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Potability of Water from Various Sources in Ibarapa East Local Government, Oyo State, Nigeria.

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ABSTRACT: Safe water is essential for human existence since water is life. Its usefulness to life cannot be over emphasized. However, water to be consumed by the user must be subjected to various laboratory tests and found meeting the required standards. Reconnaissance survey was carried out for the identification of location of water samples collected for analysis. These samples were collected from five common sources of water within the Ibarapa East Local Government of Oyo State in accordance with laid down standards procedures. Both physical and chemical properties of samples collected were determined.
Four out of five sampled water tested, that is rain water, deep well water, shallow well water and pipe borne water were potable and could be placed for various usage by the people of the studied area without necessarily undergone further treatment due to their results which clearly shown that they fell within allowable and acceptable limits and guidelines of World Health Organization (WHO), National Agency for Food Drug Administration and Control (NAFDAC) and Nigeria standard for drinking water quality.

Keywords: potable, suitability, water, consumption, standard

I. INTRODUCTION

Water is one the most abundant substances in nature. Water, common name applied to the liquid state of the hydrogen-oxygen compound (H_20) is the major constituent of living matter. Water covers approximately three fourth of the earth surface and it can be found in the ground in form of well and bored holes and as surface water in form of lakes, rain (precipitation), oceans, river, springs etc .it exist in the three state of matters (liquid, solid and gas) having know how essential water is to supporting life then there should be enough water for human consumption. Although the earth is made up of 75% water but 97.5% of the water is sea water and 2.5% fresh water. The sea water is quite unsafe for human consumption due to the pressure or certain substances and organism in the water presence in large quantity. Surface water in most cases is unfit for human consumption because it is not prevented from possible surface contaminations. Moreover, amount of water existing as surface water cannot be enough for human consumption. Hence, there is need to tap the underground water through boreholes, tube well as hand dug wells etc.

Water is generally used for domestic purposes like cooking, washing, drinking, bathing, etc. water is used in agriculture for irrigation purpose to supply water for plant growth and in fishing. It is also used in recreational purpose. Furthermore, water is used in industries, like Nigeria breweries and bottling company etc. and also for hydro-electric power generation.

Hence, provision of water supply for domestic, industrial, agriculture, and all other purposes or needs required engineering installation necessary to treat and certify it fit for consumption, therefore, this water needs to be well treated and distribution so as to eradicate or reduce the outbreak of epidermis. Extensive water treatment plant and water works scheme are essentials for providing water safe for human consumption.

Protection of human health is the primary reason for setting standards for potable water. The study aimed at assessing the quality of common water from different sources available for use in the chosen study area (Ibarapa East local Government of Oyo State) to ascertain its' potability through the following objectives:

- to collect samples from various sources of water
- to determine the quality of water from different sources.
- to analyze the potability of various samples collected.
- to compare the test results of various samples with some of available standards.
- to suggest based on the findings if any basic water treatments.

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This study was limited to sources of water in Ibarapa East Local Government. Water samples are taken from different sources randomly in this area. The sources of water are rain, pipe borne, deep well (borehole), shallow well and stream. Physical and chemical analyses only were covered by this study due to insufficient time and non availability of machines to carry out biological test.

Study Area

The study area of this project is located in Ibarapa East local government, Oyo state. It is situated within the basement of Oyo state of southwestern Nigeria. Eruwa which is its headquarters has an area of 838km^2 and a population of 118,226 at the 2006 census. The study area is wide covered by vegetation and comprises of larger mountains and rocks. The area falls under the tropical region because it experiences both the wet and dry season.

II. LITERATURE REVIEW

Water is a transparent and nearly colourless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Its chemical formula is H_2O, meaning that its molecule contains one oxygen and two hydrogen atoms, that are connected by covalent bonds. Water strictly refers to the liquid state of that substance, that prevails at standard ambient temperature and pressure; but it often refers also to its solid state (ice) or its gaseous state (steam or water vapor). It also occurs in nature as snow, glaciers, ice packs and icebergs, clouds, fog, dew, aquifers, and atmospheric humidity.

Sources of Water

Water present in Earth is 97% sea water and 3% of fresh water. Out of this 3%, 68.5% is trapped in glaciers and ice caps of mountains, 30.2% is present as ground water and remaining 1.3% as surface water.

- **Precipitation** which is the main source of water is one of the phases of the hydrologic cycle. It includes all moisture that reaches the earth's surface in liquid or solid form e. g rain, snow, hail etc due to the condensation of the atmospheric vapour. Water is circulated from the oceans to the atmosphere, to the ground and back to the oceans again in a cycle called the hydrologic cycle**.** Rain and snow gives most of the available water and also replenishes the ground water. The water begins its journey from the oceans and ends up returning to the ocean. (Modi, 2004).
- **Glaciers and ice caps** contain water which are trapped for centuries. Antarctic and Arctic region glaciers are trapped for millions of years. The Himalayas, which are often called "The Roof of the World", contain some of the most extensive and rough high altitude areas on Earth as well as the greatest area of glaciers and permafrost outside of the poles. Ten of Asia's largest rivers flow from there and more than a billion people's livelihoods depends on them.
- **Ground water** is nothing but fresh water trapped in subsurface of Earth. It is the water that has been percolated into rock crevices and remains as aquifers. This ground water is used through shallow wells and deep wells (boreholes).
- **Surface waters** are fresh water bodies on Earth surface. These are present as rivers, lakes and streams etc.

Water Treatment Processes

Water treatment involved physical, chemical, and biological changes that transform raw water into potable water. The water treatment process used in any specific instance depends on the quality and nature of the raw water.

These are the various methods or process involved in water treatment. The series of these treatment processes are referred to as units operation which includes: screening, aeration, coagulation and flocculation, sedimentation, pH correction, filtration and disinfection.

Screening

This is the removal of suspended solids such as debris, paper, small fishes etc. by racks and screens. To ensure efficient and reliable operation, the main units in a treatment plant it is first necessary to remove the large floating and suspended solids, which could be obstructed the flow in the plaints. This preliminary treatment usually involves a sample screening or straining. The flow is passed through a screen of 5-20 mm aperture mesh. This is placed extending above and below and covering sides of the water intake pipe.

Aeration

This is used to alter the concentration of dissolved gases to strip volatile organism and to reduce tastes and odours. It also involves removal of dissolved gases (CO_2 and H_2S).

There are different types of aeration devices but the most common ones are gravity, spay, diffused and mechanical aeration.

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Coagulation

This is the use of certain chemical called coagulants. This is used because many impurities in water are present as colloidal solids which will not settle. Thus chemical like alum, lime etc. convert sediments that can settle into bigger size called floc. Those flocs are further aggregated together to form bigger amounts suspended matter that can be precipitated. Large amount of suspended and dissolved matter are removed in this process resulting in the removal of most of the taste, colour and odour. In modern times, iron compounds are used as coagulants typically called ferric flocs, silica, soda lime.

Addition of chemical coagulants destabilized hydrophobic colloids such as salts aluminum and iron. Metal iron produced which charged reduced the repulsive forces hence particles contact and sticks together producing forces. Coagulant aids do not produce coagulation but improved the result when they are used with coagulation, these chemicals used are, caustic soda, sulphuric acid, naott, Na_2CO_3.

Flocculation

The removal of colloidal particles can be achieved by promoting agglomerative of such particles by flocculation.

This is the agitation of water by hydraulic or mechanical mixing which causes the collision between particles to produce settle able solids from a high concentration of colloidal particles. With low concentration of colloids a coagulant is added to produce bulky floc particles which enmesh the colloidal solids. Before flocculation can take place it is essential to disperse the coagulant, usually required in doses of 30 – 100 mg/l, throughout the body of water in rapid mixing chamber.

Sedimentation

This is the process where water is allowed to flow slowly through a basin so that suspended sediments will settle down. The amount of suspended matter removed during sedimentation depends on the size of the sedimentation basin, the particle size, the detention time and the amount of water involved

The purpose of sedimentation is the provision of conditions in which the flow is as uniform as possible for a period long enough to permit the greatest practicable amount of the settle able solids to be deposited before the water reaches the effluence end of the basins.

Filtration

This is the process in which water is allowed to flow through granular material such as sand in order to remove colloidal impurities. Such impurities are those not removed during coagulation and sedimentation process. During filtration, a wide rang of impurities and water contaminants are removed, it removes bacteria effectively, odour, taste, colour, iron and manganese.

These are various types of fettle in use, but early common ones are: the slow and filter and the rapid sand filter, other filter, multiple filters, up floc filter etc.

Disinfection

Disinfection is a process take to safeguard water against the pathogenic organisms which may escape other operations and those that might have accidentally got in contact with water from the water works to the consumer.

Due to the small size of bacteria, it is not possible to ensure their complete removal from water by physical and chemical means alone and for potable water suppliers it is necessary to ensure the death of harmful micro-organisms by disinfection.

III. METHODOLOGY

General Analysis

Reconnaissance survey was carried out to identify location where samples will be collected in connection with project designed and objectives, the project was limited to water sources within Ibarapa East Local Government

Sampling

Water samples were collected based on standard procedures with particular emphasis on test carried out. Sterilized bottles were used for sampling container. The container was then filled with water samples. The containers were then sealed after labeled and thereafter, taken to laboratory for subsequence test/analysis.

Laboratory

The experiment was carried out at Oyo State Water Cooperation, Asejire were the samples were thoroughly analyzed based on the standard method. The following quality parameters were analyzed for:.

Physical: pH, Turbidity, Colour, Appearance

Chemical: Total hardness, Calcium, Iron, Chloride, Nitrate, Chlorine residuals calcium hardness.

Physical Analysis

i. pH

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pH is the hydrogen ion concentration and it is defined by pH= log1/pH

Apparatus: Lovibond comparator, test tube, pH meter, beaker, water sample, phenol red indicator.

Procedure: phenol red indicator was used to determine the pH of the water sample collected. 10mm of water was then measured into each beaker. The pH meter was inserted into the water sample in the beaker and value was recorded in each case.

ii. Colour

Apparatus: Lovibond, test tube,

Procedure: 50mm mark filled with water and placed in a Lovibond. Looking vertically downward through the tube, resolving the disk, a suitable match was obtained. The figure that appeared in the opening at the bottom right corner was recorded as the apparent colour value. In case where value colour where greater than 20 unit dilution of samples were done.

Chemical Analysis

i. Total Hardness

Apparatus: calibrated syringe, calibrated plastic vessel, buffer reagent, calagmite indicator, H13812-0EDTA solution.

Procedure: The plastic vessel was rinsed with water sample and filled to 5ml mark, replaced the cap. Five drops of hardness buffer reagent was added through the cap port and carefully mixed swirled the vessel in tight circle. One drop of collegiate indicator was added through the cap port and mixed as described above. The solution became red violet colour. Take the titration syringe and push the plunge completely into syringe inserted the top into H1381-0 EDTA solution and plunger out on till the lower edge of seal was 0ml marked of the syringe and then replace the syringe up into the cap port of the plastic vessel and slowly add the titration solution drop wise, swirled to mix after each drop continue until the solution became purple and then mixed for 15min after each additional drop, solution turned blue. The ml titration solution from the syringe scale was read and multiplied by 300 to obtain mg/l (ppm) $CaCO_3$.

ii. Nitrate

Apparatus: Plastic pipette, checker disk, two glass vial

Procedure: Using the plastic pipette, fill each glasses vial with 5ml of water samples. Make one to be blanked and put into left hand opening of the checker disk. One pack of HH138050-0 reagent was added into second vial with water sample of 5ml replace the cap of glass vial shake vigorously for one minute and wait for five minute. This would be reacted sample. Remove the cap and insert into the right hand of the checker disk, hold the checker disk at distance of 30-40cm from the eyes and allow the light sources to illuminate the sample from the back of the window. Rotate the disk while looking at the colour test window in the checker disk and stop when the colour matches each other then read the value in the resul window directly in mg/l (ppm) of nitrate-nitrogen-NO_3, then multiplied the reading by given value of 4.43 to obtain mg/l of nitrate and the value was recorded.

iii. Iron

Apparatus: Calibrated plastic vessel, comparator tube and clock.

Procedure: The calibrated plastic vessel was rinsed with sample. Then to 10ml mark of sample packet of H13834 reagent was added, the solution was mixed until solid dissolved. The solution was removed and then transfers the solution into comparator cube, it was set for 1min. the colour matches the solution in the vessel was determined and the result was recorded as mg/l Fe_2.

iv. Chloride

Apparatus: Calibrated plastic vessel, calibrated syringe, EDTA reagent, sulphuric acid.

Procedure: The cap from the plastic vessel was removed then rinsed with water sample and then filled to 5ml mark and replace the cap. Through the cap port, two drops of sulphuric acid was added and carefully swirled the vessel in light circles. The solution become a violet colour while swirling the vessel, EDTA reagent was added, drop wise until the solution turns yellow. Then take the syringe and push the plunge completely into the syringe then insert tip into the sulphuric acid solution and pull the plunger out until the lower edge of the L plunger sealed is on the zone marked of the syringe placed into the cap of plastic vessel and added the titration solution slowly and dropwise, swirled to mix after each drop. Continue to add titration until the solution in the plastic vessel changes from yellow to violet.

v. Chlorine Residual

Apparatus: Lovibond comparator, comparator tube, ortholidine reagent.

Procedure: The comparator tubes was rinsed and then filled with 10ml of the water. Two drops of ortholidine reagent were added into the test tube at right hand of the comparator and shaking well. As suitable match was obtained by resolving the disc and figure shown in the opening at bottom right corner was the chlorine residual in ppm.

IV. RESULT AND ANALYSIS

Laboratory Results

The experimental results of samples for some physical and chemical parameters carried out

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were presented in table 1. Five samples were collected and ten parameters were analyzed for each of the samples and their results were compared with National Requirement of Drinking Water standard (2010), National Agency for Food and Drugs Administration and Controls (NAFDAC), 2010 and guideline on drinking water by Word Health Organization WHO.

Parameters	**Sample 1 (Rain water) mg/l**	**Sample 2 (Shallow Well Water) mg/l**	**Sample 3 (Deep Well Water) mg/l**	**Sample 4 (Pipe Borne Water) mg/l**	**Sample 5 (Stream Water) mg/l**
Turbidity	0.66	0.66	0.82	0.68	17.4
pH	6.8	7.8	7.0	7.0	7.2
Colour	5	5	5	5	70
Total Hardness	14.0	186.0	46.0	46.0	22.0
Calcium Ion	3.2	4.08	8.0	12.0	5.6
Iron	0.0	0.0	0.0	0.0	0.1
Chloride	33.5	111.0	42.5	24.5	21
Nitrate	0.0	6.9	4.1	0.84	4.0
Chlorine Residual	0	0	0	0	0
Calcium Hardness	8	102	20	30	14
Appearance	Clear with tiny particles	Clear with few tiny particles	Clear with few tiny particles	Clear with tiny particles	Cloudy brown with tiny particles.

Guideline on drinking water by World Health Organization (WHO), National Agency for Food Drug Administration and Control (NAFDAC) and Nigeria standard for Drinking Water Quality.

Test on physical and chemical parameter	**Max acceptable conc. WHO**	**Max allowable conc. NAFDAC**	**Max permitted level Nigeria Standard.**
Colour	5TCU		15TCU
pH Range	7.0-8.5	6.5-8.5	6.5-8.5
Turbidity	5NTU3		5NTU
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Calcium	200mg/l	75mg/l	
Iron	0.5mg/l or 0.3mg/l		0.3 mg/l
Chloride	1.5mg/l	200 mg/l	250 mg/l
Nitrate	1mg/l-2mg/l	10 mg/l	50 mg/l
Arsenic	0.7 mg/l		0.01 mg/l
Barium	0.003 mg/l		0.7 mg/l
Cadmium	0.5 mg/l		0.003 mg/l
Chromium	0.07 mg/l		0.05 mg/l
Lead	0.01 mg/l		0.01 mg/l
Magnesium	50mg/l	30 mg/l	0.20 mg/l
Manganese	50 mg/l		0.2 mg/l
Zinc	2.0-5.0 mg/l	5.0 mg/l	3 mg/l
Chlorine Residual			0.2-0.25 mg/l
Sulphate	200 mg/l	200 mg/l	100 mg/l
Aluminium	0.5 mg/l	500 mg/l	0.2 mg/l
Fluoride	50 mg/l		1.5 mg/l
Copper	0.5 mg/l		1 mg/l

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Discussion of Result

As present in table 1 the basic tests on these samples are physical and chemical analysis.

Physical Analysis Results

i. Turbidity

The most turbid sample was sample 5 (water fro, stream). Turbidity always occurs as a result of erosion and direct ingress of runoff into water sources. The turbid value ranged from 0.04 to 13.01. Sample 1, 2 and 3 were less turbid.

ii. pH

The values of the pH sample ranged from 6.82 – 7.8 of each sample. The standard ranges of pH value are from 6.5 – 8.5. Hence all the samples met the requirement.

iii**. Colour**

all other sample sources met the requirement aside sample 5 which was stream water having a greater value of 70 as against allowable maximum value of 5TCU.

Chemical Analysis Results

i. Total hardness

The total hardness of the sample ranges from 14.0-186.0 hardness of the sample range from soft to moderately hard. Research has shown that hardness is beneficial in drinking water notwithstanding the problem is great in the typing system. It reduces the incidence of cardiovascular disease; people who live in area of hard water suffer less of heart disease as compared to people living in area with soft water.

ii. Iron

There was no trace of iron in sample 1, 2, 3, 4 except in sample 5 which is 0.1. The standard range of iron is from 0.02 to 0.5. Hence, all the samples were acceptable.

iii. Chloride

The chlorine content of the samples ranged from 21-111.0mg/l. the chloride content of the samples were considered to fall within the allowable value since they fell below 200mg/l maximum standard.

iv. Nitrate

The nitrate present in the sample ranges from 0-6.9 mg/l. the nitrate content were also in order going by the stipulated value of 10mg/l maximum.

v. Chlorine Residual

There was no trace of chlorine residual in all the samples as shown in the table.

vi. Calcium Hardness

The calcium present in the samples ranges from 8-102mg/l. the calcium contents were considered to be adequate in all samples since they were below 200 mg/l WHO recommended value.

V. CONCLUSION

Conclusively, four out of five sampled water tested, that is rain water, deep well water, shallow well water and pipe borne water were potable and could be placed for various usage without necessarily undergone further treatment due to their results which clearly shown that they fell within allowable and acceptable limits. All these aforementioned samples satisfied the guidelines of World Health Organization (WHO), National Agency for Food Drug Administration and Control (NAFDAC) and Nigeria standard for drinking water quality. However, sample number 5 which was stream water would require some certain treatment to become potable water which would be safe for consumption having shown by the analysis result of its turbidity and colour which were indications of unsuitability.

Therefore, water from rain, deep well, shallow well and pipe borne located in studied area are recommended for domestic uses for the people of Ibarapa East Local Government Area of Oyo State, Nigeria.

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