COMPARATIVE BACTERIOLOGICAL SURVEY OF DRINKING WATER SOURCE IN AUCHI AND ENVIRON

BY

OZO ISRAEL AKHERE **AST/2382070777**

DOGOH FAVOUR **AST/ 2382071063**

BEING A PROJECT WORK PRESENTED TO THE DEPARTMENT OF BIOLOGICAL LABORATORY TECHNOLOGY, SCHOOL OF APPLIED SCIENCE AND TECHNOLOGY AUCHI POLYTECHNIC, AUCHI, EDO STATE.

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF HIGHER NATIONAL DIPLOMA (HND) IN BIOLOGICAL LABORATORY TECHNOLOGY (MICROBIOLOGY OPTION)

DECEMBER, 2022

CERTIFICATION

This is to certify that this project titled "**COMPARATIVE BACTERIOLOGICAL SURVEY OF DRINKING WATER SOURCE IN AUCHI AND ENVIRON**" is a work carried out by;

OZO ISRAEL AKHERE	**AST/2382070777**
DOGOH FAVOUR	**AST/ 2382071063**

in the department of Biological Science Laboratory Technology (Microbiology Option), Auchi Polytechnic, Auchi. Having completed my course work, it is accepted in partial fulfillment for the Higher National Diploma (HND) in Microbiology.

____________________________ __________________

MR. REMISON A. **DATE**
PROJECT SUPERVISOR

____________________________ __________________

MR. OHIMAI A. **DATE**
(HEAD OF DEPARTMENT)

DEDICATION

With all sincerity of heart, we dedicate this project work to God Almighty, the giver of life, strength, knowledge, wisdom, understanding and ever loving kindness throughout our stay in school.

ACKNOWLEDGEMENT

All thanks to God Almighty for giving us the grace, wisdom and understanding to complete this project work.

Our special thanks go to our project supervisor Mr. Remison A. for making this project work a successful one, may God bless you Sir.

We sincerely acknowledge our HOD Mr. Anthony Ohimai and to all our lecturers in Biological Science Laboratory Technology for the knowledge they have impacted on us.

Our special appreciation goes to our parents for their prayer and financial support throughout our academic pursuit, may God in His infinite Mercy bless you and keep you save (Amen).

We also want to appreciate our wonderful siblings, family members, course mates and well wishers for their prayers and words of advice throughout our years in school.

ABSTRACT

The project work is all about comparative bacteriology survey of drinking water source in Auchi and environ. Good quality water is odourless, colourless, tasteless, and free from faecal pollution. A reliable supply of clean wholesome water is highly essential in a bid of promoting healthy living among the inhabitants of a defined geographical region. Safe and potable water supplies in urban centre in Nigeria are still inadequate inspite of four decades of independence and several efforts from various governments. From the analysis the total bacteria count of the water sources showed variation from the two samples (table 1) the result shows that Rain, River and Borehole water has high quality in terms of contamination with *coliform*. The isolation of *coliform* from the water sources is of *feacal* contamination which also indicates poor sanitary condition of the water source. The analysis showed that rain, river and borehole water in (independence layout locality) Auchi metropolis has been found to be unsafe for consumption and for industrial uses, because of the large number of bacteria that grew on agar plate incubated for 24 hours. It is recommended that personal hygiene should be adopted by everyone using natural water , that is water obtained from any of the natural sources should be boiled or treated before consumption and water purification method that provides safe drinking water should be made available by government in order to avoid out break caused by pathogenic organisms found in water.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Water is an essential element for the survival of all living organisms. In humans, it is shown to make up about 70% of the body mass (Eldon and Bradley, 2018). Many infectious diseases in developing countries are associated with contaminated water (Tar, 2019). Thus good drinking water is a luxury but one of the most essential requirements of life (Ajewole, 2015). Studies have shown that over one billion people in the world lack access to safe drinking water and 2.5 billion people do not have access to adequate sanitation services (Tar, 2019). In many developing countries including Nigeria, clean pipe borne water availability is limited and inadequate for the teeming population. Thus, an increasing number of people in semi-urban areas in the country depend on dug wells and water vendors for water supply (Idowu *et al.*, 2018).

Due to the inability of government to meet the ever increasing water demand, people resort to ground water sources such as shallow wells and boreholes as alternative water resources (LAWMA, 2020). Natural groundwater is usually of good quality but this can deteriorate due to inadequate source of protection and poor resource management. Pollution of ground water stems from different sources that include insanitary condition during borehole construction, splashing of runoff into wells, if left uncovered, flooding at borehole site, leachate from old burned waste pit or latrine into the hole through cracks in aquifer and annular of the hole (Essien and Bassey, 2019). Other sources of contamination include closeness of borehole to septic tanks especially where space is a constraint and boreholes are drilled around the area (Essien and Bassey, 2019). Majority of the human population in semi-urban and urban areas in Nigeria are heavily reliant on wellwater as the main source of water supply for drinkingand domestic use due to inadequate provision of potable pipe borne water. These ground water sources can easily be contaminated by faecal matter and thus increase the incidence and outbreaks of preventable water-borne diseases (Alonge *et al.*,2018).

Packaged water is any potable water that is manufactured or processed for sale which is sealed into food-grade bottles, sachet or other containers and intended for human consumption (Warburton, 2020). Sale of packaged water has exploded all over the world in recent years, largely as a result of public perception that it is safe, taste better and has a better quality compared to raw tap water (De-FrançaDoria *et al.*, 2019; Fisher *et al.*, 2015).

Packaged water has been implicated as a source of outbreak of cholera and typhoid fever as well as traveller's disease in countries such as Portugal and Spain (Blake *et al.*,2016; Bordalo and Machado, 2014). Several studies have shown that packaged water can be contaminated with bacteria at various stages of production (Semerjian, 2018). Under improper or prolonged storage of bottled water, bacteria can grow to levels that may be harmful to human health (Warburton, 2020). Accurate and timely information on the quality of water is necessary to shape a sound public policy and to implement the water quality improvement programme efficiently. One of the most effective ways to communicate information on water quality trends is with indices. The water quality index (WQI) is commonly used for the detection and evaluation of water pollution and may be defined as 'a rating reflecting the composite influence of different quality parameters on the overall quality of water' (Mishra, 2015). The indices are broadly characterized into two parts: the physicochemical and biological (bacteriological) indices.

Physicochemical indices are based on the values of various physicochemical qualities in a water sample. These are vital for water quality monitoring(APHA, 2015). A number of scientific procedures and tools have been developed to assess the water contaminants (Dissmeyer, 2020). These procedures include the analyses of different parameters such as pH, turbidity, temperature, dissolved oxygen, alkalinity amongst others. These parameters can affect the drinking water quality if their values are in higher concentrations than the safe limits set by the World Health Organization (WHO) and other regulatory bodies (WHO, 2018). Bacterial contamination of drinking water is a major public health problem worldwide; because this water can be an important vehicle of diarrheal diseases, thus the need to evaluate the bacterial quality (Suthar *et al.*, 2019).

Monitoring the bacterial quality of drinking water is done through laboratory testing for the coliform groups. The total coliform refers to a large assemblage of gram-negative, rod shaped bacteria that share several characteristics. These include *E. coli, Klebsiella, Enterobacter, Streptococcus, Staphyloccocus spp.* etc. 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. Thus studies have been conducted to ascertain these parameters in varying drinking water sources, well water (Ezeribe *et al.*,2019) borehole water (Ibe and Okplenye, 2015), lake (Okorondu and Anyadoh-Nwadike, 2015), packaged water (Ugochukwu, 2015) and stream/river water (Joshi *et al.*,2019). It is on these bases that this research was carried out on Comparative bacteriological survey of drinking water source in Auchi and environ.

1.2 Statement of the Problem

Water is being increasingly used and drinking water yet, testing to see whether the water is of good quality is almost nonexistent. Although, it is true that soils generally function to reduce the effect of micro organisms by a simple filtration mechanism especially larger bacterial and protozoa, pollution of borehole water by micro organisms especially is located near septic tanks.

1.3 Scope of the study

The studied area is Auchi, which is the second-largest city in Edo state Nigeria, after Benin city. Auchi is the headquarter of Etsako west local government Area of Edo state.

1.4 Significance of the study

This study will enable us to know

- The standard requirement for water quality.
- the microorganisms present in contaminated Borehole water.
- different ways in which borehole water can be contaminated.
- ways in which borehole waters can be prevented from contamination

1.5 Limitations of the Study

- **Lack of Electricity**: Due to constant interruption of power supply, the project practical work was delayed, and it became stressful and boring.
- **Inadequate Equipment and Apparatus:** Some of the equipment and materials used were not enough for the project practical's.
- **Lack of Laboratory Space**: Due to the fact that the laboratory is not spacious enough, and almost all students were carrying out one project practical or another, I had little or no space to carry out my practical work.
- **Inadequate Finance:** Due to economic situation at present, there were no enough funds to purchase some of the materials used for the practical work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Water Analysis

Microorganisms are natural components of streams, lakes, rivers and underground waters. These organisms have enormous impact on the process that occur in aquatic ecosystem such as carbon, nitrogen, and sulphur transformation. They can also have an impact on the quality of water by controlling the amount of oxygen and other elements in the and by causing diseases in aquatic organisms as well as humans. Microorganisms from other sources also are introduced into the aquatic environment as a result of pollution. The sources of water supply are usually water from any of these sources is treated to make it suitable for drinking. The aim of microbiological examination of water is to determine the sanitary quality and its suitability for general use. The sanitary quality of water is the relative extent of the absence of suspended matter, colour, taste, and unwanted dissolved chemical, bacteria indicative of faecal presence and other asthetically offensive objects or properties (Pipes, 2020). The major concern about the water quality is pollution by faecal materials and toxic chemical is called potable water. Potable water is unsafe for consumption. When fecal materials contaminate source of water supplies, they may contain pathogenic organisms which may cause epidemic outbreaks of cholera, typoid fever, bacillary dysentery, hepatitis or other diseases. Water borne pathogens are causative agents for many human diseases and their presence poses a potential threat to the human population. It is well known that water resources are subjected to frequent dramatic changes in microbial and chemical qualities as a result of the variety of activities on the watershed. For rural populations, the provison of reliable and clean water supplies is an important element in the quality of life. The microbial quality of drinking water is a cause of concern worldwide. A large percentage of ill health in less developed countries stems from lack of safe water adequate sanitation (Pipes, 2020). Water analysis is therefore a standard routine procedure carried out by the sanitary microbiologists of the municipal water purification plant. The purpose of analysis of municipal water is to determine the raw water quality, the need for purification and possible changes during distribution (Pipes, 2020).

Microorganisms are natural components of lakes, rivers, underground waters and streams. These organisms are numerous and perform various functions in the aquatic systems. However, their presence in drinking water poses great risk to man and animals. Water sources could be perfectly clean in appearance, free from characteristics of odor and taste and yet is contaminated. It is well known and proven fact that water contaminated with sewage and other pollutants could cause disease. The degree of pollution and natural purification of water bodies can measure physically, chemically and biologically and no single yardstick is enough depending on the nature of the polluting substances and the uses the receiving body of water is to serve. Water is only safe for drinking (i.e potable) if it is free from disease producing microorganisms and chemical substances harmful to health. Microbiological examination of water is therefore a very useful and significant method of biological assessment of new or intermittent water pollution (Willey *et al.*, 2018).

2.2 Microorganisms as Indicators of water quality

Indicator organisms are used as a proxy to monitor conditions in a particular environment, ecosystem, area, habitat, or consumer product. Certain bacteria, fungi and helminth eggs are being used for various purposes.

2.3 Types Indicator bacteria

Certain bacteria can be used as indicator organisms in particular situations. The presence of bacteria commonly found in human feces, termed coliform bacteria (e.g. E. coli), in surface water is a common indicator of faecal contamination. For this reason, sanitation programs often test water for the presence of these organisms to ensure that drinking water systems are not contaminated with feces. This testing can be done using several methods which generally involve taking samples of water, or passing large amounts of water through a filter to sample bacteria, then testing to see if bacteria from that water grow on selective media such as MacConkey agar. Alternatively, the sample can be tested to see if it utilizes various nutrients in ways characteristic of coliform bacteria (Pipes, 2020). Coliform bacteria selected as indicators of faecal contamination must not persist in the environment for long periods of time following efflux from the intestine, and their presence must be closely correlated with contamination by other faecal organisms. Indicator organisms need not be pathogenic. Non-coliform bacteria, such as Streptococcus bovis and certain clostridia may also be used as an index of faecal contamination.

Indicator fungi

Penicillium species, *Aspergillusniger* and Candida albicans are used in the pharmaceutical industry for microbial limit testing, bioburden assessment, method validation, antimicrobial challenge tests, and quality control testing. When used in this capacity, Penicillium and A. niger are compendial mold indicator organisms (Ashbolt *et al.*, 2016). Molds such as *Trichoderma*, *Exophiala*, *Stachybotrys*, *Aspergillusfumigatus*, *Aspergillusversicolor*, *Phialophora*, *Fusarium*, *Ulocladium* and certain yeasts are used as indicators of indoor air quality.

Indicator helminth eggs

Identification and quantification of helminth eggs at UNAM University in Mexico City, Mexico. Helminth eggs (or ova) are a good indicator organism to assess the safety of sanitation and wastewater reuse systems for resource recovery because they are the most environmentally resistant pathogens of all pathogens (viruses, bacteria, protozoa and helminths) and the isolation and identification of pathogens in water is not the basis to determine the portability of water especially as regards its microbiological quality (Ashbolt *et al.,* 2016). This is because

- Pathogens may be present in very small numbers and are likely to escape detection by laboratory procedures
- Pathogens are likely to enter water supply sporadically and may not survive for a long period of time
- It takes 24 hours or longer to obtain results from a routine laboratory examination for pathogenic microorganisms.

If routine examination targets pathogenic organisms only, by the time the pathogens are isolated; many people would have consumed the water and would be exposed to those pathogenic microbes before any meaningful action could be taken to correct the situation. In practice therefore, Microbiologists use water testing procedures that do not depend on the isolation and identification of pathogenic organisms. Rather, tests are usually based on the findings of microorganisms whose presence indicate or show the possibility of the presence of pathogenic microorganisms. These kinds or organisms are referred to as indicator microorganisms (Ashbolt *et al.,* 2016).

2.4 Characteristics of Indicator Organisms

Indicator microorganisms have some important characteristics which make them suitable for the purpose. These characteristics include:

1. It is present in water and absent from unpolluted water
2. Indicator organisms are present in water when pathogens are present
3. The quantity of indicator organisms correlates with the amount of pollution

4. It survives better and longer than the pathogens
5. It is generally harmful to humans and other animals
6. It has uniform and stable properties
7. It can be easily detected by simple standard laboratory procedures

The organism that carry satisfies the requirement of an ideal indicator of fecal water pollution is Escherichia coli and is the organism that is mostly used. However, other bacteria that can also be used as pollution indicators include Streptococcus faecalis and Clostridium perfringes are normal inhabitants of the large intestine of humans and other animals. It has also been suggested waste into water can be used as indicators of pollution. Viruses that can be used include the coliform bacteriophages and reoviruses (Norwalk virus).

Escherichia coli and other coliform bacteria

The coliform bacteria are gram negative nonsporing, facultatively anaerobic bacillus which can ferment lactose within 48 hours with the formation of acid and gas at 35OC. examples of coliform include Escherichia coli, Klebsiella, Enterobacter, Hafnia, Serrati and Citrobacter. Water bacteriologist usually consider any member of the Enterobacteriaciae which grows at 37OC and normally possesses the enzymes β-galactosidases as coliform (Chantran and Heartha, 2017).

Escherichia coli are a normal inhabitant of the human intestinal tract and other warm blooded animals and thus is regarded as a feacal type of coliform. Some members of the coliform group, for example Enterobacteraerogenes are widely distributed in nature and found in soil, water, grains and also the intestinal tract of human and other animals and other animals and are regarded as the non faecal coliform (Chandran and Heartha, 2017).

2.5 Water Pollution

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

Water pollution affects the entire biosphere – plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and population, but also to the natural biological communities.

Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that water pollution is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. An estimated 580 people in India die of water pollution related illness every day. About 90 percent of the water in the cities of China is polluted. As of 2007, half a billion Chinese had no access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries also continue to struggle with pollution problems. For example, in the most recent national report on water quality in the United States, 44 percent of assessed stream miles, 64 percent of assessed lake acres, and 30 percent of assessed bays and estuarine square miles were classified as polluted. The head of China's national development agency said in 2007 that one quarter the length of China's seven main rivers were so poisoned the water harmed the skin (Wachman and Richard, 2007).

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water, or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water.

Point sources

Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes (USGS, et al., 2020). The CWA definition of point source was amended in 1987 to include municipal storm sewer systems, as well as industrial storm water, such as from construction sites.

Non-point sources

Nonpoint source pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. A common example is the leaching out of nitrogen compounds from fertilized agricultural lands. Nutrient runoff in storm water from "sheet flow" over an agricultural field or a forest are also cited as examples of NPS pollution.

Blue drain and yellow fish symbol used by the UK Environment Agency to raise awareness of the ecological impacts of contaminating surface drainage

Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, because this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, it becomes a point source.

Groundwater pollution

Interactions between groundwater and surface water are complex. Consequently, groundwater pollution, also referred to as groundwater contamination, is not as easily classified as surface water pollution (USGS *et al.*, 2020). By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. non-point source may be irrelevant. A spill or ongoing release of chemical or radionuclide contaminants into soil (located away from a surface water body) may not create point or non-point source pollution but can contaminate the aquifer below, creating a toxic plume. The movement of the plume, called a plume front, may be analyzed through a hydrological transport model or groundwater model. Analysis of groundwater contamination may focus on soil characteristics and site geology, hydrogeology, hydrology, and the nature of the contaminants.

Causes

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical changes such as elevated temperature and discoloration. While many of the chemicals and substances that are regulated may be naturally occurring (calcium, sodium, iron, manganese, etc.) the concentration is often the key in determining what is a natural component of water and what is a contaminant. High concentrations of naturally occurring substances can have negative impacts on aquatic flora and fauna.

Water Pollutants

Major water pollutants are as follows:

- **Sewage –** Sewage pollutants include domestic and hospital wastes, animal and human excreta etc. The sewage let off cause's oxygen depletion, spread of diseases/epidemics. **Metals –** Metals like mercury are let off into water bodies from industries. Heavy metals like mercury cause poisoning and affect health causing numbness of tongue, lips, limbs, deafness, blurred vision and mental disorders.

- **Lead –** Industrial wastes also lead to lead pollution. If lead enters the human body system in higher quantities it affects RBCs, bone, brain, liver, kidney and the nervous system. Severe lead poisoning can also lead to coma and death.
- **Cadmium –** Source for cadmium pollution is industries, fertilizers. Cadmium gets deposited in visceral organs like liver, pancreas, kidney, intestinal mucosa etc. Cadmium poisoning causes vomiting, headache, bronchial pneumonia, kidney necrosis, etc.
- **Arsenic –** Fertilizers are source for arsenic pollution. Arsenic poisoning causes renal failure and death. It also causes liver and kidney disorders, nervous disorders and muscular atrophy, etc.
- **Agrochemicals like DDT –** It is a pesticide. Accumulation of these pesticides in bodies of fishes, birds, mammals and man affects nervous system, fertility and causes thinning of egg shells in birds.
- **Bacteria, Viruses and Parasites –** These are sourced from human and animal excreta, they are infectious agents.
- **Plastics, Detergents, Oil and Gasoline –** They are a waste from industries, household and farms. They trigger organic pollution and is harmful to health.
- **Inorganic Chemicals –** Inorganic chemicals like acids, salts, metals are a result of industrial effluents, household cleansers, and surface run-off and are injurious to health.
- **Radioactive Materials –** Mining and ores processing, power plants, weapons production and natural give rise to radioactive pollution like that of uranium, thorium, cesium, iodine and radon. Radioactive pollution causes serious health diseases to all organisms.
- **Sediments –** Sedimentation of soil, silt due to land erosion and deposition causes disruption in ecosystem.

- **Plant Nutrients –** Nutrients like nitrates, phosphates, and ammonium are let off from agricultural and urban fertilizers, sewage and manure. Excess of nutrients cause eutrophication and affect the ecosystem.
- **Animal Manure and Plant Residues –** These substances in water causes increased algal blooms and microorganism population. This increases oxygen demand of water, affecting aquatic ecosystem. This is introduced into water due to sewage, agricultural run-off, paper mills, food processing etc.
- **Thermal Pollution –** Temperature changes of water caused due to using water as cooling agent in power plants and industries causes increase in water temperature affecting the aquatic life.

Causes of Water Pollution

The contaminants that lead to water pollution include a wide variety of substance like chemicals, pathogens, temperature changes and discoloration.

- Industrial activity causes huge water pollution. Wastes from factories are let off into freshwater to carry waste from plants into rivers. This contaminates water with pollutants like lead, mercury, asbestos and petrochemicals.
- Sewage let off from domestic households, factories, commercial buildings are untreated in water treatment plants yet are disposed into the sea. Sewage containing flush chemicals and pharmaceuticals causes greater problems.
- Solid waste dumping and littering of cardboard, plastics, glass, styrofoam, aluminium tins, etc., in water bodies.
- Oil spills from tankers and ship travel causes oil pollution. Oil does not dissolve in water and forms a thick layer on the water surface.

- Burning of fossil fuels and emissions from industries and motor vehicles causes formation of acidic particles in the atmosphere. These particles fuse with water vapor resulting in acid rain. Acid rain harms aquatic life.
- Increase in water temperature is a result of global warming and thermal plants use water as cooling agents for mechanical equipment's.

Other causes of water pollution:

Detergents, by-productions of disinfection, food processing waste, insecticides, petrochemicals, debris from logging operations, volatile organic compounds, personal hygiene and cosmetic products, drug pollution, chemical wastes, fertilizers, heavy metals, and sedimentation are other causes of water pollution.

Effects of Water Pollution

Water pollution extensively affects health in humans and aquatic ecosystems.

- Groundwater contamination causes reproductive and fertility disorders in wildlife ecosystems.
- Sewage, fertilizer and agricultural run-off has nutrients, organic substances which lead to increase of algal bloom causing oxygen depletion. The lower oxygen levels affect the natural ecological balance of rivers and lake ecosystem.
- Consumption and swimming in contaminated water causes skin diseases, cancer, reproductive problems, stomach ailments in humans.
- Industrial effluents and agricultural pesticides accumulate in aquatic environments causing harm to aquatic animals and lead to biomagnifications. Heavy metals like mercury, lead are poisonous to small children and women. These chemicals interfere in the development of nervous system in fetuses and young children.

- Rising water temperatures destroy aquatic ecosystem. Coral reefs are bleached due to warmer temperatures. Warmer waters forces indigenous water species to seek cooler water causing ecological shift of the affected area.
- Littering by humans like plastic bags, clog and suffocate aquatic animals.
- Water pollution causes soil erosion in streams, rivers and flooding due to accumulation.

Water treatment

Water supplies are usually obtained from surface waters (rivers, lakes and streams) and aquiters (underground layers of water being rocking) and sub-surface water called groundwater. Usually surface waters are more polluted than underground water sources. Water for public supply must be treated to eliminate pathogens and eliminate or decrease to safe levels any harmful substances which may be present. Water supplies such as deep wells that are relatively clean and free of contaminating require less treatment than those from surfaces laden with wastes (Dada *et al.*, 2020).

Ground water treatment

Water obtained from bore holes and springs is generally of good quality and may need little more than aeration, rapid sand filtration and disinfection. However, if the water contains nitrates there is need to either store the water for extended periods to permit denitrification or nitrate removal can be achieved by ion-exchanged processes (Chauvin, 2020).

Treatment of surface waters

Cities and municipals that source their raw water from streams, lakes and rivers needs to treat the water in order to eliminate pathogenic microorganisms as well as harmful chemicals. In many cities, there are public water works which treat and distribute water in the towns.

The treatment of water for distribution usually involves the following processes aeration, coagulation or flocculation, sedimentation, filtration and disinfection/chlorination (Chauvin, 2020).

The first step in the treatment of water from surface water sources is the impoundment of the water in large reservoir such as dams or catchment basins where the water is allowed to stand long enough for the particulate matter to settle. These reservoirs are also referred to as sedimentation basins. The particles that settle out include sand and gravel. Sedimentation basins are mainly used when the water supply is highly turbid. A major problem of sedimentation is that growth of algae is encouraged and this can produce odours and flavours (Chauvin, 2020). However this is usually controlled by pretreatment with copper sulphite (0.3ppm). Bacterial growth may also occur at the bottom process. Due to the aeration/oxygenation the biodeterioration of some synthesic detergents abd herbicides may occur.

Coagulation or flocculation

Many water works do not have storage reservoirs as discussed above. Both in water works that have reservoirs and those that don't, the removal of humid substances (e.g. reduced iron and manganese and complex soluble organic compounds of natural origin) is necessary as their presence in water imparting a brown colour. Flocculation is employed for the clarification of water and involved the addition of small quantity of coagulant (5 to 70mg/l) of alum, or aluminum potassium phosphate. Alum cause materials still suspended in the water to coagulate, forming aggregates that strongly sink to the bottom. The clumps remove unwanted materials from the water including some bacteria and viruses as the settle out. To remove the flocs (clarification), the water is passed upwards through a floc blanket clarifier (a tank within which the flocs form a sludge blanket) below a layer of clarified water (Dada *et al.*,2020)

Filteration

After the coagulation, the clarified water is filtered to removethe remaining suspended particles and microorganisms. Basically two types of filters are used namely rapid sand filters and slow sand filters.

- **Rapid sand filter:** the rapid sand filter is suitable in filtering water containing only fine particles and dissolves substances. The rapid sand filters consists a bed of sand (grain size-1mm) which acts essentially as a mechanical sieve. Rapid sand filters are used in large water works and filters the water at a very fast rate. While using the rapid sand filters when the filterations rate falls, air is blown upwards through the sand to dislodge the particulates and this followed by water (back-washing) to remove the solids.
- **Slow sand filters:** slow sand filters contains finer sand and the upper layer supports a biofilm of microorganisms (bacteria and algae which serve as biofilter) the slow sand filters acts as a mechanical sieve as well as effecting biological purification by mineralizing some of the dissolved organic matter and removal of some nitrogen and phosphorus. Slow sand filters can eliminate certain taste and odour causing substances and can reduce the levels of any cyanobacterial toxins which may be present (Dada, *et al.*, 1990).

Disinfection/chlorination

This involves the treatment of water with chlorine or other disinfectants to kill harmful bacteria, protozoa and viruses that may remain. Chlorination is done by bubbling chlorine gas through the tank until it reaches a concentration of 1-2ppm. Chlorine reacts with organic materials and therefore reduces or eliminates them (Dada *et al.*,2020)

CHAPTER THREE

MATERIALS AND METHOD

3.1 Sample Collection

Water samples were collected from three different sources, comprising of Rain water, River water and Borehole water in Auchi, labeled A , B and C. Sterile universal sampling bottles were used to collect the samples. The samples were there after brought to the laboratory of Auchi polytechnic Auchi for analysis and survey.

3.2 Materials

Testtubes, Test tube racks, Aluminum foil paper, conical flasks, Cotton wool, Beakers, Syringes (10ml/1ml), Masking tape, Water samples, Distilled water, Autoclave, Incubator, Weighing Scale, Slide, wireloop.

3.3 Reagents

Hydrogen perioxide, Eosin Methylene blue (EMB), Nutrient Agar (NA), Crystal violet, lugos iodine, Acetone, Satranin and Immersion oil.

3.4 Sterilization of Materials

All glass wares were first washed with detergent and rinsed with distilled water, wrapped with aluminum foil paper after sterilization with the use of an autoclare at 121^0c for 15 minutes.

3.4.1 Procedures/Methods

i). E M B Agar of 28g was measured using a weighing balance and diluted in 100ml of distilled water in a conical flask and was placed in an autoclave for about 15minutes.

ii). Test tube racks were labeled A, B and C and twelve (12) testubes were placed on each rack respectively.

iii). The Syringe was used to measure 9ml of distilled water and was poured into each tubes a total of six in each rack labeled A, B and C and the lid was covered using aluminium foil paper to avoid contaminator.

iv). Each testubes on each rack was labelled as sample A (Rain water) 10^{-1} to 10^{-6} and sample C (Borehole water) 10^{-1} to 10^{-6} respectively from the original sample, 0.1ml of sample A was added to the test tube 10^{-1}, then 0.ml was taken from 10^{-1} and added to 10^{-2} respectively till the last test tube 10^{-6}, same was done for sample B and C respectively.

v). From 10^{-6} dilution, 0.1ml was taken from each test tubes labeled A , B and C using a syringe and dropped into a petri dish labeled EMB10^{-6} A, EMB10^{-6} B, EMB 10^{-6} C and NA 10^{-6} A, NA 10^{-6} B and NA 10^{-6} C.

vi). The EMB Agar was then added to the labelled EMB sample 10^{-6} A , B and C in little quantities.

NOTE: During the addition of the EMB into the three different petri dishes of various samples, the tip of the conical flask was heated to avoid contamination and allowed to cool before adding it to the petri dish.

vii The NA was also allowed to cool and then added into different petri dishes labelled NA sample A 10^{-6}, NA sample B 10^{-6}, and NA sample C 10^{-6}.

NOTE: After the addition of the EMB Agar and Nutrient Agar into the Petri dishes, it was allowed to gel for 10 minutes to avoid leakage.

viii The petridishes were then taped together and turned upside down and placed in the incubator for 24 hours.

3.5 GRAM STAINING AND PREPARATION OF SMEAR

3.5.1 Smear Preparations

i. A clean slide was first obtained and labeled and a drop of cell was taken from petri dish A , B and C using wire loop and placed in the middle of the slide. During the transfer, the wire loop was heated in bunsen flame to avoid contamination .
ii. Wire loop was used to spread out the smear.
iii. The smear was allowed to air dry and observe for a thin white film.

3.5.2 Gram Staining Procedures

After the smear was prepared and air-dried, it was flooded with crystal violet for 5 minutes. Then excess stain was poured off and gently washed off with tap water. After which the smear was flooded with lugos iodine (mordant) for one minute and rinsed gently with tap water.

- Acetone was poured on the slide (decolorized) for five seconds and rinsed with tap water.
- The smear was stain with safranin to counter stain for one minute and flooded with water.
- Counter stain for one minutes and flood with water
- The slide was blot dried and viewed under oil immersion microscope.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Result

The result of the comparative bacteriological survey of Drinking water source in Auchi.

Table 1: total variable plate count of bacteria from rain water, river water and borehole water.

Samples	Dilution factors	Table plate count (cfu/mg).
Sample A rain water	10^6	$3.6x10^4$
Sample B river water	10^6	2.7×10^4
Sample C Borehole Water	10^6	2.1×10^4

Table 2: Cultural, morphological and Environmental characteristics of bacteria isolated from 3 water source in Auchi and environment.

Isolate	Source &samples	Cultural characteristic	Morphological arrangement	Biochemical test				Suspected Organism
				Gram stain	Catalase test	Coag test	Indo test	
A[1]	Rain water	Greyish white on nutrient Agar	*Cocci* arranged in cluster form rodlike	+	+	-	-	*Staphylococus aureus*
B[2]	River Water	Deep purple colony on EMB.	*Cocci* arranged in chains and slim thin rod in appearance	+	+	-	-	*Staphylococus*
C[1]	Borehole water	Greyish white colouration on nutrient Agar	*Baccilus* arrangement in chain form. Rod-like and single	-	+	-	-	*Escherichia Coli*

4.2 Discussion

The analysis examination carried out on the water sources that serves as public water supply were intended to assist in the determination of the quality of drinking water in independence layout of Auchi (World Health Organization (WHO) 1985) have stipulated standards for water meant for human consumption and the result of the present investigation did not meet the standards.

The total bacteria count of the water sources showed variation from the two samples (table 1) the result shows that Rain, River and Borehole water has high quality in terms of contamination with coliform. The isolation of coliform from the water sources is of feacal contamination which also indicates poor sanitary condition of the water source.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Rain, river and borehole water in (independence layout locality) Auchi metropolis has been found to be unsafe for consumption and for industrial uses, because of the large number of bacteria that grew on agar plate incubated for 24 hours.

5.2 Recommendation

Judging from the result obtained, I would like to recommend the following:

Personal hygiene should be adopted by everyone using natural water , that is water obtained from any of the natural sources should be boiled or treated before consumption.

Water purification method that provides safe drinking water should be made available by government in order to avoid out break caused by pathogenic organisms found in water. The government should make more sacrifices to provide adequate treatment facilities that purifies sewage prior to discharge or disposal, so as to save our drinking water from continuous pollution.

REFERENCES

Ajewole, I. (2015). An overview, Water and Food Forum. *A publication of the Nigerian Institute of Food Science Technology*, (5), 1-15

Alonge, U., Udo, P. and Ajewole, I. (2018). Water an overview, food forum, A publication of the Nigeria institute of food science and technology, *Journal of American Dietary Association*, 4(1):15

Apha, G. (2015). Drinking water in developing countries. *Annual review of energy and environment*. 23:253-286.

Ashbolt, N.J., Ben, P. and Gil, U. (2016). Microbial contamination of drinking water and disease outcome in developing region toxicology 198:229-238.

Blake, R.E., Gibbons, N.E., Cowan, S.T., Holt T.G. and Liston, J. (2016). Bergeys Manual Of determinative Bacteriology: Williams and Wilkinns co., Baltimore, pp. 1246.

Bordalo, A. and Machado, Y.A. (2014). *An integrated water resource management approaches to mitigating water quality andquantity degradation, in xalapa, Mexico.* Master of Applied Science in the Faculty of Civil Engineering. University of British, 1-110

Chantran, K.K. and Heartha, C. (2017). Evaluation of Colilert. *Niger Journal of Microbiology*, 15 (1): 18-26.

Chauvin, E. (2020). Assessment of the quality of bottled/sachet water in the Tarkwa-Nsuaemmunicipality (TM) of Ghana. *Research Journal of Applied Sciences, Engineering*, 3(5): 377-385.

Dada, A.C. Alonge, S., Umoru, U. (2020).Sachet water phenomenon in Nigeria: Assessment of the potential health impact. *Applied Microbiology recourse*. 3:15-21.

De-Franca, D., Ngmekpele, Q. and Ephraim, J. (2019) Sachet Water Quality in Obuasi, Ashanti Region,Ghana, *Journal of Biology, Agriculture and Healthcare*, 5(4): 37-42.

Dissmeyer, S.M. (2020). Water: an essential but over looked nutrient. *Journal of the American Dietetic Association*, 1(5) :200-206.

Eldon, G. and Bradley N. (2018) Evaluation of maximum contaminant levels in Turkish bottled drinking waters utilizing parameters reported on manufacturer's labeling and government-issued production licenses. *Journal of Food Composition and Analysis* 20, 262–272.

Ezeribe, M.O., Omemu, A.M., and Fapetu O.M. (2019). Microbiology and physico-chemical analysis of different source bof drinking water in Abeokuta, Nigeria. Niger, *Journal of Microbiology* 15(1): 57-61

Fisher, V., Hutin, Y.L. and Paquest, C.A. (2015). Large cholera outbreak in Kano city, Nigeria, importance of handwashing with soap and the danger of street vendor water. *Journal of Water Health.* 1:45-52.

Ibe, M.J., Oluojo M.J., and Golden, D.A. (2015). Modern food micro biology. New York:*springer science business media Inc*.

Idowu, B., Olaoye, O.A., and Onilude, A.A. (2018). Assessment of micro biological quality of sachet packaged water in western Nigeria and its public significance. *Elsevier. Public health.* 123:729-734

Lagos State Waste Management Authority, (2020). Microbiology and physio chemical. analysis of different water sample use for domestic purpose in Abeokuta and Ojota , Lagos state Nigeria . *African Journal Biotechnology*. 7(3): 617-621.

Mishra, J.A. (2015). Problem on water quality standards and monitoring in Nigeria.*28thWEDC International conference*.139-141.

Okorondu, G. and Anyadoh-Nwadike, A.O. (2015). Microbiological analysis of some vended sachet water in Ogbomoso, Nigeria. *African Journal Food Science.*; 3(12): 406-412.

Pipes, S.T. (2018). Food safety knowledge end practices of street food vendors in the city of Abeokuta, Nigeria. *Food Control*. 19:396-402.

Semerjian, V. (2018). Contamination of sachet water in Nigeria: Assessment and health impact, *Online Journal health and Applied Science*, 9(4):15.

Suthar, A. (2019). The microbiological quality of drinking water sold on the streets in Kummasi, Ghana, *Journal of Applied Microbiology*. 37:334-339.

Tar, P.P. (2019). Contaminants in drinking water. *Research report Punjab Agricultural University, tribune publications*. Friday July 15 2019.

Ugochukwu, O. (2015) Mineral content of 70 bottled water brands sold on the Turkish market: Assessment of their compliance with current regulations, *Journal of Food Composition and Analysis* 22 (2018)728–737.

USGS, L.R., Keller, R. and Gromes, T.A (2020). Typical and atypical enteropathogenic Escherichia coli. Emerging. *Infecioust diseases* 5:508-513.

Wachman, R.B., and Richard, L.C. (2007). An introduction 7th edition daryl fox pub. Pp. 258-260.

Warburton, U. (2020). Water distribution on earth free online encyclopedia n En.Wikipidia. org/water distribution on earth.

World Health Organization (who) (2018). Water quality guidelines, standard and health. IWA Pub. Location London U.K. Pp. 23-45.