H
27	Nickel (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.07	-
28	Lead (mg/l)	0.002	0.001	0.002	0.001	0.003	0.002	0.001	0.002	0.005	ND	0.01	Okay
29	Vanadium (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	okay

The physio–chemical analysis showed that pH, DO, BOD, Iron, Magnesium, Manganese and Cadmium did not meet the recommended standard in some of the drinking water sources sampled. Although over 75% of physic-chemical parameters were within the recommended showing that the sources pose no threat in regards to those parameters. But there is need for treatment of exceeded parameters as they are indicators and catalysts of more harmful substance inside the water. Water with low pH (less than 6.5) is acidic, soft and corrosive. It can leach metal ions such as iron, manganese, copper, lead and zinc to the aquifer, plumbing fixtures and piping. It can contain elevated level of toxic metals which are cancerous and detrimental to health (Wilkes Environmental Center, 2008). High DO levels speed up corrosion in water pipes. Corrosion in water pipes can increase the contaminants level in water (WHO, 2009, USEPA, 2009). Iron is an essential element in human nutrition, but estimates of daily requirement depend on age, sex and physiological status (WHO, 2008). However, Intake of high level of iron damages liver, heart and pancreas for individuals with mutated genes that abnormally absorb and accumulates iron in organs within the body (Wilkes Environmental Center, 2008, Dalton, 2013). Consumption of high concentrations of magnesium in drinking water causes laxative effect and osmotic diarrhea (USEPA, 2009). Excess Manganese can cause neurological disorder while cadmium is toxic to kidney.

Table 3: Result of Microbial analysis compared with WHO Standards

Sampling Points	Bacterial isolates	Fungal Isolates	Heterotrophic Bacteria ($x10^2$ CFU/ML)	Heterotrophic Fungi ($x10^2$ CFU/ML)	Total Coliforms (MPN/100ML)	Faecal Coliforms (E.Coli) (MPN/100ML)	WHO	Remark On Water Quality
A	Bacillus cereus,Pseudomonas	Aspergillus niger,Rhizopus sp	33	11	ND	ND	0	Very poor
B	Staphylococcus aureus, Bacillus cereus	Aspergillus niger, Rhizopus sp	11	2	ND	ND	0	Very poor
C	Bacillus cereus, Pseudomonas	Aspergillus niger, Penicllium sp. Aspergillus flavus	22	7	ND	ND	0	Very poor
D	Bacillus cereus	Aspergillus flavus, Geotrichium sp	4	1	ND	ND	0	Very poor
E	Bacillus cereus, taphylococcus aureus Proteus vulgaris, Shigella sp Klebsiella	Penicllium sp,Aspergillus flavus	25	4	3	ND	0	Very poor
F	Bacillus cereus, Pseudomonas Shigella sp, klebsiella	Aspergillus niger, Rhizopus sp Penicllium sp	20	5	2	ND	0	Very poor
G	Bacillus ereus,Staphylococcus aureus Proteus vulgaris, Shigella sp Enterobacter aerogenes	Aspergillus niger, Penicllium sp Aspergillus flavus	38	13	1	ND	0	Very poor
H	Bacillus cereus,	Penicllium sp,	34	10	4	ND	0	Very poor

	Enterobacter aerogenes Proteus vulgaris	Rhizopus sp geotirchium						
I	Bacillus cereus, Pseudomonas aeroginosa, Bacillus subtils, Micrococcus varians Escherichia coli	Aspergillus niger, Rhizopus sp Penicllium sp	13	3	10	3	0	Very poor
J	Bacillus cereus, Pseudomonas aeroginosa,Bacillus subtils	Aspergillus niger, Penicllium sp	9	2	ND	ND	0	Very poor

The result of the biological quality revealed strong microbial pollution at all sources thus is not suitable for consumption directly without proper treatment. This is an indication that the drinking water sources cannot be consumed or supplied to people without adequate treatment. According to the WHO guidelines (2008), drinking water should not contain any microorganisms known to be pathogenic or any bacteria indicative of fecal pollution and also if fecal indicators are shown to be present, then it must be assumed that pathogens could also be present. Most of the sources were ground water, so using total coli forms and fecal coli forms organisms count as indicators revealed no contamination for sample A-D and J and no contamination for samples E- H for fecal coliform organism count, but the isolation of heterotrophic bacteria and fungi revealed high microbial pollution for the whole sources. The collection and consumption of these water sources indicate high chances and exposure to water borne diseases and its related cases like cholera, dysentery, typhoid, etc. People can stay safe and be protected from water borne and related diseases by making sure they boil their water before drinking. Also private water supply owners should make sure they analyze and treat their water before supplying it for consumption. Chlorine is used in disinfecting water and it destroys pathogens and control micro-organisms, etc. This will take care of high microbial pollution of these sources. As an oxidant also, chlorine is used in iron and manganese removal, for destruction of taste and odour compounds (Agunwaba, 2000). Shock chlorination can also be used to control iron and sulphate reducing bacteria and to eliminate fecal coli form bacteria in water wells (Wilkes University Center, 2008).

To be effective, shock chlorination should be done on a regular basis at least once or twice a year as part of a routine well maintenance programme. A large volume of chlorinated water is siphoned down the well to displace all the water in the well and some of the water in the formation surrounding the well. It will disinfect the entire well depth, formation around the bottom of the well, pressure systems, distribution systems and some water treatment equipment.

CONCLUSION

Normally, before water gets to the final usage, e.g., drinking, it is expected that the water has been collected, stored and treated for which ever standard method and is now available for use. The problem is not how it's collected, harvested or stored. The whole burden lies on how well it is treated and distributed for human consumption. The medium and the vessels with which we transmit or store water for drinking can equally impart or contaminate the water which has been analyzed, treated and approved for consumption. Therefore extra carefulness is needed in the final process both in the packaging of the water to ensure no recontamination

RECOMMENDATION

There should and must be great need and care to always do the following in cases relating to water consumed directly.

1. All sources private home owner suppliers, water co-operation companies both government and private that provide water consumption must routinely sanitize their facilities and equipment.
2. Continual analysis of the water should be carried out from time to time either on monthly bases to check and ensure that the water quality characteristic is still within limit and up to standard.
3. The statutory bodies charged and involved with drinking water standard for health purposes should and must make sure of routine check regularly on drinking water companies as well as other public and private sectors that supply water for consumption.
4. Any unregistered companies should be identified and penalized accordingly.
5. Other law enforcement agencies should also be used at local levels to ensure maximum protection.
6. In addition, Health awareness, education and advertisement should always be created by government, health organizations and officers to alert people on the need of drinking potable water.

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