PARASITES ASSOCIATED WITH SELECTED SACHET WATER SOLD IN IJEBU-IGBO

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BY

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CERTIFICATION

This is to certify that this project was carried out by: **OLUWADARE ISAIAH AYODEJI (18-06-0035), KAYODE FAITH ADURAGBEMI (18-06-0037), AREOLA MERCY OLATEJU (18-06-0038)** and **OLUSOLA FUNMILAYO VICTORIA (18-06-0039)** of Science Laboratory Technology Department, Abraham Adesanya Polytechnic, Ijebu-Igbo, Ogun State under my supervision.

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DEDICATION

This project is dedicated to God Almighty, the most gracious and the most merciful.

Also to our parents for showing us love and delight in our education.

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Our gratitude goes to God, who made this project a reality and for the great things he has done for us. Our utmost gratitude goes to our parents for their prayers and support both financially and morally and their encouragement. We are so grateful to you.

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ABSTRACT

Sachet water is a major source of drinking water for low and medium class Nigerians. Evaluation of sachet water for the presence of intestinal cysts and eggs of parasites was carried out in Ijebu-Igbo, Ogun state, Nigeria. This was in order to determine the safety and stability of such water for human consumption. The physical, chemical and bacteriological properties as well as mineral composition of the fifteen (15) selected sachet water and the five (5) sachet drinking water brands sold in Ijebu-Igbo water companies were analyzed successfully. Findings show that drinking water sachets, distributed and hawked in Ijebu-Igbo may not pose any health threat for now as no parasitic organisms were found in them. This study indicated that *T.trichuria* infection persists as a result of feacal contamination resulting from improper handling. It is therefore recommended that the consumers who buy sachet drinking water from the hawkers should properly clean the cellophane packet, especially the area to be cut open before drinking. Patronizing hawkers who are generally dirty and with unsanitary commercial habits should be avoided. Finally, government agencies regulating the sachet water industry should increase and sustain the tempo of monitoring in order to ensure highest standards in the areas of water source, treatment and filtration techniques employed by industries.

Key words: Intestinal parasites, Eggs, Cyst, Sachet water, Lagos State, Nigeria.

TABLE OF CONTENTS

CHAPTER ONE

1.0 INTRODUCTION

Water is one of the indispensable resources for the continued existence of all living things including man hence adequate supply of fresh and clean drinking water is a basic need for all human beings. Water is defined as a substance that is colorless, odorless, clear and capable of existing in a liquid, solid or gaseous phase. It is a basic necessity of life, second to air, because it serves as a source of nourishment to man, animal, microorganisms and even plants (Anochie, et al., 2018). Water is a unique solution, it makes up about 80percent of the cell's composition. Water is very distinct from any other way of quenching taste because of its chemical composition. Water has been part of nature from time immemorial and can sometimes be contaminated in its natural environment (Atuanya, et al. 2019).

In Nigeria, water is produced into many products such as sachet water popularly known as "pure water". Sachet water is commercially treated water, manufactured, packaged and distributed for sale in sealed polythene containers for human consumption. The production of sachet water in Nigeria started in the late 90s and today the advancement in scientific technology has made sachet water production one of the fastest growing industries in the country (Elimian et al, 2019). Many individuals and corporate bodies in Nigeria now engage in packaging water in polythene sachets of about 50-60cl which they sell to the public. Thus, drinking water is commercially available in such easy to open sachets. The production, marketing and consumption of sachet water have increased

tremendously. There are now several brands of this sachet water marketed in Nigeria. The majority of consumers tend to be more concerned with the appearance and taste of water than the invisible loads of potentially harmful micro-organisms as well as other contaminants that may be present in the water (Mgbakor 2018).

The continuous increase in the sale and indiscriminate consumption of sachet water in Nigeria is of public health significance, as the prevalence of water related diseases in developing countries is determined by the quality of their drinking water (Fardami, et al 2019). Sachet water is seen to be a good supplement to other types of packaged water and can be bought at cheaper price. It is a source of drinking water for low and medium class Nigerians (Obioma, et al, 2017).

Parasites are organisms that live in a close relationship with other organism (hosts) and are capable of causing harm to their host. Their routes of transmission are of great importance in the health of many populations in developing countries, where the frequency of infection is a general indication of local hygiene and environmental sanitation levels (Okeke, et al, 2018).

Parasitic infections which have direct life cycle and do not need an intermediate host to infect a new host are acquired through direct ingestion of infected eggs or cysts. Infections can also be acquired through contaminated food or drinks. The resistance capacity of intestinal parasites is a feature of profound influence on the epidemiology.

For example, eggs of *Ascaris* can remain viable for up to six years in the soil (Onyegeme et al 2017).

In recent years, lots of research has been carried out in various parts of the country to determine the purity of sachet water, and most of the results point towards the same conclusion; that our so called "pure water" may not be completely safe for drinking. The results of the studies on sachet water to determine purity and safety have almost always churned up evidence of microbial and in some cases chemical contaminants (Ugochukwu, Giwa, Giwa, 2019). Considering the myriad brands of sachet water marketed in Ijebu Igbo, Ogun State coincide with the increasing population of students using the water, there is need to determine the quality of the water. This will provide information on the safety and microbiological quality of the sachet water marketed in Ijebu Igbo, Ogun State. This study therefore aim to investigate the parasite prevalence in sachet water in Ogun State.

Aim and Objective of the Study

The general aim and objective of this present study is to determine parasite associated with sachet drinking water in Ijebu Igbo, Ogun State, Nigeria.

CHAPTER TWO

LITERATURE REVIEW

2.0 WATER

Water is one of the most important of all natural resources known on earth. It is important to all living organisms, ecological systems, human health, food production and economic development. Sometimes poor quality water causes many diseases in humans, therefore quality of water must be tested for both the chemical as well as for the microbial contaminants. Water is an essential component for survival of life on earth, which contains minerals, important for humans as well as for world and aquatic life (Okeke, et al, 2018). Lakes and surface water reservoirs are the planet's most important freshwater resources and provide innumerable benefits. They are used for domestic and irrigation purposes and provide ecosystems for aquatic life especially fish, thereby functioning as a source of essential protein and for significant elements of the world's biological diversity. They have important social and economic benefits as a result of tourism and recreation, are culturally and aesthetically important for people throughout the world (Obioma *et al.,* 2017). Physico-chemical parameters are very essential and important to test the water, before it is used for drinking, domestic, agricultural or industrial purpose and to get the exact idea about the quality of water (Elimian et al, 2019).

2.1 Importance of Water

Water is one of the most important substances on earth, all living organisms depend on this substance for life. It is a liquid at standard ambient temperature and pressure, but can also exist as a solid or gas. Excluding fat, water composes approximately 70% of the human body by mass. It is a crucial component of metabolic processes and serves as a solvent for many bodily solutes. Water has so many uses, including cooking, washing and recreation. It is also necessary for the healthy growth of farm crops and farm stock and also plays an important role in the manufacture of many products. On earth 96.5% of the planets water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland (Greenhalg, 2001). It is reported that less than 0.3% of all freshwater is in rivers, lakes and the atmosphere, and an even smaller amount of the Earth's freshwater is contained in biological bodies (Kortatsi, 2006). Some health authorities have suggested that people drink at least eight glasses, of water per day (1.89 litres) (USEPA, 2000) and the British Dietetic Association recommends 1.8 litres (Greenhalg, 2001).Over large parts of the world, humans have inadequate access to potable water and use sources contaminated with disease vectors, pathogens or unacceptable levels of toxins or suspended solids. Reduction of waterborne diseases is a major public health goal in developing countries.

2.2 Pollution of Water

Water is referred to as polluted when it is impaired by anthropogenic contaminants which results in it being unable to support a human use. Some of these uses of water includes drinking, cooking, washing etc, or undergoes a marked shift in its

ability to support its constituent biotic communities, such as fish and plants (http//environment.about.com/environmental events/waterdayqa.htm). Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water (WHO, 2008). Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Water pollution is a major global phenomenon that requires continuous evaluation and the needed revision of policies to address the issue at both the local and international levels. It has been reported that water pollution related deaths and disease are the leading cause of mortality worldwide (Fardami et al., 2019), accounting for the death of more than 14. 000 people daily.

Fardami et al., (2019) reported that in India 580 people die daily from water pollution related sickness. It is reported that about 90% of the cities in China suffer from varying degrees of water pollution (EPA, 2019), with about 500 million people lacking access to safe drinking water (Laws, 2000). Developing countries are mostly affected by water pollution however developed nations also have water pollution issues. The USEPA in 2002 reported that, 45% of assessed stream miles, 47% of assessed lake acres and 32% of assessed bays and estuarine square miles are polluted (USEPA, 2017). Surface water and groundwater are interrelated, surface water seeps through the soil and becomes groundwater, alternatively groundwater also feed surface water sources, however, they

have often been managed as separate resources (USGS, 2018). Access to Nigeria's water resources are not evenly distributed at the spatial level. Only about 39.9 percent of households had access to pipe borne water. Two (2) percent got water supply from tanker services whilst three other sources wells, boreholes, and rivers/streams account for 16 percent each (GSS, 2019).

In addition, access to pipe-borne water as a source of drinking water was 67.8 percent in urban areas compared to 14.9 percent in rural areas. At the national level, 42 percent did not have access to good safe drinking water. In Accra, over 91 percent of households had access to pipe-borne water in the year 2000 with 43.6 percent having pipe-borne inside their houses (GSS, 2019). Water pollution could occur from so many sources: these are grouped into two main categories. These are: Point source pollution and Non-point source pollution. The former refers to contaminants that enter the waterway from a single identifiable source, which may include a pipe or a ditch, discharges from sewage treatment plants, factory, or a city storm drain. The latter refers to diffuse contamination that does not originate from a single discrete source. This is often the cumulative effect of small amounts of contaminants gathered from a large area. An example being the leaching out of nitrogen compounds from fertilized agricultural lands.

2.2.1 Domestic sources of Water Pollution

A major cause of water contamination is effluent (outflow) from septic tanks and cesspools. Misuse of these systems for disposal of anything other than domestic or sanitary waste can pose a substantial threat to ground water (Onyegeme-Okerenta *et al.*,

2017). Residential wastewater systems can be a source of many categories of contaminants including bacteria, viruses and nitrates from human waste and organic compounds. Injection wells used for domestic wastewater disposal (septic systems, cesspool drainage wells for storm water runoff, groundwater recharge wells) are of particular concern to ground water quality if located close to and up gradient water wells. Improper storing or disposal of household chemicals such as paints, synthetic detergents, solvents, oils, medicines, disinfectants, pool chemicals, pesticides, batteries, gasoline and diesel fuel can lead to ground water contamination (Yakubu 2017)

When stored in garages or basements with floor drains, spills and flooding may introduce such contaminants into the ground water because community landfills are not equipped to handle hazardous materials. Similarly, waste dumped or buried in the ground can contaminate the soil and leach into the ground water. As urban areas grow, there is an increase in rain water runoff caused by the additions of paved surfaces. Some municipalities use storm water drainage wells to dispose off waste, this additional runoff particularly if the area is not served by storm sewer or has a limited sewer system. Storm water drainage that communities use to control water during storm events pose a threat to ground water particularly in kart areas or areas with high water table. Fertilizers, herbicides, insecticides, fungicides and pesticides applied to the lawn and garden contain hazardous chemicals that can travel through the soil and contaminate the ground water (Anochie, *et al.*, 2018)

In garage, items that are improperly used, stored or disposed of may potentially contaminate ground water especially if there is a drain to the ground in the floor of the

garage. Sources include batteries that contain lead, cadmium or mercury. Paints containing lead and barium, gasoline and oils containing compounds, barium from diesel fuel combustion. Water used in the home and entering a septic system or sewer system may contain detergents from dish washing and laundry, organic compounds from garbage, disposal bacteria, nitrates and sulphates from sewage, greases and oils. Cleaning agents, aerosol sprays coolants and solvents which all contain carbon tetrachloride household pesticides. Water percolating through landfills is known as Leachate. From landfills that contain household and other waste may pick up dissolved solids and volatile organic compounds. Lawns with over applied or misapplied fertilizers, herbicides and fungicides might introduce these contaminants tetrachloride and heavy metals such as manganese into the ground (USEPA, 2017).

2.2.2 Natural sources of water contamination.

Water contains some impurities even if it is unaffected by human activities. The types and concentrations of natural impurities depends on the nature of the geological materials through which the ground water moves and the quality of the recharge water. Ground water moving through the sedimentary rocks and soils may pick up a wide range of compounds such as magnesium, calcium and chlorides. Some aquifers have high natural concentration of dissolved constituents such as arsenic, boron and selenium. The effect of these natural sources of contamination of water quality depends on the type of contaminants and its concentration. Some of the contaminants that occur naturally are: Aluminium, arsenic, barium, chloride, chromium, coliform bacteria, copper, fluoride,

hardness, iron, lead, manganese, mercury, nitrate, selenium, silver, sodium, sulphate and zinc (Squire, *et al.*, 2017).

2.2.3 Other Sources of water pollution

Water that runs off or flows over the ground after a rainstorm picks up debris, chemicals, soil, yard waste, fertilizer, motor oil and other pollutants. Storm water is carried into local retention (storm water) ponds or directly into local waterways through storm drains that eventually reach water bodies. Sometimes this water is partially treated through a storm water pond. These provide temporary storage of storm water runoff and capture a variety of pollutants that would otherwise work their way downhill to waterways and wetlands. The responsibility for permitting storm water management systems rests with water management authorities. After developers complete construction of permitted systems in residential areas, the permit and the legal responsibility for maintaining these systems are typically passed on to homeowners. For generations, thousands of acres of farmland have been cultivated throughout Nigeria (Titilawo *et al.*, 2018)

In many cases, nutrient-rich water from farm fields has drained or been pumped into natural water bodies without treatment, impacting water quality. This overabundance of nutrients encourages algal blooms that deplete oxygen from the water and block sunlight from reaching underwater vegetation, critical to fish and wildlife habitats. Sediments from soil at construction sites can wash into waterways, which can create problems for aquatic life. Cloudy water caused by suspended matter reduces the amount of sunlight able to reach submersed plants. The settling out of the sand, silt and other

matter suspended in the water onto the bottom of the water body destroys submersed grass beds and other bottom-dwelling plants and animals, in addition to impacting drainage and navigation. Pollution of surface waters is generally categorized as point source or nonpoint source. With point source pollution, the cause of the problem can be traced to a single source -- for example, a pipe or culvert discharging wastewater from a factory. Some industrial and sewage treatment plants connect directly to a water body and create point source pollution, but not all pipes create point source pollution. In the past, pollution from industrial and domestic point sources was common (Okeke *et al.*, 2018). However, stronger regulations, newer technologies and more advanced treatment of wastes have reduced pollution. These sources are regulated by state and local laws.

2.2.4 Microorganisms associated with Water Pollution

Several microorganisms are used to detect the presence of pathogens in water sample, Coliform bacteria are the most commonly used, although not an actual cause of disease. Several microorganisms are found in surface water which are implicated in human health problems, including, Cryptosporidium parvum, Giardia lamblia, Salmonella, Novovirus and parasitic worms (Tongo, *et al.*, 2017). High levels of pathogens in water may result from the inadequate treatment of sewage discharges, which is a common feature in developing countries (EPA, 2019), however this may also occur in developed countries, where older cities with aging infrastructure may lead to the leakage of sewage collection systems which can cause sanitary sewer overflows. Apart from microorganisms, other contaminants of water include organic substances like; detergents, disinfection by-products, food processing waste, fats and grease, insecticides

and herbicides, petroleum hydrocarbons, including fuels and lubricants and fuel combustion by-products Acidity caused by industrial discharges (especially sulfur dioxide from power plants), Ammonia from food processing waste, Chemical waste as industrial by-products. Fertilizers containing nutrients--nitrates and phosphates—which are found in storm water runoff from agriculture, as well as commercial and residential use(Elimian et al., 2019), Heavy metals from motor vehicles (via urban storm water runoff) (Elimian et al., 2019) and acid mine drainage, Silt (sediment) in runoff from construction sites, logging, slash and burn practices or land clearing sites.

2.3 Sachet Water in Nigeria

Due to the unreliability of the water supply system in Nigeria, sachet water was introduced to provide affordable and instant drinking water to the general public, this has seen a tremendous increase due to the crisis in the water supply system in the country. The sachet is usually bagged in small polythene bags usually 500ml, this product has found its way into almost every home in the country. There have been reports that suggest the use of this product in hospitals, even in theatres and delivery rooms. The production of sachet water is carried out by both small and large scale industries that pack and machine-seal sachet water, this bag of water is mostly referred to as —pure waterl. According to the Stockholm Environment Institute (1993), —ice-waterl vendors get their local name because most of them add blocks of ice to water sachets contained in ice-boxes or pots to cool the water. However, to majority, —ice-waterl simply means hand-tied sachet water weather it is coole2d or not. Sachets are produced by both large corporations and small family businesses often regarded as —cottage industries.l

Corporate producers are few in number and generally located in the large cities. Some of the large scale producers in Nigeria, Everpure, IceCool, Mobile Water, Standard Water, Voltic and Special Ice Water, however the number of the small scale industries producing sachet water are unknown. Governmental agencies tasked with managing the industry are not able to account for all the small scale producers because there are several unregistered producers in business, however they have been reported to be around 3,000 and on the rise each day. The proliferation of these producers is as a result of strong seasonal demand, intermittent water supply and low barriers to market entry, most of these small scale producers are typically family enterprises drawn to the industry because it is a relatively simple business to run, does not require extensive education, and has low initial investment.

2.3.1 Sachet Water Production

The production of sachet water is a relatively simple process, most of these producers are located within areas where there is the supply of treated water from the Nigeria Water Company Limited , therefore a water pump draws directly from a piped connection, in some areas where there is no water supply these producers have a borehole or well from which they draw their water. The water is then passed through a filtration media and into the sachet machine which fills a fixed volume (typically 500 mL) of a plastic roll, then heat-seals and slices the edge to create the individual sachet. These sachets are then packed into bags of thirty each. The machines used in the production of the sachet water are mostly manufactured in China and marketed under several brand names with the most common being the Koyo Machine. The filtration of the water is

mostly done with a separate filtration media which is usually fixed to a wall, this contains a combination of carbon and sand filters of varying pore sizes for trapping different particles and organisms. These machines sometimes contain ultraviolet filters for killing remaining bacteria and viruses, some of the producers who deliver straight to the market usually cool the water before distribution.

2.3.2: Sachet Water Quality

Past studies on bacteriological purity of sachet water in Nigeria has been conducted by several researchers such as Tongo Ezemonye et al (2017) and Mustapha et al (2018), in Owerri, Ibadan and Lagos. The Sachet waters were reported to contain bacteria such as *Bacillus* sp., *Pseudomonas* sp., *Klebsiella* sp., *Streptococcus* sp., *Serratia sp*, *Chromobacterium sp*, *Proteus mirabilis* and oocysts of *Cryptosporidia* sp (a protozoan parasite).

Another study by Yakubu (2017), to ascertain the parasites associated with sachet drinking water in Awka, Anambra State, Southeast Nigeria indicated that all the tested water samples met World Health Organization (W.H.O) recommended standard, of being colorless, tasteless, and odorless with average pH of 6.93. Some parasites were found on the surface of the sachets. Identified parasites included cysts of *Ascaris lumbricodes* (5.6%), *Entamoeba histolytica* (4.6%), Hookworm (2.8%), *Trichuris trichuria* (2.8%) and *Giardia lamblia* cysts (1.9%).

Most other studies have reported a compromise of water quality in one way or the other (Dada 2018, Tongo. *et al.* (2017), Samuel 2019).

Due to the high demand for sachet water and the lack of serious supervision and regulation most of the sachet water produce does not meet the required standard. In the developed world vended water technology has evolved but in many developing nations sachet is the common technology available.

There has been several studies on the quality of sachet water in Nigeria, in 2006 Dodooet al., studied the quality of 29 brands of sachet water exposed to different temperature conditions in the Cape Coast Metropolis . In this study, 45% were reported to be contaminated with total coliform bacteria, with colony forming units (CFU) ranging from 0 cfu/100ml to 98 million cfu/100ml, with three out of seven brands reporting positive for E. coli. This study indicated that sachet water quality in Nigeria was poor, however in comparing the quality of sachet water with other water products, sachet water is of a higher quality than hand –filled hand –tied water which was dominating in Nigeria before the introduction of sachet water this was reported in a study by Obiri-Danso et al., (2018). Most of the water used in the production of sachet water in Nigeria is either from the GWCL or from underground water sources, these underground water has been proven from several studies to be microbially contaminated, as was reported by Obiri-Danso et al., (2008). Recent research on sachet water has primarily focused on sub-standard quality and potential disease transmission, with some elaboration on health impact.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Ijebu-Igbo, a town in Ogun state, Nigeria and still an economic and commercial nerve centre of the Nation. It is located in the southwestern geopolitical zone of Nigeria. The smallest in area of Nigeria's 36 States, but containing the nation's largest urban area.

3.2 Collection of Sachet Water

A total of 5 different brands of sachet water was purchased randomly from hawkers, producers and wholesalers within 2 L.G.A of Ogun State. They all had the National Agency for Food and drug Administration and Control (NAFDAC) certification number. They were conveyed to the Microbiology laboratory of Abraham Adesanya Polytechnic (AAPOLY).

The 5 sachet water were named and the area of collection and local government indicated (Table 1). They were then subjected to Macroscopic and parasitological examinations to determine the presence of parasitic cysts and eggs.

3.3 Laboratory Examination

Wearing sterilized gloves, each sachet was shaken, opened with a sharp scissors and emptied into individual sedimentation flask, covered and was left overnight. This was observed macroscopically immediately after it settled. The colour, odour, taste, pH were noted using the WHO range (colourless, odourless, tasteless, pH 6.5-8.5). For each left

overnight, the supernatant was decanted. The sediment was shaken and 10mls of each sample was centrifuged at 2,500rpm for a minute. The sediment from each tube was checked for parasite by concentration method described by WHO (1991). This method enables detection of small numbers of parasitic eggs and larvae through concentration by sedimentation. About one gram of the sediment and 10ml of formalin were mixed together and strained with the aid of sieve directly into a centrifuge tube. Then 3ml of mixture was thoroughly mixed using glass rod and centrifuged at 250rpm for 1 minute. The supernatant of debris and formalin-ether was poured away by quickly inverting the tube. The sediments were agitated to form suspension with the remaining fluid on the sides of the tube. A drop of the suspension was transferred onto a clean slide for microscopic examination under a cover slip using the x10 and x40 objectives. This was repeated until the sediment in each centrifuge tube finished. The surface of the sachets of water was also washed off and was allowed to settle for some minute. The resulting water was centrifuged and observed microscopically. The method of centrifuging used in this study was to ensure the concentration of impurity in the water samples. This method is acceptable because parasite eggs/cysts are rarely seen in volumes of liquids except when they are concentrated.

CHAPTER FOUR

RESULTS

4.0 IDENTIFICATION OF INTESTINAL CYSTS AND EGGS IN THE WATER WITHIN THE SACHET

The macroscopic and microscopic examination results of the 15 analyzed packaged drinking water from producers, wholesalers and hawkers in Ijebu-Igbo is shown in Table 4. 1. None of the packaged drinking water has any parasite in the water within the Nylon. All the tested packaged drinking water also met the standard pH of 6.5-8.5 recommended by W.H.O. The packaged drinking water was odourless, colourless and tasteless. Some particles though low, were seen in most of the packaged drinking water, none has moderately high particles. These particles were like crystals and fibers in varying degrees.

4.1 IDENTIFICATION OF INTESTINAL CYSTS AND EGGS HABOURED ON THE SACHET

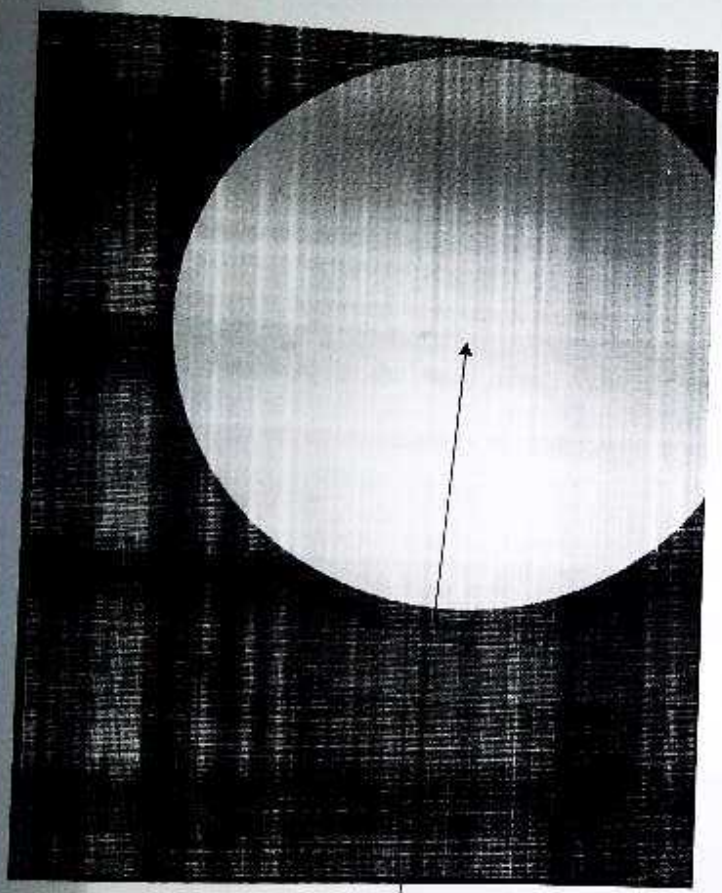
The microscopic examination result of the fifteen (15) analyzed sachets of the packaged drinking water from the hawkers, wholesalers, producers. The sachets of the packaged drinking water was rinsed and centrifuged, the sediment was observed microscopically and the parasite observed were recorded and shown in Table 4.2.

TABLE 4. 1: Analysis of all sampled packaged water purchased in Ijebu-Igbo.

Source	Water samples	Parameters Measured			Parasite Cysts/Ova	Particles
		pH	Odour	Colour	Taste	
awkers	A	6.54	Odourless	Colourless	Tasteless	Nil	Low
	B	6..53	Odourless	Colourless	Tasteless	Nil	Low
	C	6.54	Odourless	Colourless	Tasteless	Nil	Very Low
	D	6.54	Odourless	Colourless	Tasteless	Nil	Low
	E	6.60	Odourless	Colourless	Tasteless	Nil	Low
holesalers	A	6.56	Odourless	Colourless	Tasteless	Nil	Low
	B	7.00	Odourless	Colourless	Tasteless	Nil	Low
	C	6.54	Odourless	Colourless	Tasteless	Nil	Very Low
	D	6.60	Odourless	Colourless	Tasteless	Nil	Low
	E	6.60	Odourless	Colourless	Tasteless	Nil	Low
roducers	A	6.57	Odourless	Colourless	Tasteless	Nil	Low
	B	7.00	Odourless	Colourless	Tasteless	Nil	Low
	C	6.55	Odourless	Colourless	Tasteless	Nil	Very Low
	D	6.60	Odourless	Colourless	Tasteless	Nil	Low
	E	6.65	Odourless	Colourless	Tasteless	Nil	Low

Table 4.2: Ova or Cyst of Parasites haboured on the Sachets of the Purchased Packaged Drinking Water in Ijebu-Igbo, Ogun State

orces	No of sachets	*A. lumbricoides*	*E. histolytica*	*T. trichuira*	*G. lamblia*	Hook worm	Total (%)
owkers	5	-	-	5	-	-	5(33.3)
holesalers	5	-	-	-	-	-	-
oducers	5	-	-	-	-	-	-
tal/%	15	-	-	5	-	-	5(33.3)



Trichuris trichuria

CHAPTER FIVE

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 Discussion

The research recorded low contamination of the sachet of the different sachet water brands examined in the study area. Although other researchers have recorded several high rates of contamination of water with parasites at different parts of the country (Alli et-al.2011).

Findings show that drinking water sachets, distributed and hawked in Ijebu-Igbo may not pose any health threat for now as no parasitic organisms were found in them. The non - occurrence of parasites in these products could be as a result of use of uncontaminated water sources and improved methods of water treatment. For instance, industries like Yemoji Water Corporation uses ultra violet radiation to treat deep borehole water. All sachet drinking water industries visited, used automated packaging machines as opposed to electric manually operated impulse sealers. Such hand held sealers could bring human hand in close contact with packaged water during various stages of production and this could lead to infection (Adam et-al).

The bulk of parasitic infection resulted from sachet drinking water is from hawkers, who sell sachet water along the streets. The outside sachet of the water has parasites due to improper handling of the water from the hawkers..E.g; In Lagos, it is further reported that Nigeria also noted that *Entaemoeba coli* and other entheric

pathogens formed a significant part of the isolates on the outside sachet surfaces of samples collected from cooling receptacles (pail, basin, wheel barrow, and refrigerator). (Egwari et al. 2007). It was therefore not surprising that some packets analysed in this present study had halize eggs on them. The hawkers who were mostly children probably picked up the parasites while playing with feacal contaminated soil and while handling dirty currency notes.

Hawkers may also immediately after visiting the toilet rush out to hawk the water without washing their hands, thus contaminating the sachets of drinking packaged water. Omemu *et al.* (2005) noted that *T.trichuria* infection persists as a result of feacal contamination resulting from improper handling. In an effort to select the desired type of water through "pick and drop" process and to choose the cooler or warmer sachet drinking water, buyers may also contaminate the packets, consequently predisposing the consumer to infection. It is thus clear that sachet drinking water from industries and wholesale dealers in Ijebu-Igbo does not pose any health risk in terms of parasitological analysis for now. However, there is a serious need for bacteriological and fungal analysis and their health implications, as a result of the particles seen in the sachet water. The attitude of the hawkers is a serious source of concern as they seem responsible for actually contaminating the cellophane packaging material of the water during packing and hand out the water to consumers.

5.2 Conclusion

The physical, chemical and bacteriological properties as well as mineral composition of the fifteen (15) selected sachet water and the five (5) sachet drinking water brands sold in Ijebu-Igbo water companies were analyzed successfully. Though, the average temperature values of the sachet drinking water samples significantly meets with the standard of the WHO and NIS standard.

In conclusion, hawkers and the consumers are mostly responsible for contaminating the sachet of the water during packing and handing out of the water.

5.3 Recommendation

It is therefore recommended that the consumers who buy sachet drinking water from the hawkers should properly clean the cellophane packet, especially the area to be cut open before drinking. Patronizing hawkers who are generally dirty and with unsanitary commercial habits should be avoided. Finally, government agencies regulating the sachet water industry should increase and sustain the tempo of monitoring in order to ensure highest standards in the areas of water source, treatment and filtration techniques employed by industries. It is suggested that similar research be carried out in other parts of Nigeria, to amass a critical body of information needed to regulate and sanitize the sachet drinking water industry. This is highly desirable since sachet drinking water "Pure Water" is universal in Nigeria. Such research is also desirable in developing countries of Africa where drinking water is sold as sachet water.

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