# BACTERIOLOGY OF RETAIL SACHET WATER SOLD IN AUCHI POLYTECHNIC, CAMPUSES

**BY**


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**BEING A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF BIOLOGICAL SCIENCE LABORATORY TECHNOLOGY, SCHOOL OF APPLIED SCIENCE AND TECHNOLOGY, AUCHI POLYTECHNIC, AUCHI**

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## CERTIFICATION

This is to certify that this project titled "**BACTERIOLOGY OF RETAIL SACHET WATER SOLD IN AUCHI POLYTECHNIC, CAMPUSES**" is a work carried out by;

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## 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.

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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**

This project work examines the bacteriology of retail sachet water sold in Auchi Polytechnic Campuses. In this study, three sample sachet water used for the purpose of the analysis i.e Sample M (Myclin), A (Alex green) and D (De-basit). From the analysis of the samples, bacteria were found to be associated with sachet water, the total viable count for bacteria ranges from $1.3x10^3$ to $4.6x10^3$ (cfu/ml). Sample D had the lowest bacterial count while sample M had the highest bacterial count. The isolated bacteria includes *Staphylococcus aureus, Streptococcus* and *Bacilus species.* They produce several enterotoxins which are heat stable which makes them withstand inadequate heating. In conclusion, it is revealed from the analysis that the high level of bacteria contamination is strongly attributed to poor quality of water source, improper pipeline maintenance, lack of personal hygiene. However, the act of testing for the presence of coliform is a measure of the efficiency of the treatment process employed and the integrity of the water distribution system. This study recommends among others that Sachet water producers should adhere strictly to standard practices to ensure product of appropriate quality and also that regulation and inspection of packaged water producing facilities should be done by regulatory agencies to ensure compliance with standard practices.

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# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background of the Study

Water is one of the most essential commodities needed for the survival of all eco system (Saleh *et al.,* 2017). It is very abundant in native as it's occupies about 70% of the earth's crust. Despite its relative abundance, good quality drinking water is not readily available to man, according to Ajewole (2019) about 1.2 billion people lack access to portable water worldwide and while only about 30% of the Nigerian populace have access to clean drinking water. Access to safe drinking water is key to sustainable development, food production, poverty reduction, and quality (Adekunle *et al.,* 2017)

The non-availability of good quality drinking water has resulted into a number of health challenges as water is known to be a primary causative agent of much contagious disease. In developing countries of the world, 80% of all disease and over 30% of death are related to drinking water (Onwuluzo and Akuagbazie, 2009, Olaoye and Onilude, 2018). Research have shown that when clean water and needed hygiene condition are provided, the chances of occurrence of diarrhea, sleeping sickness and guinea worm infestation can be eliminated or prevented by 50, 80 and 100% respectively (Alhassan and Ujoh, 2012).

Nigerian Government's neglect or insufficient investment in water infrastructure development has led to unsafe epileptic public water supply (Dada, 2018). This insufficiency of water supply has given rise to the involvement of private individuals in the production of packaged drinking water (pure water) (Dada 2018). The advent of sachet water has significantly help in tackling the insecurity associated with household drinking water supply with the renewed

global commitments toward the achievements of millennium development goals (MDGs) by 2015 (Ndinwa *et al.,* 2012).

Commonly sachet water is known to be a safe and instant means of quenching public thirst. This water is now common in Nigeria Ghana and other bordering West African countries (Cheabu and Ephraim, 2020). Sachet water is usually consumed without further processing especially during the dry and hot seasons in Nigeria. in addition to the prevalence of sachet water, bottled water are also widely consumed in many parts of the world by huge number of urban places due to its pleasant taste, absence of odour and the believe that it is mostly free of germs. Bottoled water are also consumed due to water scarcity resulting from natural disaster such as earthquake, ysunami, flood, drought and hurricane or other form of societal disasters like terrorist attack, war outbreak, sabotage and blockage that are capable of obstructing public and private water supplies for extended period of time, (Guler and Alpaslan, 2018). The hygiene of the environment and conditions under which majority of brands of package water are produced and stored are faced with a number of uncertainties (Ndinwa *et al.,* 2012). Constant and periodic assessment of package drinking water is needed to satisfactory enlighten the consumer about quality (Alhassan and Ujoh, 2012; Cheabu and Ephraim, 2020). National and international organization standards have been explicitly developed for safe drinking water quality virtually all the available standards have upper limits for physical chemical and microbiological properties which when exceeded are dangerous and have the potential of been harmful to the end users.

A number of studies have been carried out the quality assessment of sachet drinking water across different Nigerian towns/cities and some part of the world. Nearly in all these studies reported across the country and some part of the world nearly in all these studies reported

across the country and some part of the word, the quality of approximately 50% drinking water available to the populace seems to be unfit for consumption, It is however not out of place of assume that similar situation can be obtainable in other Nigeria cities or towns (Musa *et al.*, 2020)

## 1.2 Purpose of Study

The purpose of this study is to find out the bacterial associated with retail sachet water in Auchi Polytechnic Campuses.

## 1.3 Scope of Study

This study investigated various commercially available sachet water at point to sale in Auchi Polytechnic Campuses.

# CHAPTER TWO

# 2.0 LITERATURE REVIEW

## 2.1 Water

Water is a transparent fluid which form the world streams lakes, oceans and rain is he major constituent of the fluid of living things. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but often co-exist on earth with it liquid state, ice and gaseous state, stream (water vapour). Water covered 71% of the earth, 96.5% of the planets water is found in seal and ocean. 1.7% in glacier and the cap of Antarctica and green land, it more factor in the other larger water bodies, and 0.001% in our as vapour cloud, and precipitation. (NDAA 2020). Only 2.5% of the earth water is fresh water and 98.8% of that water is in ice and ground water, less than 0.3% of all fresh water is in rivers, lakes and the atmosphere and an even smaller amount of the earth fresh water 0.003% is contain between biological bodies and manufacture product. (Wikipedia, 2020).

Water on earth moves continually through the water cycle, evaporation, transpiration, condensation, precipitation, and run of water usually reaching the sea (Kulshreshtha, 2017). Water played an importance role in the world economic as it function as a solvent for a whole variety of chemical substance and facilitate industrial cooling and transportation approximately 70% of fresh water used by Human goes to agriculture.

## 2.2 Physical and Chemical Properties of Water

Water is a liquid at standard temperature and pressure, it is tasteless and odorless. The intrinsic colour of water and ice is a very slight blue have, although both appear in small quantities. Water vapour is essentially invisible as a gas (Kulshreshta, 2017).

Water is transparent in the visible electromagnetic spectrum. Infrared light is strongly absorbed by the hydrogen-oxygen or OH bond Since water molecule is not linear and the oxygen atom has higher electro negativity than hydrogen atom, the oxygen atom carry a slight negative charge, where as the hydrogen atom are slightly positive, as a result, water is polar molecule with an electrical dipole moment.

All of the component in cell (Protein DNA, and polysaccharides) are dissolved in water deriving their structure and activity from there interaction with the water. Pure water has a low electrical conductivity but these increase with the dissolution of a small amount of ionic material such as sodium chloride.

The boiling point of water (and all other liquid) it's depend on the barometric pressure, At 4181.3j/ckg.k), water has a high specific heat capacity as well as a high heat evaporation (40.65 KJ.Moi$^{01}$).

The density of liquid water is 1000K/m$^3$, At 4$^o$c ice a density of 917 kg/m$^3$. Water is miscible with many liquid, such ethan01, in all proportions, forming a single homogenous liquid. On the other hand, water bad most dense oil are immiscible, usually forming layers with the lest dense liquid at the top layer, and the most dense liquid at the top layer, and the most dense liquid forming a layer at the bottom. Water can be split by electrolysis into hydrogen and oxygen.

As an oxide of hydrogen water is formed when hydrogen or oxygen containing compound burn or react with oxygen; containing compound. Water is not fuel, it is and end product of combustion of hydrogen. Element which are more electro positive than hydrogen such as lithium, sodium, calcium, potassium and calcium displace hydrogen from water forming hydroxide.

## 2.3 Uses of Water

Water is most important in agriculture for irritation.

For Drinking: The humans body contains from 55% to 7% water, depending on the body size. To function properly, the body requires between one and seven liters of water per day to avoid dehydration. The precise amount depends on the level of activity, temperature, humidity and other factors.

Water is also useful to carry out some domestic works, like washing, cooking, bathing and flushing of toilet.

## 2.4 Tap Water

Tap water is water supplied to a tap (value) inside the household or workplace, replacing the manual carrying of water from sources outside the building. It uses include drinking, washing, cooking and flushing of toilet.

## 2.5 History of Tap Water

Tap water is the essential component of "indoor plumbing", which has existed since antiquity but was available to very few people until the second half of the 19$^{th}$ century. When it began to propargate in what are now to developed countries. It became common in many regions during the 20$^{th}$ century and is now lacking only among the poor, especially in developing countries (Ashole 2017)

## 2.5 Drinking water

Drinking water or portable water is a heater safe enough to be consumed by humans or used health low risk of immediate o long term harm (Wikipedia, 2020) in most developed

countries, the heater supplied households. Commerce and industries meets drinking heater standards, even though only a very small portion is actual consumed or used in food preparation. Typical uses for other than portable purposes include toilet flushing, washing and landscape irrigation. The word portable came into English from the Latin word portabilis meaning drinking.

## 2.6 WHO Regulation of Drinking Water

According to these standards, portable water for human consumption must be free of microbial indicators of feacal contamination and coliform count per 100ml of drinking heater must be zero (WHO, 2020)

Members of the *feacal coliform* group especially *E. coli* are used as indicators of possible sewage contamination because they are commonly found in human and animals feaces. Other microbial indicators of possible feacal contamination are *Feacal enterococci* especially *E. feacalis* and clostridium perpringens spores. Microbial contamination by human or animal excreta is the most common reason for heater to be considered unsafe for drinking because of the high probability of presence of pathogenic organisms. coliform bacteria describe a group of enteric bacteria that include *E. coil, Klebsiella* species and *Enterobacter species* (Choa *et al.,* 2017)

## *2.7 Coliform* Bacteria

*Coliform* is a family of bacterial common in soils, plants and animals. *The coliform* family is made up of several group one of which is the *feacal coliform* group, which is found in the intestinal tract of worm-blooded animals including humans. the presence of fecal coli in drinking heater or at swimming sites is evidence that humans or animals waste has been or is

present. This may be cause for loncor because many diseases can be spread through faecal transmission. While colitonm themselves are not normally causes of serious illness, they are easy to culture and their presence is used to indicate that other pathogenic organisms of facal origin may indicate that other pathogenic organisms of facal origin may be present such pathogenic include bacteria, illness, or protozoa and many multi cellular parasites.

## 2.8 Waterborne Disease

Waterborne Disease are caused by pathogen microorganisms that most commonly are transmitted in fresh water. Infections commonly result during bathing, washing, drinking. In the preparation of food, or the consumption of food thus infected. Various form of waterborne disease abound in developing countries, according to the World Health Organization, such disease account for an estimated 4.1% of the total global burden of disease and cause about 1.8 million human deaths annually. The World health Organization estimates that 88% of the burden is attributable to unsafe water supply, sanitation end hygiene (WHO 2020).

## 2.9 Water Pollution

Water pollution is the discharge into water body of any substance (usually by man) which may become harmful to plants and animals in the heater and make them unfit for human consumption.

### 2.9.1 Causes of water pollution

Some of the major causes of water pollution are the discharge or dumping of the following into water bodies

- Petroleum Hydrocarbons (crude or spined)
- Poisonous chemical

- Human waste
- Phosphate detergents
- Fertilizers
- Cleaned vegetation
- Heat (thermal)

## 2.10 Effects of Oil Pollution in Water

Crude and refined oils are some of the poisonous chemicals in water bodies. Deoxygenation causes death of fish species especially those lacking accessory breathing organs as the surface water is covered with oil preventing oxygen dissolving in water, hence less photosynthetic activities by green aquatic plants gills fish are damaged thereby impairing respiration.

Aquatic vegetation is killed leading to los of fish habitats and food poisonous chemicals. There are many poisonous chemicals in our water bodies today due to the discharged of waste from factories, hospitals and abattoirs. Some poisonous chemicals discharge with wastes into water bodies include heavy metals such as zinc, calcium, copper, lead, manges, nicket, iron, mercury and petroleum hydro carbons (oil)

## 2.11 Effect of poisonous chemicals

Drinking water or eating fish contaminated with heavy metals will lead to the bioaccumulation (storage) of the metals in human organs leading to serious health problems even death. Exceeding the recommended maximum lits of meals in water and fish are toxic to human's body.

## 2.12 Human's wastes

As industries and population continue to grow, more human wastes are produced and dumped in water. Nature's own purification system cannot handle this and as a result, the water

is over loaded with impurities. Most streams, rivers, lakes have been foiled with human and animal waste such as feaces and urine may contain disease-causing organisms.

### 2.12.1 Effects of Human wastes

a. Disease

   Untreated human and other animal waste, may harbor urines bacteria and eggs of worms that causes disease such as dysentery, cholera, typhoid, hepatitis (Jaundlees) and bilharziasis

b. Destruction of Aquatic life

   The immediate effects of aquatic pollution are the destruction of aquatic organism. Sewage and other organic substances dumped into water bodies encourage rapid growth of bacteria and algae. The required oxygen for the breakdown of the organic substances and required oxygen come from the water hence the dissolved oxygen in the water is reduced to a vessel that cannot support aquatic organism. Fish and other aquatic organisms die of asphyxiation fish is a source of animal protein.

## 2.13 Phosphate Detergents

Phosphate detergents increase the quantity of phosphates in the weather and help to stimulate excess growth of algae leading to algal bloom making the water turbid and fool my.

### 2.13.1 Fertilizers

Fertilizers (Nitrates and phosphate) washed from the farm land causes over growth of algae causing algal bloom and aquatic vegetation

Some farmers dump their cleared vegetation how water. The decay of the vegetation causes the shortage of oxygen in water.

## 2.14 Water Treatment

Water has always played a prominent role in human civilization. When people first began settling in one place and growing crops for sustenance, it has invariably neat water source like fulers, lakes or ground water spring

## 2.15 Bacterial associated with sachet water

Bacteria are typically single-celled organisms and are a natural component of water. Here are seven types of bacteria to be concerned about as you fill up your next glass of water:

*1) Escherichia Coli: Escherichia Coli* (also known as *E. Coli*) can cause nausea, vomiting, abdominal pain and diarrhea if consumed in contaminated water. Symptoms usually appear within one to eight days.

2) *Campylobacter Jejuni*: Drinking water contaminated with Campylobacter jejuni can cause infections with symptoms of cramping, diarrhea, fever, and pain. Symptoms of infection appear between two and ten days after exposure.

4) *Giardia Lamblia: Giardia Lamblia* is actually a parasite which causes the infection, *giardiasis.* Symptoms include nausea, cramps, gas, and diarrhea. The incubation period for *giardiasis* is two weeks.

5) *Salmonella*: Salmonella is a common pathogen that causes chills, fever, headache, diarrhea, and pain. Salmonella contaminates water and food and symptoms occur in one to three days after consuming.

6) *Legionella Pneumophila: Legionella pneumophila* can cause serious bacterial infections known as Legionnaires disease. Some symptoms of legionnaires infection are fever, shortness of breath, cough, and muscle aches. Legionnaires is very serious and usually involves hospitalization or can even result in death.

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Materials

3 samples of sachet water (Myclin De-basit, Alex Green) Petri-dish, beakers, Auto clave, gas cylinder, cornnical flask, Bunsen-burner, McCartney bottles, syringe and needle, pipette, microscope, microscope slide, distilled water, test tubes, test tube rack, incubators, Gram staining reagents (Crystal violet, iodine, Acetone  Safranin immersion oil) Aluminium foil, wire loop, Lactose, Sucrose, Glucose, Maltose, Hydrogen Peroxide Nutrient agar, Simmon citrate Agar, Mannitol, Salt Agar base, Triple Sugar Iron Agar, cotton wool, weighing balance, Spatular, Mortal and pestle, Durham tube.

### 3.2 Collection of Samples

3 samples of Sachet water was bought from the vendors in Auchi Poly Campuses, Edo State. The samples were transported into the laboratory of Auchi Polytechnic for analysis.

The sample were labeled A, D, M

A = Alex Greene

D = D Basit

M = Mycylin

### 3.2 Sterilization Method

All glass wares used for this study were soaked in soapy water and later washed and rinsed with warm water and rinsed again with distilled water. The media used was properly

sterilized using the autoclave at 121$^{o}$c for 15 minutes. During inoculation, the inoculating loop was constantly flamed to redness at the end of every inoculation.

### 3.4 Media Preparation

The media was prepared according to Manufacturers instruction and specification and therefore sterilized at 121$^{0}$C for 15 minutes using an auto clave. The media used for this study is nutrient agar (NA).

After autoclaving, it was allowed to cool to 45$^{0}$C and mixed well before dispensing aspectically in 1m volume of petri dishes. The medium was allowed to solidify in the plate and were used afterwards.

### 3.5 Analysis of Sample

#### 3.5.1 Serial Dilution

Disttled water was poured into a beaker and a 10ml syringe was used to aspectically withdraw 9mls from the beaker into 24 test tubes, the test tube were labelled with a masking tape, a decimal dilution ($10^{-1}$, $10^{-3}$, $10^{-5}$, $10^{-7}$) for the test tubes.

#### 3.5.2 Enumeration by pour plate method

The enumeration method used was pour plate method using 0.1ml of the serially divided inoculums with the aid of syringe and needle into petri dishes containing solidified nutrient Agar. The sterile nutrient agar was removed from the autoclave and poured inside the petridish containing 0.1ml of the serial diluted inoculums and then allow to solidify.

The inoculums was allowed to settle before incubation, the nutrient Agar plate were incubated at $37^0$C for 18hours after which the colonies were counted. Pure culture were obtained and the cultural characteristics observed and recorded.

### 3.5.3 Isolation of pure culture of Bacteria

Pure colonies were obtained by picking discrete single colony of bacteria grown on Nutrient Agar (NA) Subculturing on Fresh solidified Nutrient Agar (NA) plate for 24 hours inside and incubator at $37^0$C.

## 3.6 Procedure for identification of Bacteria

The isolates were characterized based on their morphological, cultural characteristics and were identified. The microbiological identification procedures and biochemical reaction are as follow.

### 3.6.1 Gram Reaction

This was carried out to differentiate gram positive from gram negative organisms.

**Method**

A wire loop was sterilized in Bunsen flame and allowed to cool then a loopful of growth was collected from the Agar plate and applied on a clean grease free slide and heat fixed by passing over a flame three times to dry, then a drop of crystal violet was added and left for 60 seconds and then washed off, a drop of iodine was added and washed off after 60 seconds, it was decolourized with acetone and washed off immediately, the slide was counter stained with Safranin for 60 seconds and then washed off with water. The slide was allowed to dried using air

dry method and then examined microscopically under a microscope using oil immersion at x 100 objective lens.

### 3.6.2 Catalase Test

This was used to differentiate Bacteria that produce the enzyme catalase.

**Method**

A wire loop was burn red hot using a Bunsen burner and allow to cool then it was to collect colony of the organism and put on a clean slode and then a drop of hydrogen peroxide solution ($H_2O_2$) was added to the colony on the side, it was observed for immediate active bubbling.

### 3.6.3 Coagulase Test.

This was used to identify bacteria which produces the coagulase enzyme which cause plasma to clot by coverting fibrinogen to fibrin. The test tube method was used.

A blood sample was withdrew with syringe and needle and inoculated into Mccartney bottle and was put inside a centrifuge to spin and allow to separate the serum from the red blood.

The serum was withdrew with pipette and poured into a test tube, a wire loop was heated red hot using a Bunsen burner and allowed to cool, the wire loop was used to pick the colonies and inoculated into the tube containing the serum and mixed gently, the test tube was observed for clumping or clothing of the organism, it coagulase for positive result.

### 3.6.4 Indole Test

This test was carried out for indole production by testing organism which is important to identify *Enterobacteria.*

**Method**

A sterile wire loop was used to inoculate a colony of organism into a sterilized test tube containing Simmons Citrate Agar which was allowed to solidify in a slanted position.

A wire loop was heated red hot in a Bunsen burner and allowed to cool, it was used to pick the colony organism at zigzag at the top of the test tube containing the Simmon Citrate Agar (SCA) it was incubated for 24hours.

The triple sugar iron Agar (TSIA) the media was prepared according to the manufacturer instruction and was autoclave for $121^0$C for 15 minutes for sterilization and was allowed to cool, and poured into a test tube and allowed to solidify and a wire loop was heated red hot using a Bunsen burner and allowed to cool, it was used to pick the colony of organism and deep straight, from the top to the bottom of the test tube and incubated for 24hours.

For mannitol Salt Agar Base (MSAB) the media was prepared according to the manufacturer instruction and was Autoclaved at $121^0$C for 15 minutes and allowed to cool, after cool it was poured into a peri-dish and allow to solidify and a wire loop was heat red hot using a Bunsen burner and allowed to cool, it was used, the colony organism and spread zigzag on the petri-dish containing the (MSAB) and was incubated for 24 hours.

**Observation**

Simmon citrate Agar had no growth, the was no changes in the colour, so it was Negative.

For triple sugar iron Agar it was observed that some sample were positive because some turned Red/yellow – Alkali / Acide, Glucose only and pepeon, while the other was Red/Red – Alkali / Alkali, no sugar are utilized, utilize peptore.

For Mannitol Salt Agar base (MSAB) it was observed that the samples appeared Positive and Negative.

### 3.6.5 Sugar Fermentation Test

This test is used to determine the ability of bacteria to utilize different sugars, sugar used are Glucose, Lactose, Maltose, Sucrose.

**Method.**

The four sugar solution, (Glucose, Lactose, Maltose and Sucrose) were prepared and poured into a bottle and 9mls of distilled water was added to the sugar in each bottle, some drops of methyl red was added to each bottles. A Durham tube was added (inverted) into the bottles and was Autoclaved at $121^0$C for 15minutes then allow to cool. A wire loop was burn red hot in a Bunsen burner and allow to cool, the wire loop was used to pick colony organism and inoculated into the Autoclave, Bottle containing the sugar was stirred together for each bottle, and it was incubated for 24hours at $37^0$C.

The reaction was observed after 24hours, the colour change red to yellow indicate a Positive test, while a retention of the red colour is Negative, when the Durham tubes moves up, it indicates gas Production.

# CHAPTER FOUR

## 4.1 Result

The result of Bacteriology assessment of retail sachet water sold in Auchi Polytechnic Campuses, Auchi Edo State

Table 1: Total Viables plate count of bacteria from retail Sachet water.

| Sample | Dilution factor | Total plate count (cfu/ml) |
|---|---|---|
| Sample A (Myclin) | $10^3$ | $4.6x10^3$ |
| Sample B (Alex Green) | $10^3$ | $2.2x10^3$ |
| Sample C (De-Basit) | $10^3$ | $1.3x10^3$ |

Myclin = 46

Alex Green =22

De-Basit = 13

Table 2: Cultural, Morphological and Biochemical Characteristics of Bacteria Isolated from 3 Sachet water sold in Auchi Polytechnic Campuses, Auchi , Edo State.

| Isolate | Source/ samples | Cultural characteristics | Morphological/arrangement of cells | Biochemical Test | | | | Sugar fermentation | | | | Suspected organism |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gram stain | Catalased test | **Coagulase Test** | **Indole test** | Glucose | Lactose | Maltose | sucrose | |
| B1 | M (Myclin) | Whitish to creamy colour colonies on nutrient agar | Cocci arranged in clusters | + | + | + | - | + | + | + | + | *Staphylococcus aureus* |
| B2 | A (Alex green) | White and creamy in colonies | Cocci arranged in chains | + | - | - | - | + | + | + | + | *Streptococcus* |
| B3 | D (De-basit) | Whitesh in colour | *Baccilli* arranged in chains | + | + | - | - | + | varable | + | + | *Bacillus species* |

## 4.2 Discussion

The high level of bacteria contamination are strongly attributed to poor quality of water source, improper pipeline maintenance, lack of personal hygiene. (Obiri-Danso *et al.,* 2015; NAFDAC , 2018, Olaoye and Onilude, 2018).

The act of testing for the presence of coliform is a measure of the efficiency of the treatment process employed and the integrity of the water distribution system (Da Silva *et al.,* 2018).

It would not be out of place to state that the treatment process and distribution system employed by most of the water vendors are doubtful as it does not comply with standard operating procedure.

In this study bacteria were found to be associated with sachet water. From table 1 the total viable count for bacteria ranges from $1.3x10^3$ to $4.6x10^3$ (cfu/ml), sample D had the lowest bacterial count while sample M had the highest bacterial count.

Table 2 shows bacteria isolated from sachet water sample M (Myclyn) A (Alex green), D (De-basit). This include *Staphylococcus aureus, Streptococcus* and *Bacilus.* They produces several enterotoxins which are heat stable which make them withstand inadequate heating (Martin and Maurice, 2015).

The presence of these pathogens in such water could account for the incidence of diarrhea, food poisoning and *gastroententis* especially among the students.

There is therefore need for NAFDAC to intensify efforts in the routine monitoring of activities in the packaged drinking water industry.

***Staphylococcus:*** it a Gram Positive that cocci shape arranged in cluster. It is a ubiquitous bacterium that causes a wide range of infections. It is a major environmental contaminant of food and water, the human skin and nose are known to be major sources of the organisms (Kadariya *et al.,* 2014).

Humans involved in sachet water production are likely to be contributors to contamination The presence of staphylococcus aureus in sachet water could either introduced during the manufacturing or post manufacturing such as improper handling storage and transportation and also skin contact with the sachet.

***Streptococcus*:** it is an aerobic gram positive bacterium. This bacterium is responsible for a wide array of infection (Carapetis *et al.,* 2005).

It causes infection such as sore throat infection of the superficial layers of skin.

*Streptococcus* in sachet water indicate possible contamination from human excreta, the bacterium isolated suggesting that pathogenic organism in faecal materials might have been present.

The producer of sachet water might infect the water through direct contact with discharge from the nose and throat, through droplet when someone with the infection coughs or sneeze.

***Bacillus:*** it is naturally widely distributed in nature and it is a Gram Positive rod bacterium that is responsible for food poisoning (Ishida *et al.,* 2019). It can proliferate because of unhygienic

practices and can be attached to drinking water infrastructure. This suggest that the ubiquity of the organism, poor hygiene and attachment to equipment may be why *Bacillus* has been isolated from sachet water.

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATION

### 5.1 Conclusion

In conclusion, it is revealed from the analysis that the high level of bacteria contamination are strongly attributed to poor quality of water source, improper pipeline maintenance, lack of personal hygiene. However, the act of testing for the presence of coliform is a measure of the efficiency of the treatment process employed and the integrity of the water distribution system. It would not be out of place to state that the treatment process and distribution system employed by most of the water vendors are doubtful as it does not comply with standard operating procedure.

### 5.2 Recommendation

From these study, the following recommendations are made:

- Sachet water producers should adhere strictly to standard practices to ensure product of appropriate quality.
- Regulation inspection of packaged water producing facilities should be done by regulatory agencies to ensure compliance with standard practices.
- The public should be guided on brands of water micro biologically and physic chemically approved suitable for drinking.

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