RESEARCH ARTICLE

Comparative microbiological analysis of tap water and stream water in ago-iwoye

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ABSTRACT

Water is one of the most abundant resources on which life on earth depends; in some places, availability of water is critical, limited and renewable. Shortage of water could lead to disease outbreak and economic loss, hence water is a necessity, it is a unique liquid and without it life is impossible. Water plays a vital role in the proper functioning of the earth's ecosystem. Man uses water for various purposes which include drinking, transportation, industrial and domestic use, irrigation in agriculture recreation, fisheries, and waste disposal among others. Contaminated water sources are vehicles for the transport of waterborne diseases such as cholera, shigellosis and Campylobacteriosis. A comparative study was carried out to determine the quality of two water sources: tap water and stream water. Seven tap and three stream water samples were collected and the serial dilution method was used. The water sources were assessed for microbiological quality. It was revealed that the stream water has the highest contaminant and has a higher microbial load than the tap water. The total viable counts for the tap water ranges from 98 cfu/m^3-300 cfu/m^3, coliform count is from 110 cfu/100 mL -298 cfu/100 mL, *Salmonella-Shigella* count was present in some samples while it was absent in some of the tap water samples. For the stream water, the total viable count ranges from 287 cfu/m^3-300 cfu/m^3, coliform count is from 200 cfu/100 mL -358 cfu/100 mL, while *salmonella-shigella* count showed positive in all the samples. Seven bacteria were isolated from all the samples which are *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Citrobacter spp* and *Proteus mirabilis*. The prevalent microbe is Pseudomonas aeruginosa with a frequency of 5 followed by *Escherichia coli* with a frequency of 4, while seven fungi were also isolated from the water samples which are *Aspergillus niger*, *Mucor spp.*, *Alternarian spp.*, *Penicillium spp.*, *Aspergillus fumigates*, *Aspergillus flavus* and *Epidermophyton spp*. It is concluded that both water samples contain pathogenic organisms that can lead to water diseases if not monitored properly.

Key Words: *Ecosystem, Bacteria, Fungi, Waterborne diseases, Total coliform count, Total Viable count*

INTRODUCTION

Water is one of the most abundant resources on which life on earth depends; in some places, the availability of water is critical, limited, and renewable. Shortage of water could lead to disease outbreaks and economic loss, hence water is a necessity, it is a unique liquid and without it life is impossible. Water plays a vital role in the proper functioning of the earth's ecosystem. Man uses water for various purposes which include drinking, transportation, industrial and domestic use, irrigation in agriculture recreation, fisheries, and waste disposal among others [1,2]. Water that is of a good drinking quality is important to human physiology, and man's continued existence depends so much on its availability [3].

The quality of water for drinking deteriorates due to inadequacy of treatment plants, direct discharge of untreated sewage into rivers and streams, and inefficient management of piped water distribution system. The contaminated water, therefore, has a critical impact on all biotic components of the ecosystem and this could affect its use for other purposes. Water receives its bacteria spores from the air, sewage, organic waste, dead plants, and animal, at times almost all microorganisms may be found in water, but bacteria appeared to be the major water pollutants. The majority of the bacteria found in nature live on dead decaying organic matter as saprophytes [4].

The ensuring of good quality drinking water is a basic factor in guaranteeing public health, the protection of the environment, and sustainable development [5]. The water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability. The provision of potable water to rural and urban populations is necessary to prevent health hazards associated with poor drinking water [6]. A significant proportion of the world's population use potable water for drinking, cooking, and personal and home hygiene [7].

Before water can be described as potable, it has to comply with certain physical, chemical, and microbiological standards, which are designed to ensure that the water is potable and safe for drinking [8]. Potable water is defined as water that is free from disease-producing microorganisms and chemical substances deleterious to health [9]. Water is the most common solvent for many substances and it rarely occurs in its pure nature. Water can be obtained from several sources, among which are streams, lakes, rivers, ponds, rain, springs, and wells [10].

Unfortunately, clean, pure, and safe water can exist only briefly in nature and is immediately polluted by prevailing environmental factors aided by human activities.

Bacteria also help in the digestion of poisons from food and water. The presence of other species could cause various diseases to man and other animals. Water obtained from wells, boreholes, streams, and river are never chemically pure, even rainwater contains dissolved materials from the air as well as suspended dust intermixed with microorganisms [11].

Impurities in water may be floating as suspended matter consisting of insoluble materials of greater density than water which could be removed by sedimentation and in the form of bacteria. The bacteriological examination of water is performed routinely by microbiologists, and this will ensure a safe supply of water for drinking, bathing, swimming, and other domestic and industrial uses. The microbiological examination is usually intended to identify water sources that have been contaminated with potential disease-causing microorganisms. Such contamination generally occurs either through improperly treated sewage or improperly functioning sewage treatment systems. Chemical analysis can however determine whether water is polluted and provides other useful information.

To determine whether water is contaminated or contains any microorganism known to be pathogenic or indicative of faecal pollution, it is necessary to carry out a bacteriological examination (analysis) on it.

Justification

In many developing countries, the availability of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on the non-public water supply system. Confirmation of physicochemical and microbiological standards is of special

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interest because of the capacity of water to spread diseases within a large population. Although the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water-borne diseases to the barest minimum in addition to being pleasant to drink, which implies that it must be wholesome and palatable in all respects.

OBJECTIVES

The general objective of this research is to microbiologically compare the analysis of tap water and stream water in Ago-Iwoye concerning total viable counts, total coliform counts, and *Salmonella-shigella* counts.

The specific objectives of this study include:

- To determine the total viable bacteria, total coliform counts *Salmonella-Shigella* counts in tap water and stream water in Ago-Iwoye
- To characterize and identify the bacteria from the water samples
- To determine the fungal presence in the tap and stream water.

LITERATURE REVIEW

Water is examined microbiologically to determine its sanitary quality and its suitability for general use. The aim is that it will be acceptable for internal consumption and other uses in contact with the man. Water may contain poisonous chemical substances, pathogenic organisms (infective and parasitic agents), industrial or other wastes or sewage and is referred to as being contaminated or polluted. Most of the infections in developing countries can be attributed to a lack of safe drinking water (like Cholera, Typhoid, Hepatitis, Poliomyelitis, etc.).

Water that is wholesome and fit for drinking is said to be potable. The source of water contamination responsible for the spread of infectious diseases is almost invariably faeces. Faecal contamination of water is established by the isolation of an organism that occurs only in faeces, never free-living. There are several such organisms like *Escherichia coli, Clostridium perfringens*, and *Streptococcus faecalis*. The finding of *E. coli* or *Clostridium perfringens and S. faecalis* is sufficient evidence that the water in question is not safe, since enteric pathogens may be presumed present [12].

The World Health Organization and many other authorities continue to support the use of bacterial indicator levels and their isolation as a basis for judging and verifying drinking water quality. A bacterium can be used as the indicator organism if it fulfills most of the following criteria; present in faeces in abundant number; present in scanty number in other sources; easy to isolate, identify and enumerate, unable to grow in water; able to survive longer in water than other pathogens; more resistant to disinfectants such as chlorine.

Estimation of Hydrogen sulphide (H_2S) for detection of faecal contamination of drinking water is also in use [13].

Indicator organisms

Escherichia coli

Escherichia coli is a member of the family Enterobacteriaceae, and is characterized by the possession of the enzymes b-galactosidase and b-glucuronidase. It grows at 44°C –45°C on complex media, ferments lactose and mannitol with the production of acid and gas and produces indole from tryptophan. However, some strains can grow at 37 °C but not at 44°C –45°C, and some do not produce gas. *E. coli* does not produce oxidase or hydrolyze urea [14].

Complete identification of the organism is too complicated for routine use, but several tests have been developed for rapid and reliable identification. Some of these methods have been standardized at international and national levels and accepted for routine use; others are still being developed or evaluated. *Escherichia coli* is abundant in human and animal faeces; in fresh faeces it may attain concentrations of 109 per gram. It is found in sewage, treated effluents, and all-natural waters and soils subject to recent faecal contamination, whether from humans, wild animals, or agricultural activity. Recently, it has been suggested that *E. coli* may be present or even multiply in tropical waters not subject to human faecal pollution. However, even in the remotest regions, faecal contamination by wild animals, including birds, can never be excluded. Because animals can transmit pathogens that are infective in humans, the presence of *E. coli* or thermotolerant coliform bacteria must not be ignored, because the presumption remains that the water has been faecally contaminated and that treatment has been ineffective [15].

Thermotolerant coliform bacteria

Thermotolerant coliform bacteria are the coliform organisms that can ferment lactose at 44°C –45°C; the group includes the genus Escherichia and some species of *Klebsiella, Enterobacter*, and *Citrobacter*. Thermotolerant coliforms other than *E. coli* may also originate from organically enriched water such as industrial effluents or decaying plant materials and soils. For this reason, the term "faecal" coliforms, although frequently employed, is not correct, and its use should be discontinued. Regrowth of thermotolerant coliform organisms in the distribution system is unlikely unless sufficient bacterial nutrients are present, unsuitable materials are in contact with the treated water, the water temperature is above 13°C, and there is no free residual chlorine. In most circumstances, concentrations of thermotolerant coliforms are directly related to that of *E. coli*. Their use in assessing water quality is therefore considered acceptable for routine purposes, but the limitations about specificity should always be borne in mind when the data are interpreted [16]. If high counts of thermotolerant coliforms are found in the absence of detectable sanitary hazards, additional confirmatory tests specific to *E. coli* should be carried out. National reference laboratories developing national standard methods are advised to examine the specificity of the thermotolerant coliform test for *E. coli* under local conditions. Because thermotolerant coliform organisms are readily detected, they have an important secondary role as indicators of the efficiency of water treatment processes in removing faecal bacteria. They may therefore be used in assessing the degree of treatment necessary for waters of different quality and for defining performance targets for the removal of bacteria.

Coliform organisms (total coliforms)

Coliform organisms have long been recognized as a suitable microbial indicator of drinking-water quality, largely because they are easy to detect and enumerate in water. The term "coliform organisms" refers to Gram-negative, rod-shaped bacteria capable of growth in the presence of bile salts or other surface-active agents with similar growth-inhibiting properties and able to ferment lactose at 35°C –37°C with the production of acid, gas, and aldehyde within 24 hours –48 hours. They are also oxidase-negative and non-spore-forming and display b-galactosidase activity. Traditionally, coliform bacteria were regarded as belonging to the genera *Escherichia, Citrobacter, Enterobacter,* and *Klebsiella* [17].

However, as defined by modern taxonomical methods, the group is heterogeneous. It includes lactose fermenting bacteria, such as *Enterobacter cloacae* and *Citrobacter freundii*, which can be found in both faeces and the environment (nutrient-rich waters, soil, decaying plant material) as well as in drinking water containing relatively high concentrations of nutrients, as well as species that are rarely, if ever, found in faeces and may multiply in relatively good-quality drinking-water, e.g. *Serratia fonticola, Rabnella aquatilis*, and *Buttiauxella agrestis*. The existence both of non-faecal bacteria that fit the definitions of coliform bacteria and of lactose-negative coliform bacteria limits the applicability of this group as an indicator of faecal pollution. Coliform bacteria should not be detectable in treated water supplies and, if found, suggest inadequate treatment, post-treatment contamination, or excessive nutrients. The coliform test can therefore be used as an indicator both of treatment efficiency and the integrity of the distribution system. Although coliform organisms may not always be directly related to the presence of faecal contamination or pathogens in drinking water, the coliform test is still useful for monitoring the microbial quality of treated piped water supplies. If there is any doubt, especially when coliform organisms are found in the absence of thermotolerant coliforms and *E. coli,* identification to the species level or analyses for other indicator organisms may be undertaken to investigate the nature of the contamination. Sanitary inspections will also be needed.

Faecal streptococci

Faecal streptococci are those streptococci generally present in the faeces of humans and animals. All possess the Lancefield group D antigen. Taxonomically, they belong to the genera Enterococcus and Streptococcus. The taxonomy of Enterococci has recently undergone important changes, and detailed knowledge of the ecology of many of the new species is lacking; the genus Enterococcus now includes all streptococci that share certain biochemical properties and have a wide tolerance of adverse growth conditions—*E. avium, E. casseliflavus, E. cecorum, E. durans, E. faecalis, E. faecium, E. gallinarum, E. hirae, E. malodoratus, E. mundtii,* and *E. solitarius*. Most of these species are of faecal origin and can generally be regarded as specific indicators of human faecal pollution for most practical purposes. They may, however, be isolated from the faeces of animals, and certain species and subspecies, such as *E. casseliflavus, E. faecalis var. liquefaciens, E malodoratus,* and *E. solitarius*, occur primarily on plant material. In the genus

Streptococcus, only *S. bovis* and *S. equinus* possess the group D antigen and therefore belong to the faecal streptococcus group. They derive mainly from animal faeces. Faecal streptococci rarely multiply in polluted water, and they are more persistent than *E. coli* and coliform bacteria.

Their primary value in the water-quality examination is therefore as additional indicators of treatment efficiency. Moreover, streptococci are highly resistant to drying and may be valuable for routine control after new mains are laid or distribution systems are repaired, or for detecting pollution of ground waters or surface waters by surface run-off.

MATERIAL AND METHODS

Study area

The study was carried out in Ago-Iwoye, Ogun State. It is a town in Ijebu North Local Government Area of Ogun State, Nigeria.

Collection of samples

Tap Water Analysis: A total of 7 tap water samples were collected in Ago-Iwoye. The outside of the tap was wiped using a clean sterile cloth. The tap was turned on at maximum flow rate and the water was allowed to flow for 1 minute to 2 minutes. The tap was then disinfected for a minute with flame using ignited cotton wool soaked in spirit. The tap was then opened and water was allowed to flow at a medium rate for 1 minute to 2 minutes. A previously sterilized glass container was opened for collecting a 2-liter sample of water by holding the bottle steady under the water jet. Small airspace was left in the container to allow for shaking at the time of analysis. The flask was properly stoppered with its cap and brown paper fixed on it with a string.

While for the collection of stream water, 3 water samples were collected in 5 sterile bottles. All the bottles were sealed immediately with a sealant and transported to the Microbiology laboratory, Ago-iwoye for further examination.

Materials used

Petri dishes, conical flasks, beaker, cotton wool, sterile bottles, autoclaves, incubator, test tube and test tube rack, syringe, distilled water, peptone water, detergents, measuring cylinder, microscope, etc.

Media used

- Nutrient agar
- MacConkey agar
- Eosine Methylene
- Blue Salmonella
- Shigella agar
- Mannitol Salt agar

Media preparation

All the media used were prepared according to the manufactures prescription.

Microbiological analysis

A tenfold serial dilution up to 105 ml was made by adding 1ml of the water sample to 9ml of peptone water. The method was used for both tap water and stream water. 0.5 ml of the sample water was then inoculated on the media used. All the plates were incubated at 37°C for 24 hours. After observing growth on the plates, the numbers of colonies were counted, district colonies were subculture, and characterization and identification tests were carried out.

For the fungal identification, 0.5 ml of the sample was inoculated with a syringe and poured on Sabouraud Dextose Agar containing 50 mg of Chloramphenicol per liter. These were incubated for 1 - 3 weeks. The presence of yeast and filamentous fungi was recorded as described by Arvanitidou [18].

Characterization of bacteria isolates

This was done by carrying out a Gram staining test. Using a sterile technique, a smear was made from 24 hours old culture by placing a drop of sterile water on a clean grease-free slide and a colony was picked from the culture plate with the aid of a sterile cooled loop and then emulsified. The smear was air-dried and heat-fixed by passing the slide over the flame. The slides were flooded with crystal violet and the stain was allowed to act for 1 minute. It was then rinsed in slowly running tap water. It was then flooded with Lugol's iodine for another 1 minute and rinsed with water and decolorized briskly with alcohol for 5 seconds (care was taken to avoid over decolorization). It was then flushed with water immediately and allowed the slide to drain. The slides were later counter-stained with safranin for 1 minute and rinsed with water, then it was examined microscopically using oil immersion objection (x100), while the gram-negative bacteria are indicated by pink to red color which indicates the retaining of the safranin (secondary stain). This indicates a thin peptidoglycan wall in the bacteria cell.

Biochemical test for the identification of bacteria

Morphological and biochemical characteristics of the microbial isolates were used for the identification of the isolates according to Baron, Benson and Bitton [19, 20,21]. The Bergey's Manual of determinative bacteriology was used to compare the characteristics with the results obtained.

Catalase test

A colony of the bacteria from the culture plate was picked with a sterile glass rod and smeared into a 3% hydrogen peroxide solution. Bubble formation was observed.

This test is used to identify bacteria capable of producing the enzyme catalase, which breaks down hydrogen peroxide into water and oxygen. The reagent used is 3% hydrogen peroxide. A positive result is identified by the production of bubbles, which indicates oxygen production, and a negative result is identified by no bubble production.

$$2H_2O_2 \rightarrow 2H_2O + O_2.$$

Kligler iron agar test

The ability of the organism to ferment lactose and glucose and also determine the production of hydrogen sulfide. An inoculum from a pure culture was transferred aseptically by streaking and then stabbing on a sterile Kligler Iron Agar (KIA) slant, the inoculated tube was then incubated at 37°C for 24 hours and the result was determined.

In a positive test, the pH indicator in the medium changes from its normal red to yellow indicating acid production, the position of the color change distinguishes the acid production associated with glucose fermentation from the acidic by-products of lactose or sucrose fermentation and if the color of the agar in the tube turns black, that indicates Hydrogen Sulfide production.

Indole test

The test organisms were inoculated into sterile tryptone soy broth and incubated at 37°C for 48 hours. A drop of Kovac's reagent (4-para-dimethy laminobenzaldehyde) was added and the shock was gently observed for color change at the interphase of the two fluids. A positive result was indicated by the reformation of a pink to red color. No color change from pink to red indicates a negative result.

Oxidase test

The edge of the microscopic slide was used to pick a colony of the test organisms and placed on a filter paper soaked in 2 to 3 drops of 1 tetremethy1-P phenylenediamine dihydrochloride solutions. A positive reaction is shown by the development of a dark purple color within 10 seconds, and if there is no dark purple coloration within 10 seconds.

Urease test

Urease- An enzyme that splits urea into ammonia (NH_3) and carbon dioxide ($C0_2$) can be detected by using a phenol red indicator by turning to a purple-pink or red-violet coloration. The isolates were tested for this enzyme using Christensen urea medium.

$$NH_2CO.NH_2+H_20 = 2NH_3+C0_2$$

The isolates were inoculated into slants of Christensen urea medium ad incubated at 37°C for 24 hours and then examined after the phenol red indicator was added. A change in color of the indicator to red-violet indicates a positive result. No color change indicates negative results [22].

Observation and identification of fungal isolates

A drop of Lacto phenol blue was added to a clean and grease-free glass slide. Using a sterile syringe for each plate, a colony was picked and added to the slide and covered with a cover slide. It was placed on the microscope and magnification was done using x10 to view and identify it.

RESULTS

Table 1 show the morphological characteristics of the isolates from tap and stream water samples used in this analysis. It was revealed that most of the

isolates are Gram-negative rod bacteria, while Gram +ve cocci also appear.

Table 2 four shows the biochemical characterization of the isolated bacteria. It was revealed that seven bacteria were isolated from both the tap and stream water samples and they are *Staphylococcus aureus, Escherichia coli, Salmonella typhi, Pseudomonas aeruginosa, Bacillus cereus, Citrobacter spp* and *Proteus mirabilis*. The prevalent microbe is *Pseudomonas aeruginosa* with a frequency of 5 followed by *Escherichia coli* with a frequency of 4.

DISCUSSION

Water can be clear in appearance, free from peculiarities of odor and taste, and yet be contaminated. Special procedures are necessary to determine its sanitary quality. As a potential carrier of pathogenic microorganisms, water can endanger health and life. Therefore, an inspection of a water-producing system by a qualified sanitarian or engineer is necessary in form of what is regarded as a sanitary survey. Many of the organisms that cause serious diseases, such as Typhoid fever, Cholera, and Dysentery can be traced directly to polluted drinking water. These disease-causing organisms called pathogens are discharged along with faecal wastes and are difficult to detect in water supplies.

Fortunately, less harmful, easily isolated bacteria called indicator organisms can be used indirectly to detect pathogens. Among these indicators are coliform bacteria. They live in the intestine of man and other animals, and are almost always present, even in healthy persons. The presence of coliforms in water is a warning signal that more dangerous bacteria may be present. Diseases resulting from the ingestion of pathogens in contaminated water have the greatest public health impact worldwide [23].

The present study aims to compare the microbiological analysis of tap water and stream water. Seven tap glasses of water were collected within Ago-iwoye. The waters were collected in Abobi, Mini campus, Igan road, Itamerin, Ayegbami, and Mariam, while the stream water samples were collected at the back of the mini campus and abattoir area.

The result of the microbiological analysis of tap and stream water analysis in Ago-iwoye, Ogun State, Nigeria revealed that both waters had microbial loads signifying contamination. The result of the tap water samples reveals that the total viable count ranges from 98 cfu/m^3-300 cfu/m^3, while the total coliform count ranges from 112 cfu/100 mL -298 cfu/100 mL. Only samples 1, 4, 5,7,10 had no Salmonella counts.

For the stream water analyzed microbiologically, the total viable count ranges from 285 cfu/ml^3-300 cfu/ml^3, while the coliform count is from 200 cfu/mL -358 cfu/mL, and the Salmonella-Shigella count shows positive in all the samples, revealing that Salmonella was present in all the samples. The TVCs for all the water samples were generally high, exceeding the limit of 1.0 x 10^2 cfu/ml for water. The recommended standard for water is nil.

The reason for the higher microbial count and coliform counts in stream water could be attributed to the fact that the tap water has been treated for human consumption with the addition of chemicals like chlorine that inhibit microbial growth while the stream water is open to pollution from all areas. Pollution can be from human activities like washing, and throwing of dirt and human wastes in streams. Pollution can also come from the dropping of animals, leaves, and the presence of aquatic bodies in the streams that increases the level of contamination though their activities.

The coliform counts per 100 ml of the water samples on the EMB agar plate also exceed the standard limit for water. The presence of coliforms group in these water samples generally suggests that a certain selection of water may have been contaminated with faeces either of human or animal origin. Other more dangerous microorganisms could be present. Also, the total coliform for samples examined during this study was exceedingly high as against the EPA Maximum Contamination Level (MCL) for coliform bacteria in drinking water of zero total coliforms per 100 ml of water. The high coliform count obtained in the samples may be an indication that the water sources were faecally contaminated. None of the water sources in this study complied with the EPA standard for coliforms in water. This result compared favorably with the report of Banwo [24] which indicates that the presence of bushes and shrubs makes it likely possible that smaller mammals may have been coming around these water bodies to drink water, thereby passing out faeces into the water.

Seven bacteria species were isolated from all the water samples and these were identified as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Salmonella spp.*, *Bacillus cereus* and *Proteus mirabilis*, while the fungal result shows that seven fungi belonging to five species were isolated and these are *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigates*, *Mucor spp.*, *Epidermophyton spp., Alternarian spp.* and *Penicillium spp.*

The isolated bacteria species were identified to be the same with those commonly encountered in water and aquatic environments as was also reported in a study on streams and surface water in Wyoming in the U.S.A. reported by Mulusky and reviewed by Banwo [24]. These identified isolates include *Staphylococcus aureus*, *Salmonella species*, *Escherchia coli*, *Pseudomonas aerugionosa*, *Enterobacter aerogenes, Bacillus species*, *Proteus species*, *Klebsiella species*, *Flavobacterium species* and *Acinetobacter sp*. The result shows that the stream water contains more microorganisms in comparison to the present study result with that done in Kebbi state of Nigeria on microbiological analysis of sachet drinking water is not encouraging [25]. Microbial water quality may vary rapidly and widely. Short-term peaks in pathogen concentration may increase disease risks considerably and may also trigger outbreaks of waterborne disease. Results of water quality testing for microbes are not normally available in time to inform management action and prevent the supply of unsafe water. Outbreaks of waterborne disease can affect large numbers of persons, this necessitates priority in developing and applying controls on drinking-water quality to check disease outbreaks.

CONCLUSION

It was concluded from this study that the microbial loads of stream water are higher than that of stream water in Ago-iwoye. Also, most of the water samples analyzed microbiologically were unfit for human consumption. The result of this study, thus, suggests thorough treatment of tap and stream water to make it potable from a bacteriological point of view. Appropriate programs must be put in place to educate the general populace on the need to purify water to make it fit for drinking and other domestic purposes.

The pathogenic organic and the indicator organisms present in all the water samples render them unfit for human consumption though they can be used for other purposes. Water should meet different quality specifications depending on the particular uses. Thus, potable and domestic water should be harmless for the health of man and should have proper organoleptic properties, and should be suitable for domestic use. Water quality should be controlled to minimize acute problems of water-related diseases, which are endemic to the health of man.

TABLE 1
Percentage of occurrence of isolate

Isolate	Occurrence	Percentage
Citrobacter spp	3	15
Escherichia coli	4	20
Pseudomonas aeruginosa	5	25
Staphylococcus aureus	3	15
Salmonella spp	2	10
Proteus mirabilis	2	10
Bacillus cereus	1	5

TABLE 2
Biochemical characterization of bacteria isolates from tap and stream water.

Shape	Gram Strain	Catalase	Oxidase	Urease	Indole	Citrate	Slope	Butt	Gas	H_2S
Rod	-ve	+	-	+	+	+	R	Y	-	+
Rod	-ve	+	+	+	+	+	R	Y	+	-
Rod	-ve	+	+	+	+	+	R	Y	-	-
Cocci	+ve	+	+	+	+	+	R	Y	-	+
Rod	-ve	+	+	-	+	+	Y	Y	-	+
Rod	+ve	+	-	+	-	-	R	Y	-	+
Rod	+ve	+	+	+	-	-	R	R	-	-

Positive (+) ;Negative (-);R-Alkaline Slope ;Y-Acidic

REFERENCES

1. Ajayi AO, Akonai KA. Distribution pattern of enteric organisms in the Lagos lagoon, Nigeria. Afr j biomed res. 2005;8(3):163-8.
2. Shittu OB, Olaitan JO, Amusa TS. Physico-chemical and bacteriological analyses of water used for drinking and swimming purposes in abeokuta, nigeria. Afr J Biomed Res. 2008;11(3): 285-90.
3. Lamikanra A. Essential Microbiology for students and practitioner of Pharmacy, Medicine and microbiology. Lagos: Amkra books. 1999: 406.
4. Sullia SB, Shantharam S. General microbiology. Oxford and IBH Publishing.
5. Rajini K, Roland P, John C, et al. Microbiological and physicochemical analysis of drinking water in George Town. Nature and science. 2010;8(8):261-5.
6. Nikoladze G, Mints D, Kastalsky A. Water treatment for public and industrial supply. Mir pub; 1989:163.
7. World Health Organization, WHO., World Health Organisation Staff. Guidelines for drinking-water quality. World Health Organization; 2004.
8. Tebbutt TH. Principles of water quality control. Elsevier; 1997.
9. Ihekoronye AI, Ngoddy PO. Integrated food science and technology for the tropics. Macmillan.1985:95-195.
10. Omezuruike OI, Damilola AO, Adeola OT, et al. Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria. Afr J Biotechnol. 2008;7(5):617-21.
11. Joanne M. Prescott/Harley/Klein's Microbiology;2008.
12. Townsend SA. The relationships between salmonellas and faecal indicator concentrations in two pools in the Australian wet/dry tropics. J appl bacteriol. 1992; 73(2):182-8.
13. Rajesh B, Rattan L. Microbiology of Water, Milk and Air. Essential of Medical Microbiology, Brothers Medical Publishers. 2004:447-50.
14. Nagaraju D, Sastri JC. Confirmed faecal pollution to bore well waters of Mysore city. Environmental Geology. 1999; 38(4):322-6.
15. Sinton LW, Finlay RK, Hannah DJ. Distinguishing human from animal faecal contamination in water: a review. N Z j mar freshw res. 1998; 32(2):323-48.
16. Mark DS, Frederic KP. Evaluation of the H2S Method for Detection of Faecal Contamination of Drinking Water. WHO/SDE/WSH/02.08 Geneva.2002.
17. Kaspar P, Guillen I, Rivelli D, et al. Evaluation of a simple screening test for the quality of drinking water systems. Tropical Medicine and Parasitology: Official Organ of Deutsche Tropenmedizinische Gesellschaft and of Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ). 1992;43(2):124-7.
18. Arvanitidou M, Spaia S, Velegraki A, et al. High level of recovery of fungi from water and dialysate in haemodialysis units. J Hosp Infect. 2000;45(3):225-30.
19. Baron EJ. Bailey and Scott's diagnostic mocrobiology. InBailey and Scott's diagnostic microbiology 1990:861.
20. Benson HJ. Microbiological applications; a laboratory manual in general microbiology. 2003:459.
21. Bitton G. Wastewater microbiology. John Wiley & Sons; 2005 May:118.
22. Kolhatkar A, Ochei J, McGraw T. Medical Laboratory Science: Theory and Practice. 2008.
23. Neil K. Topley and Wilson, Microbiology and Microbial Infections.
24. Banwo K. Nutrient load and pollution study of some selected stations along Ogunpa River in Ibadan, Nigeria. Afr J Microbiol. 2006; 25:7-11.
25. Kalpana S, Bagudo AI, Aliero AA. Microbiological analysis of sachet drinking water marketed at two sites in Aliero, Kebbi State, Nigeria. Cont J Microbiol. 2011;5(1):29-36.