PHYSIOCHEMICAL AND MICROBIAL CHARACTERISTICS OF SACHET WATER SOLD IN ADO-EKITI

BY

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MATRIC NUMBER:WMA/13/1030

A PROJECT SUBMITTED TO THE DEPARTMENT OF WATER RESOURCES MANAGEMENT AND AGRO-METEOROLOGY, FACULTY OF AGRICULTURE, FEDERAL UNIVERSITY OYE-EKITI,EKITI STATE

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DECLARATION

I declare that the work in this project entitled PHYSIOCHEMICAL AND MICROBIAL CHARACTERISTIC OF SACHET WATER SOLD IN ADO-EKITI was carried out by me in the department of Water Resources Management and Agro-Meteorology, Federal University Oye –Ekiti, Ekiti-State, under the supervision of PROF A.A OLUFAYO. The information derived from the literature has been duly acknowledged in the text and a list of references provided.

ADETONA TEMITOPE SIKIRU Signature____________________

Matric number **Date**______________________

WMA/13/1030

CERTIFICATION

This project entitled PHYSIOCHEMICAL AND MICROBIAL CHARACTERISTIC OF SACHET WATER SOLD IN ADO-EKITI by ADETONA TEMITOPE SIKIRU with matric number WMA/13/1030 meet the regulation governing the award of bachelor of science of federal university oye ekiti ,ekiti state and is approved for it contribution to knowledge and literary.

PROF A.A OLUFAYO SIGNATURE________

Supervisor in charge

Department of, Water Resources Mgt., DATE 19-03-2019

And Agro-Meteorology

Dr. Akintola . O·A SIGNATURE________

H.O.D

Department of Water Resources Mgt., DATE 19-03-2019

And Agro-Meteorology

DEDICATION

I dedicate this project to almighty GOD for his guidance and protection over me throughout my days in Federal University Oye Ekiti, I also dedicate this project to my mother Mrs. Bola Adetona for her support towards my education in Federal University Oye-Ekiti from(I00-500) level.

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ABSTRACT

This study focus on the physiochemical and microbial characteristics of pure water sachet in Ado-Ekiti. A total of sixteen pure water sachet from sixteen brand were collected at random and their physiochemical and microbial parameters were analysed The colour, taste, odour, turbidity, temperature, pH, electrical conductivity, total dissolved solids, total hardness, chloride, sulphate, nitrate, phosphate. and microbial parameters of the stored samples were analysed ,turbidity of the sample was determined using D70 jackson turbidity meter, physiochemical analysis of the sixteen sachet water(sample A-H) that was analysed for Ph, zinc, iron, chloride, calcium, nitrate ,and hardness shows that their was no significance difference for in their value. while there was significant difference in the value analysed for conductivity, alkalinity TDS. Meanwhile for (sample I-P) there was significant different i the value analysed for nitrate, pH, alkalinity, hardness, zinc, iron, sulphate. Meanwhile, there was significant difference in the value of conductivity, and TDS.

Moreover ,for sample(A-H) temperature ranges between (8.1-9.1) with sample A having highest value of 9.1,also for sample(A-H) alkalinity ranges between(73.04-117.07) 0with A having the highest value while sample H has the least value for alkalinity, for sample (A-H) analysed for zinc, all the samples contain values with detectable limit. However for samples(I-P) analysed for pH. pH ranges from 8.0 -8.4,with sample (O & P) having the least PH, and sample A having the highest value for pH, also for sample (I-P) analyzed for zinc all the

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CHAPTER ONE

PHYSIOCHEMICAL AND MICROBIAL CHARACTERISTIC OF PURE WATER SACHET SAMPLES IN ADO-EKITI

1.1 INTRODUCTION

"Water quality" according to (m. meybeck) is a term used here to express the suitability of water to sustain various uses or processes. Any particular use will have certain requirements for the physical, chemical or biological characteristics of water; for example limits on the concentrations of toxic substances for drinking water use, or restrictions on temperature and pH ranges for water supporting invertebrate communities. Consequently, water quality can be defined by a range of variables which limit water use. Although many uses have some common requirements for certain variables, each use will have its own demands and influences on water quality. Quantity and quality demands of different users will not always be compatible, and the activities of one user may restrict the activities of another, either by demanding water of a quality outside the range required by the other user or by lowering quality during use of the water. Efforts to improve or maintain a certain water quality often compromise between the quality and quantity demands of different users. There is increasing recognition that natural ecosystems have a legitimate place in the consideration of options for water quality management. This is both for their intrinsic value and because they are sensitive indicators of changes or deterioration in overall water quality, providing a useful addition to physical, chemical and other information. The composition of surface and underground waters is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal differences in runoff volumes, weather conditions and water levels. Large natural variations in water quality may, therefore, be observed even where only a single watercourse is involved. Human intervention also has significant effects on water quality. Some of these effects are the result of hydrological changes, such as the building of dams, draining of wetlands and diversion of flow. More obvious are the polluting activities, such as the discharge of domestic, industrial, urban and other wastewaters into the watercourse (whether intentional or accidental) and the spreading of chemicals on agricultural land in the drainage basin. Water quality is affected by a wide range of natural and human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water available. Their influence is generally greatest when available water quantities are low and maximum use must be made of the limited resource; for example, high salinity is a frequent problem in arid and coastal areas. If the financial and technical resources are available, seawater or saline groundwater can be desalinated but in many circumstances this is not feasible. Thus, although water may be available in adequate quantities, its unsuitable quality limits the uses that can be made of it. Although the natural ecosystem is in harmony with natural water quality, any significant changes to water quality will usually be disruptive to the ecosystem. MORESO , according to a research conducted by (department of community medicine, university of jos) pure water sachet is The commodity known as sachet water was introduced to the Nigerian market around 1990 and started attracting nationwide attention from 2000 when the NAFDAC registered 134 different 10 packaged water producers. This led to the emergence and proliferation of private water enterprises that operated side by side with the government-owned public water utilities. The private enterprises purportedly treat "not-fit-for drinking" water such as well water and borehole and in some case pipe-borne water, to make them fit for drinking, although the consumers cannot by themselves ascertain the quality of this drinking 9 water. Realistically, sachet water produced in recent years by small-scale industries has experienced drastic improvement in processing as the raw water is now treated by aeration, double or single filtration using porcelain molecular candle 11 filters or membrane filters. Water in sachets is readily available and the price is affordable, but there are concerns about its purity. The integrity of the hygienic environment and the conditions where the majority of the water in sachets are produced has also been questioned. Dada also documented the increased microbial contamination of sachet water 12 as it moved down the distribution line. Studies in Nigeria have documented claims of past outbreaks of water-borne illnesses resulting from the consumption of polluted sachet water, bacterial contamination with organisms such as bacillus sp, pseudomonas sp, klebsiella sp, streptococcus sp, alkalinity of the water and presence of chemicals such as aluminium and fluoride above the 12,13,14 recommended values. NAFDAC is mandated to enforce compliance with internationally defined drinking water guidelines, but the regulation of the packaged water industry aimed at good quality assurance has remained a challenge to the agency as it has in the past declared a possible 'gradual' nationwide ban on sachet waters to allow the manufacturers of sachet water to start winding down or change to bottle packaging though this is 11 yet to be seen. Observations in our immediate environment indicate a drastic increase in the population of sachet water consumers partly due to its affordability and the growing awareness of the consequences of the consumption of unsafe or untreated water. Also the industries that produce this commodity tend to be localised to the consumer area. This study has therefore been conducted to add to the body of evidence regarding sachet water. While a lot of studies have been done to assess the physical, chemical as well as microbiological quality of sachet water in Nigeria, relatively fewer studies have looked at the view of the populace regarding sachet water. Notwithstanding, majority of experts have given personal views based on their research. An example of this is Dada, who advocated for increased use and acceptance of the sachet water phenomenon and warned against labelling it as unfit for drinking by organizations responsible for maintaining standards for quality drinking water (NAFDAC, WHO) in Nigeria, citing 12 several pertinent reasons. He argued that the public perception of safety in favour of packaged water in Nigeria stems out partly from the inadequate attempts of previous governments to provide potable piped water. The second contributing factor to this perception, he argued, is the prevalent doubt on the quality of 'piped water' supplied at a reasonable charge by many informal vendors (called mai'ruwa) at the community level; its use being restricted for domestic purposes alone washing, bathing and cleaning. The sachet water, costing 5 naira to 10 naira (one bag containing 20 sachets each of 150 ml volume), is thus often relied upon for drinking purposes.

1.2 RESEARCH QUESTIONS

I. Is the water quality of sachet water found in Ado-Ekiti safe for drinking?
II. Are the water quality characteristics within acceptable limits?
III. Do sachet water companies comply with WHO standards? What is pure water sachet?
IV. What are the practical implications of unsafe water sachets?

1.3 AIM OF THE PROJECT

The aim of this research work is to investigate the physiochemical and microbial characteristics of pure water sachet found in Ado Ekiti.

1.4 OBJECTIVES OF THE PROJECT

The specific objectives are to:

(i) determine water quality parameters of sachet water found in Ado-Ekiti

(ii) suggest the ways to ensure compliance to safety regulations

1.5 SIGNIFICANCE OF THE PROJECT

The significance of the project is to:

a. reduce the incidence of water borne diseases in the study area;

b. improve the quality of pure water sachet in the study and

c. raise the level of awareness to the necessity of safe water sachet in the study area;

1.6 DEFINITION OF TERMS

I. **PHYSICAL CHARACTERISTICS OF WATER**: these are physical qualities of water which affect the quality of water e.g. Odour, taste, colour, turbidity.

II. **CHEMICAL CHARACTERISTICS OF WATER**: these are chemical qualities of water which affect the qualities of water e.g. anion (nitrate (NO_3^{-}), Sulphate (so_4^{2-}) ,phosphate(po_4^{3-})). Cation (calcium (ca^{2+}) ,magnesium(mg^{2+}) e.t.c., alkalinity, PH, Temperature ,B. O.D,C.O.D. e.t.c.

III. **MICROBIAL CHARACTERISTIC OF WATER**; these are microbiological qualities of water which affect the qualities of water. e.g. e.coli, faecal coli form, protist, e.t.c

IV. **SACHETE PURE WATER**

This is a common name given to about 500 ml of water packaged into sachets and sold freely in Nigerian market. The name "pure" does not often mean clean or safe for drinking but that it is presumed that it has undergone some water treatment.

CHAPTER TWO

2.1 LITERATURE REVIEW

2.2PHYSIOCHEMICAL AND MICROBIAL CHARACTERISTIC OFPURE WATER SACHET

The literature review in this research project is purposefully to give insight into various related research conducted by outstanding researcher on physiochemical and microbial characteristics of pure water sachet.

According to a research conducted by Journal of Clinical and Diagnostic Research (www.ncbi.nlm.nih.gov), in Dehli on physiochemical and bacteriological evaluation of packaging of sachet water in delhi which were available in the market, where sixteen water bottle and four sachet water were selected through stratified sampling from various public places in delhi and their analysis were done at test house, Ghaziabad. .Result were then compared with national (IS10500, IS14543) international (WHO, FDA, USEPA) standard. The result showed that water bottled showed better result than sachet water, the mean value of copper (0.0746mg/l) in bottled water exceed the standard value of IS10500,IS14543) while the mean value of lead (0.008mg/l) exceed the FDA standard value of (0.005), when the result of sachet water was compared with standard , the mean standard of selenenium (0.1195mg/l) and lead (0.862mg/l) were found to exceed both Indian and international standard. For biological parameters e.g. e.coliform count, the mean value for both was found to be 0(nil), whereas the mean value for sachet showed a value of 16 .75mg/l which showed the unhealthy nature of sachet. Therefore the parameters in the present study showed excess of various chemical and bacterial parameters in drinking water which pose a threat to consumers.

In another related research conducted by FUOYE Journal of Agriculture and Human Ecology (agriculture.fuoye.edu.ng) by Mr. Joseph Adeyeye ,two study area ikole and oye LGAS Ekiti state, Nigeria were selected .Eight samples from popular sachet water brandwere selected(four per local government areas) were purchased and labelled (A,B,C, D, E, F, G, H). From the study area, Oyeand Ikole LGAS, are located at the latitude: 7.893474, longitude: 5.511104 and latitude: 7.88942, longitude: 5.34482 respectively. The population of Ikole and Oye LGAS are 168,436and 134,210 respectively according to Nigerian census of 2006. There are no distinct ethnic group in these LGAS as a greater percentage of the resident is Yoruba language. Physical examination of sachet water brand was carried out in order to ascertain their external features such as label , presence of certification number and other product information ,the sachet water odour and appearance were also noted ,while flame atomic absorption spectrophotometer was used to detect heavy metals contamination such as lead, chromium, in water the water sample sprayed through a nebulizer into an air acetylene flame. Concerning the bacterial analysis in water, the most probable number technique was used for water analysis ,moreover, concerning the physiochemical analysis , hydrogen ion concentration (pH) was determined in insitu, the total dissolved solid was determined in in-situ using HANNA dissolved solid meter

2.3 AVAILABILITY AND ACCESSIBILITY OF SAFE DRINKING WATER

According to WHO (2008), safe drinking water is water that does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. The safety of water in public health is determined by its microbiological, physical, chemical and radiological quality of these, microbiological quality is usually the most important (ADWG, 1996). The provision of an adequate safe drinking water was one of the eight components of primary health care identified in 1978 by the International Conference on Primary Health Care (Dufour et al., 2002). Having better water and sanitation is essential in breaking the cycle of poverty since it improves people's health, strength to work, and ability to go to school (CAWST, 2009). Lack of safe drinking water is a serious threat to national development and may have a negative impact on the health status of its citizen and the overall performance of the work force. In many developing countries, availability of water is a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system (Okonko et al., 2008). The United Nations General Assembly adopted Resolution 64/292 recognizing that safe and clean drinking water and sanitation is a human right essential to the full enjoyment of life and all other human rights (WHO, 2011). Nigeria in the last four decades has witnessed a steady decline in the quality of service rendered by most public water 9 agencies (Amori and Makinde, 2012), which may be due to increase in population, deteriorations of the water supply facilities, poor management of resources, water pollution and lack of commitment from the government towards proving adequate and safe drinking water to its citizens which resulted in high cost of production of potable water. In the urban and rural areas of Nigeria, pipe borne water is supplied is through treatment plants owned by government while communities without water infrastructure depend directly on rivers, wells and boreholes as sources of drinking water, such sources of water are not suitable for human consumption as they are usually not treated and are contaminated by human and animal excreta and agricultural and industrial wastes (FMWR, 2000). Accessibility and availability of safe drinking water is very important for human survival. People's access to safe drinking water and adequate sanitation encourage personal, domestic and community hygiene which will improve the quality of life of millions of individuals (WHO, 2008). Access to safe drinking water is important as health and development issues at regional, national and local level. Interventions in improving access to safe water favour the poor whether in rural or urban areas, and can be effective part of poverty alleviation strategies (WHO, 2008). Despite global efforts toward the Millennium Development Goal's target, millions of people lack access to safe drinking water while billions people are not provided with improved, adequate sanitation and majority of these are in southern Asia (25%) and sub Saharan Africa (37%) (WHO, 2011). In many developing countries, availability of water is a matter of great concerns to families and communities more especially those who depend on non public water supply system (Okonko et al, 2008). The demand for treated water has exceeded the supply 10 capacity of the few available water treatment plants and consequently, water supply is irregular, epileptic and grossly inadequate. The inadequate investment in water infrastructure over the past few decades has restricted or even eliminated pipe water access on an increasingly large fraction of the urban population (Justin et al., 2012). According to USAID (1990), access to improved water and sanitation is a daily challenge for most Nigerians and the problem is particularly acute in Northern Nigeria where only few of the population have access to safe drinking water and adequate sanitation in which this situation leads to high prevalence of water borne diseases, threatening the livelihood of small holder farmers and contribute to low level of school enrolment especially among girls. The global water crises claims more lives through disease than any war claims through guns (USAID, 1990). This water scarcity results in further marginalization of living conditions and generates high rate of morbidity, particularly in most densely populated and generally poorest urban areas (Gaisie and Gyau-Boakye, 2007). The demand for good quality water for drinking and other purposes is no doubt exceeding supply especially in some regions of developing countries where drought has claimed thousands of lives and lifted economic and social damage

(Frederiksen, 1996). Water safety is affected by pollution from industry and wastewater, poor sanitation, weak infrastructure, unreliable services, and the need for collection, transportation and storage in the home (WHO, 2011). Contaminated drinking water, along with inadequate supplies of water for personal hygiene and poor sanitation, are the main contributors of diarrhea. The World Health Organization estimates that 88% of diarrheal disease is caused by unsafe water, inadequate sanitation and poor hygiene as a result, more than 4,500 children die every day from diarrhea and other diseases (CAWST, 2009). 11 In Nigeria the inadequacy of safe water and improved sanitation service is manifested in the prevalence of water and sanitation related diseases. Diarrhea which results from poor hygiene habits and consumption of poor quality water is the second main cause of infant mortality after malaria and the third main cause of under five mortality (FMWR, 2000). The prevalence of diarrhoea is higher in the rural than urban areas and in the northern zone than in the south of Nigeria (FMWR, 2000). The high morbidity and mortality rates and the impact of these diseases are due to a combination of inadequate health care, water supply and sanitation services and unhygienic practices. The drive for poverty reduction in Nigeria recognizes water supply and sanitation as an important component (FMWR, 2000).

2.4 PACKAGED DRINKING WATER

The challenges associated with drinking water have encouraged the production of packaged drinking water by private enterprises that have little knowledge about manufacturing practices (Edema et al., 2011). The increasing demand for safe drinking water has led to production of bottled water and sachet water popularly called "pure water" as an alternative, and considered it being safe for drinking. Bottled water consumption has been steadily growing up in the last three decades at a global level and only individuals who have good financial status can afford bottled water while the low income earners are left with no option but to consume sachet water that is cheaper and affordable (Adegoke et al., 2012). Studies have shown that most bottled water manufacturers in Nigeria also engage in sachet water packaging and obtain their raw water mostly from local municipal pipe water or well water (Oyedeji et al., 2010). Worldwide, sales of bottled water increase by 12 an average of 12% every year, and consumers may have reasons for purchasing bottled water, such as taste, convenience, but for many consumers, safety and potential health benefits are important considerations (Magda et al., 2008). Results of studies conducted on the quality of bottled water in many countries to assess its suitability for human consumption indicated variation in the quality. The quality of water may vary from one source to another based on several parameters such as water sources, type of water purification, and storage tanks (Mufeed, 2006). There are concerns about chlorine byproducts, contaminants such as lead, nitrates and microorganisms contamination in municipal water supplies however, some microorganisms, which are normally of little or no public health significance, may grow to higher levels in bottled water (WHO, 2008). Study conducted by International Bottled Water Association revealed that 25% of all bottled water is simply tap water placed in a bottle (Magda et al., 2008). In addition, the quality of bottled water can also substantially vary among brands as well as with time and with different production runs depending on its source, treatment technology, manufacturing operations, packaging material and shelf life before use, although bottled water should have a shelf life of 30 days unopened but most bottled water companies' labels show that their water is valid to 1 or 2 years (Magda et al., 2008). On the other hand, bottled water are most commonly disinfected with ozone, which provides a residual disinfection for a limited time and subsequently does not leave a residual taste like tap water, which uses chlorine as a final disinfectant(Magda et al., 2008). The length of time chlorine and ozone remain active in water depends on many factors including temperature. However, bottle water may be in distribution and storage conditions for several weeks, which may adversely affect its quality. According to (Magda et al., 2008) in mid 1970s there was an outbreak of Cholera in Portugal due to consumption of bottled 13 water and the Center for Disease Control and Prevention reported in 1994 an outbreak of cholera in the United States associated with bottled water. The introduction of sachet water in Nigeria was a laudable idea but studies suggested that this innovative idea is not risk free (Alli et al., 2011). The sachet drinking water was introduced into Nigeria as less expensive means of accessing drinking water than bottled water (Oyedeji et al., 2010). It also acts as improvement over the former types of drinking water packaged for sale to consumers in hand filled and tied in polythene bags (Oyedeji et al., 2010). Today, the easy accessibility to drinking water in packaged forms has resulted in big thriving water industries with several millions of litres of these products consumed every year by Nigerians (Ogundipe, 2008). Most people in the cities and rural communities depend on sachet water as their ultimate source of drinking water. The integrity of sachet water is doubtful in fact, it has been reported that most vendors do not treat their sachet water before selling to the public and many who are engaged in the production do not follow strictly standard set by Federal Environmental Protection Agency and World Health Organisation (Okpako et al., 2009; Oladipo et al., 2009). The consumption of sachet water in Nigeria is on alarming rate and people are not mind full of the source, quality and possible consequence associated with sachet water consumption. Occasionally, contamination of sachet water may occur either during processing, transportation and improper handling by hawkers and source of the water used for the production (Adegoke et al., 2012). Apart from health implication, contaminated drinking water also has serious socio-economic and political implication (Mukhtar and Oyeyi, 2005). This become of concern to public health worker and right thinking individual when considering the fact that public health including nursing 14 mothers patronize the vendor to procure water for their small children (Oladipo et al., 2009). Despite its popularity, studies conducted on the bacteriological quality of sachet water in some African cities have catalogued various levels of contamination (Adenkunle et al., 2004; Ifenyi et al., 2006; WHO, 2011). Most of the brands fall below World Health Organisation standard for drinking water and are therefore of doubtful quality. Adherence to production and analytical standard are doubtful as most of the factories are observed to lack the appropriate technology for achieving these (Alli et al., 2011). The standard of hygiene in the various stages of production of bottle and sachet water varies among various manufacturers while some employ sophisticated techniques such as ozonization and reserve osmosis. Most use ordinary boiling of well water and exclusion of particles by use of unsterilized filtration materials (Oyedeji et al., 2010). Researches conducted in different parts in Nigeria and Ghana have shown the existence of various forms of harmful bacteria and fungi in the sample of sachet water analyzed. Edema et al.(2011) examined the bacteriological quality of sachet water sold in Nigeria in which, the result indicated that 85% contain Escherichia coli and 65% of the polythene sachet used is not food grade quality and impacted polyester taste in the water. Study conducted by Adegeko et al. (2012) on sachet water in Abia State of Nigeria revealed that 5 brands out the 10 met up international standard for drinking water. Ezeugwunne et al. (2006) isolated Streptococcus faecal is, Pneumonia and Staphylococcus aureus from sachet water examined in Nnewi, Nigeria. Nwachukwu and Emeruem (2007) examined the presence of antibiotic resistant bacteria in sachet water in which various heterotrophic bacteria are resistant to eight common antibiotics. Nwosu and Ogueke (2004) isolated E. coli from sachet water examined in Owerri metropolis, 15 Nigeria. Study from Abakaliki, Nigeria by Afiukwa et al. (2010) revealed that all twenty brands of sachet water sampled contained eleven strains of bacteria which are multi-drugs resistant while Ngozi et al. (2010) isolated Klebsiella species and Enterobacter species in sachet water sampled in

Abakaliki. Study in Port Harcourt by Alli et al.(2011) on 100 different brands of sachet water indicated that 20% of the water samples harboured parasites which were attributed to the environmental condition of the area where they are produced.Okpako et al., (2009) conducted a study on the quality of drinking water in Calabar, Nigeria in which 75% of the samples contained at least two fungi species. Similarly, Dada (2009) reported22% non compliance with the regulatory standard from 100 samples of 10 brands of sachet water in Lagos. Moreover, another study conducted in Lagos, Nigeria revealed that bacteriological characteristics of sachet water deteriorate considerably as products moved further down the distribution chain. Less than 7% of sachet water contamination took place after the production (Omalu et al., 2010). Egwari and Aboaba (2002) in Lagos, southwest Nigeria conducted bacteriological study of sachet water found no enteric pathogen in the water. Study conducted in Ibadan by Ajayi et al., (2008), showed that bottled water sampled was in compliance but 30% of sachet water sampled did not comply. Indeed 5% of 78 samples showed positive coliform count. A second study from Ibadan conducted by Oyedejiet al. (2010) who examined 16 brands that include samples from Ile-ife, one brand of bottled water result indicated positive coliform count while all the sachet water brands showed bacterial growth. Study conducted by Adenkunle et al. (2004) on quality of sachet water in Ibadan, Nigeria indicated 6.4% bacterial growth. Taiwo et al. (2012) analysed the bacteriological properties of 20 brands of sachet water in Abeokuta the capital of Ogun State, Nigeria, and found that all the sachet water were 16 within the permissible limits, and they concludes that there is improvement in the quality of the sachet water produced in Abeokuta metropolis. However, Popoola et al. (2007), conducted a study on potable water in Abeokuta and isolated several bacteria species were isolated from stored water samples which have significant health implications. Oyagade and Fasuan, (2004) reported the occurrence of antibiotic resistant strains of Escherichia coli in water used for drinking purposes by Nigerians communities which signals additional danger with the use of water stored for long period of time. coli were the most consistent bacteria species encountered in the water samples at the different stages of storage. On fade and Iiori (2008) examined qualities of sachet water in Ondo State, Nigeria where the result indicated E. Coli which exceeded the international drinking water limit. Oladipo et al., (2009) isolated fourteen bacteria, including Bacillus, Pseudomonas species, Enterobacter aero genes and Proteus mirabilis from the sachet water tested in Ogbomosho, Nigeria. Ante et al. (2007) conducted a research on the portability of sachet water in Kaduna State, where the microbial parameters exceeded World Health Organisation Standard for drinking water. Similarly, a study conducted by Yahiya et al.(2011) on public drinking water in parts of Zaria, Nigeria observed the occurrence and elevated number of coli form bacteria within the period of the research.. Kalpana et al. (2011) also examined quality of sachet water sold in Kebbi State University and the nearby market in the city and reported to be contaminated. Microbial quality of sachet water marketed in Maiduguri metropolis eastern Nigeria was examined by Muaza et al. (2012) revealed the presence of coli form, 95% of the sachet examined are not fit for human consumption and hazardous to human health. . 17 Obiri-Danso et al. (2003) examined the microbial quality of sachet drinking water and bottle water sold on the street of Kumasi, Ghana, concluded that bottled water in the Ghanaian market is of good microbial quality. Study by Dodoo et al.(2006) in the cape coast of Ghana indicated high level of contamination by microorganisms. Addo et al. (2009) reported that, the quality of sachet water in Teshi-Nungua, Ghana contain coli form bacteria. Quality of bottle and sachet water in Tarka-Nsuaem municipality of Ghana assessed by Nana and Amorin (2011) revealed that, both microbial and the physicochemical parameters satisfy the international and Ghana drinking water standard. Emmanuel and Solomon, (2012) examined the quality of sachet water and bottle in the Bolgatanga Municipality of Ghana, the study revealed that except for low level of fluoride ion in some brands, sachet and bottled water brands sold in Bolgatanga municipality possessed acceptable physicochemical characteristics. However, the bottled water brands generally possessed good bacteriological characteristics, while the bulk of sachet water brands were contaminated by coliform bacteria. In Nigeria, the National Agency for Food and Drug and Administration Control is the parastatal under the Federal Ministry of Health charged with the responsibility for the regulation and control of imported and locally processed food, drugs and water products (Omotayo and Denloye, 2002). To ensure strict adherence to international standards, National Agency for Food and Drug Administration Control's regulation for bottled and sachet water in Nigeria has been put at the standards established by the World Health Organisation, and according to these standards, potable water for human consumption must be free of microbial indicators of feacal contamination, and coliform count per 100mL of drinking water be zero (WHO, 1997; Pierre, 1999). 18 Several studies on microbial quality of bottled and sachet water have indicated violation of international quality standard which is adopted governmental organization such as National Agency for Food and Drug Administration and Control, Federal Environmental Protection Agency and Standard Organization of Nigeria. Surveillance carried out by National Agency for Food and Drug Administration and Control between 2004 and 2005 revealed that some producers of packaged water indulge in quick practices such as packaging of untreated water, production under unhygienic condition, illegal production of unregistered water in unapproved premises, use of non-food grade sachet and release of packaged water for distribution and sale without date marking, these malpractices compelled the agency to formulate guideline for the production of wholesome packaged water (Edema et al., 2011)

CHAPTER THREE

MATERIALS AND METHOD

3.1 STUDY AREA

ADO-EKITI is capital city of Ekiti State in Nigeria. It is therefore the most important city in the state. It is cosmopolitan city comprising of people of divers culture and economy status.

Ado-Ekiti is located 7.62 latitude and 5.22 latitude it is situated at an elevation of 439 meters above sea level, It has a population of 424,330 making it the biggest city in Ekiti- State. The population consists of civil servants at state and federal levels, business men and women, artisans and local farmers. It has two (2) universities located in Ado-Ekiti.

The study was carried out at Ado-Ekiti metropolis the study area was divided into four zones. It is situated at an elevation of 439meters.

3.2 SAMPLE COLLECTION

A Total of 16 brands of pure water sachet was purchased within Ado-Ekiti metropolis ,Nigeria was randomly selected and was labelled A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P.

3.3 EXPERIMENTAL DESIGN

At collection, samples collected were analysed for microbial and physicochemical to assess the quality of the water. The sachet pure water was randomly selected from the stored samples for determination of microbial load and physicochemical properties such as colour, taste, odour, turbidity, temperature, , total dissolved solids, total hardness, chloride, sulphate, nitrate etc.

3.4 LABORATORY ANALYSIS

3.4.1 pH MEASUREMEANT

The measurement of pH was carried out using pH a well calibrated HANNA Hi208 Ph meter and following standard procedures.

3.4.2 ELECTRICAL CONDUCTIVITY

The Electrical conductivity of the sample was measuredusing DDS-307 Conductivity meter.

3.4.3 DETERMINATION OF LABORATORY ANDLYSIS

The Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand, Total Hardness, Chloride, Alkalinity, Sulphate and Nitrate were determined following standard procedures described in the Appendix.

3.4..4 DETERMINATION OF DISSOLVED OXYGEN

To determine the dissolved oxygen, a dilution of water was added to 1ml of each of the following reagent: phosphate buffer, magnesium sulphate, calcium chloride, and iron(III) chloride solution to 1litre of distilled water, and then aerated with a supply of clean compressed air (see appendix for detail procedure).

Several dilutions of the prepared sample so as to obtain drop in oxygen content. I put the prepared sample into a DO bottle ,filled to the brim.2ml MnSO4 solution and 2ml alkaline iodide reagent were added well below the surface of the liquid stopper with care to exclude air bubbles and mixed by inverting the bottle a number of times until a clear supernatant water is obtained.(if the reagent were added at the site of the sampling ,the solution may be left at this stage until it got to the laboratory)It was then allowed to settle for about 2min.I latter Add 2ml conc. H_2SO4 to the neck of the bottle stopper and then mixed by gentle inversion until dissolution is completed . I Add 1-2ml starch solution to ensure uniform solution before the quantity needed for titration was decanted. Na_2S_2O3 was then titrated with the solution and the colour changed from blue to original colour of sample

3.4.5 DETERMINATION OF CHEMICAL OXYGEN DEMAND

I Pippete10ml of water sample ; I measured 15ml of 0.025N potassium dichromate with a measuring cylinder. I latter add 15ml of concentrated sulphuric acid and diluted with 40ml of distilled water to get 70ml solution. 7 drops of phenolthroline ferrous sulphate indicator was added. This was allowed to cool.

Observation: the colour changed from greenish blue to orange colour, and then titration was done on the blank sample.

N.B: The titre value for the blank sample is higher than the titre value of the sample.

3.4.6 DETERMINATION OF BIOLOGICAL OXYGEN DEMAND

Procedure:

The five-BOD was computed from the DO value initial and 5-day,

For DO_5 Prepared duplicate sample and incubate in the dark at 20^0 for 5day.

The DO on day 5 in the incubated sample was determined thus.

BOD mg/l=$DO_0 - DO_5$

Where

DO_0,= dissolved oxygen on initial day

DO_5 =dissolved oxygen on day5.

3.4.7 DETERMINATION OF TOTAL HARDNESS

Total hardness was achieved thorough shaking of sample and measuring 25ml into a cylinder which was top to 50ml with distilled water and then poured into conical flask. 2ml of buffer solution with a drop of erichrome black T indicator were added to it .The sample was gently shaken and was titrated with a solution of o.o2 EDTA as a titrant to a blue colouration as end point. The actual concentration of total hardness in mg/l as $CaCo_3$ was gotten using the formular given below

$$\text{Total hardness}(mgl^{1-} \text{as } CaCo_3) = \frac{A \times B}{z} \times 1000 \quad (3.2)$$

where : A=Ml of titrant used to reach end point

B= 2.5252

Z= ml of sample used for analysis (25ml).

3.4.8 DETERMINATION OF CHLORIDE

100ml of sample was measured into a conical flask. I latter add 2ml of standard potassium chromate as an indicator and the solution was titrated with silver nitrate solution to a redish brown colouration as end point. Concentration of chloride in mg per liter is obtained.

3.4.8 DETERMINATION OF ALKALINITY

A 50ml of sample was measured water into a conical flask,I latter add 2-3 drops of sodium thiosulphate to regulate or isolate the chloride in the water,i also add 2 drops of methyl orange as an indicator to give the initial colour, H2SO4 serve as titrant in the burrete .I thus titrate from yellow as initial colour to orange as final colour, the difference between the final reading and initial reading is called titre value. the titre value multiply by 20 is the alkalinity .

3.4.9 DETERMINATION OF SULPHATE

I determined the sulphate of the sample by transferring 25ml of water sample and 25ml of distilled water into 250 conical flask. I added one gram of barium chloride, I stirred and allowed to stand for 30minute, and the colour intensity was then measured at 430nm on Sherwood 175 colorimeter.

3.4.10 DETERMINATION OF NITRATE

A 1001ml of water sample was poured into a clean dry crucible and kept in an oven at 100c^{o}till dryness. It was then removed and allowed to cooled after which 2ml of phenol disulphonic acid was added and swired round uniformly, after 10minutes, 10ml of distilled water was added in which 5ml of ammonial solution was added. Colour changes was read at 430nm on Sherwood 175 colorimetr.

CHAPTER FOUR

4.1 RESULTS

Physiochemical Parameters of 16 Samples Of Sachet Water In Ado Ekiti.

Table (4.1) shows that for samples (A-H), there was no significant differences in values of samples(A-H) analysed for PH, zinc, iron, calcium, chloride, nitrate, and hardness while there was significant difference in the value analysed for conductivity, alkalinity, TDS. Meanwhile (Table 4.2) shows that for samples(I-P),there was no significant difference in the values of samples (I-P) analysed for PH,alkalinity ,hardness,zinc,iron ,calcium, nitrate, sulphate ,while for conductivity, TDS there was significant difference .For sample (A-H),temperature ranges from 8.4-9.1,with sample A, having the highest pH of 9.1,also,for sample (A-H) , alkalinity ranges from 73.04-117.07with A having the highest value while sample H has the least value for alkalinity,for sample (A-H) analysed for zinc,all the samples contain values with detectable limit.However for samples(I-P) analysed for pH. pH ranges from 8.0 - 8.4,with sample (O & P) having the least PH, and sample A having the highest value for pH,also for sample (I-P) analyzed for zinc all the

4.2 Physical Parameters of Sixteen Sachet Water Sold in Ado-Ekiti

The result shows that all samples was colourless, odourless, tasteless, and not turbid after collection and after storage at ambient temperatures (Table 4.3a& Table 4.3b).

4.3 Physical Information For Labelling compliance of Sachet Water in Ado-Ekiti

Physical examination of the sachet water sold in Ado-Ekiti was done for labelling compliance The result showed that all brand displayed the manufacturing number, address, and national agency for food and drug administration and control number, vital information such as manufacturing date, expiring date, nutritional information was not displayed

TABLE 4.1

Mean Value(±S.E) Of Physiochemical Characteristic of Sachet Water Sold In Ado-Ekiti

Parameters	Sample A	Sample B	sample C	Sample D	Sample E	Sample F	Sample G	Sample H	WHO Standard
Ph	9.1± 0.10^b	8.7± 0.10^a	8.6± 0.10^a	8.4± 0.10^a	8.6± 0.10^a	8.8± 0.10^a	8.6± 0.10^a	8.7± 0.10^a	6.5-8.5
Conductivity	190± 0.56^d	**188±** $\mathbf{0.56^d}$	141± 0.56^c	166± 0.56^c	102± 0.56^c	27± 0.56^b	12± 0.56^a	13± 0.56^a	400
TDS(ppm)	123± 0.58^c	119± 0.58^c	91± 0.58^b	105± 0.58^c	65± 0.58^b	16±0.58a	6 ± 0.58^a	7± 0.58^a	1000
Alkalinity (mg/l)	117.07 ± 0.01^c	103± 0.01^c	**103±** $\mathbf{0.01^c}$	**98±** $\mathbf{0.01^b}$	8.33± 0.01^a	8.33± 0.01^b	78.56± 0.01.	73.04± 0.01	500
Hardness(mg/l)	**2.06±** 0.06^b	1.97± 0.06^b	1.67 ± 0.06^b	1.83 ± 0.06^b	1.26± 0.06^b	98.33 ± 0.06^c	0.47 ± 0.60^a	0.47± 0.06^a	500
Zinc(mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	-
Iron(ppm)	0.012± 0.05^a	0.010± 0.056^a	0.010 ± 0.056^a	0.010± 0.56^a	0.20± 0.056	ND	ND	ND	0.3
Calcium (ppm)	11.01± 0.01^a	11.01± 0.01^a	9.70± 0.01^a	10.33± 0.01^a	7.11± 0.01^a	6.47± 0.01^a	6.01± 0.01^a	6.67± 0.01^a	75
Chloride	1.67±	1.33±	0.98±	0.98±	0.76±	0.67±	0.33±	0.33±	250

Parameters	Sample A	Sample B	sampl e C	Sample D	Sample E	Sample F	Sample G	Sample H	WHO Standard
(ppm)	0.58^{b}	0.58^{b}	0.58^{a}	0.58^{a}	0.58^{a}	0.58^{a}	0.58^{a}	0.58^{a}	
Nitrate(pp m)	1.98± 0.06^{a}	1.89± 0.06^{a}	1.80± 0.06^{a}	1.67± 0.06^{a}	1.45± 0.06^{a}	1.33± 0.06^{a}	1.19± 0.06^{a}	1.67± 0.06^{a}	50
Sulphate (ppm)	7.22± 0.56^{a}	7.22± 0.56^{a}	6.31± 0.56^{a}	6.89 $\pm0.56^{a}$	5.78 $\pm0.56^{a}$	4.01 $\pm0.56^{a}$	3.89 $\pm0.56^{a}$	3.89 $\pm0.56^{a}$	250

TABLE 4.2

Mean values (±S.E) of Physiochemical Characteristics Of Sachet Water in Ado- Ekiti

Paramete r	**Sample I**	**sample J**	**Sample K**	**Sample L**	**Sample M**	**Sample N**	**Sample O**	**Sample P**	**WHO Standar d**
PH	8.3± 0.56^{a}	8.0 $\pm0.56^{a}$	8.0 $\pm0.56^{a}$	8.4 $\pm0.56^{a}$	8.4 $\pm0.56^{a}$	8.3 $\pm0.56^{a}$	8.0 $\pm0.56^{a}$	8.0 $\pm0.56^{a}$	6.5-8.5
Conducti vity	144± 0.01^{c}	135 $\pm0.01^{c}$	106 $\pm0.01^{c}$	55 $\pm0.01^{b}$	29 $\pm0.01^{a}$	58 $\pm0.01^{b}$	60 ±0.01b	152^{c} ±0.01	400
TDS (ppm)	95± 0.58^{d}	84± 0.58^{d}	67 $\pm0.58^{c}$	35 $\pm0.58^{b}$	17 $\pm0.58^{a}$	35 $\pm0.58^{b}$	95 $\pm0.58^{d}$	95 $\pm0.58^{d}$	1000
Alkalinit y (mg/l)	71.67 $\pm0.58^{a}$	71.67 $\pm0.58^{a}$	81.00 $\pm0.58^{a}$	73.04 $\pm0.58^{a}$	78.56 $\pm0.58^{a}$	69.50 $\pm0.58^{a}$	66.01 $\pm0.58^{a}$	67.97 $\pm0.58^{a}$	500

Parameter	Sample I	sample J	Sample K	Sample L	Sample M	Sample N	Sample O	Sample P	WHO Standard
Hardness (mg/l)	1.67 ±0.58[a]	1.33 ±0.58[a]	1.41 ±0.58[a]	0.97 ±0.58[a]	0.47 ±0.58[a]	0.97 ±0.58[a]	1.03 ±0.58[a]	1.78 ±0.58[a]	500
Zinc (ppm)	ND	ND	ND	ND	ND	ND	ND	ND	3.0
Iron (ppm)	0.020 ±0.06[a]	0.020 ±0.06[a]	0.020 ±0.06[a]	0.010 ±0.06[a]	ND	0.010 ±0.06[a]	0.010 ±0.06[a]	0.010 ±0.06[a]	0.3
Calcium (mg/l)	9.56 ±0.01[a]	7.67 ±0.01[a]	6.60 ±0.01[a]	7.23 ±0.01[a]	7.67 ±0.01[a]	9.67 ±0.01[a]	9.43 ±0.01[a]	10.36 ±0.01[a]	75
Chloride (ppm)	0.67 ±0.56[a]	0.56 ±0.56[a]	0.56 ±0.56[a]	0.47 ±0.56[a]	0.33 ±0.56[a]	0.47 ±0.56[a]	1.00 ±0.56[a]	1.33 ±0.56[a]	250
Nitrate (ppm)	1.45 ±0.50[a]	1.45 ±0.50[a]	1.67 ±0.50[a]	1.56 ±0.50[a]	1.33 ±0.50[a]	1.34 ±0.50[a]	1.51 ±0.50	1.89 ±0.50[a]	50
Sulphate (mg/l)	6.31 ±0.01	6.67 ±0.01	5.54 ±0.01	5.09 ±0.01	4.33 ±0.01	5.01 ±0.01	6.68 ±0.01	7.51 ±0.01	250

Table 4.3a: Physical Parameters of sachet water sold in Ado-Ekiti

Parameter	sample A	Sample B	Sample C	sample D	Sample E	Sample F	sample G	sample H	WHO standard
Odour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15TCU
Colour	Colourl ess	Colourl ess	colourl ess	colourl ess	colourl ess	colourl ess	colourl ess	colourl ess	unobjectio n
Taste	Tastele ss	Tasteles s	Tastele ss	Tastele ss	Tastele ss	Tastele ss	Tastele ss	Tastele ss	unobjectio
Turbidity	0.39	0.32	0.31	0.32	0.30	0.30	0.31	0.30	5NTU

Table4.3b

Physical Parameters of sachet water sold in ado-Ekiti

Parameter s	Sample I	Sampl eJ	Sample K	sampl eL	sampl eM	Sampl eN	sample O	sample P	WHO standard
Odour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15TCU
Colour	Colourl ess	Colour less	colourl ess	colour less	colour less	colour less	colourl ess	colourl ess	unobjectio n
Taste	Tastele ss	Tastel ess	Tastele ss	Tastel ess	Tastel ess	Tastel ess	Tastele ss	Tastele ss	unobjectio
Turbidity	0.32	0.34	0.33	0.30	0.30	0.30	0.32	0.32	5NTU

4.4 Microbial Characteristics of Sachet Water Sold in Ado-Ekiti

Sixteen sachet pure water were obtained from sixteen brands and analysed for total coliform, E. Coli , and S.aeurus, and the result showed that for sample (A-H) analysed for total coliform and E coli, the result shows that all the samples record no occurrence for both parameter, and for S.aeurus only sample F were observed to have record of occurrence (Table 4.4a).

However, the result for sample(I-P) analysed for total coliform and Ecoli shows that all the samples have no records of occurrence, but for parameter S.aeurus only sample (O & P) was found to have occurrence. (Table 4.4b)

Table 4.4a Mean Value of Microbial Parameters In Sachet Water sold in Ado-Ekiti

Parameters	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	Sample G	Sample H
Total coliform (cfu/ml	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecoli (cfu/ml)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.aeurus (cfu/ml)	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00

Table 4.4b

Mean Value of Microbial Parameters In Sachet Water sold in Ado-Ekiti

Parameters	Sample I	Sample J	Sample K	Sample L	Sample M	Sample N	Sample O	Sample P
Total coliform (cfu/ml	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecoli(cfu/ml)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.aeurus(cfu/ml)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00

CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATIONS

1. Physical examination of sachet water sold in Ado-Ekiti for labelling compliance showed that all the samples displayed the manufacturing number, address and national agency for food drug administration and control number.

2. Analysis of all the samples of water sachet sold in Ado-Ekiti for physical parameters showed that all the samples were colourless, odourless and tasteless.

3. Analysis of samples of water sachet sold in Ado-Ekiti for microbial parameters shows that all the samples analysed for total coliform and Ecoli record no occurrence, but samples analysed for S.auerus, only sample (F ,O,P) had occurrence for S.auerus.

5.2 RECOMMENDATION

1. Considering the high patronage of sachet water in the study area, it is recommended that all manufacturing industry must adhere to NAFDAC guideline and all existing rule should be enforced.
2. Furthermore, to safe guide the health of the people, there is need for regular monitoring of water quality and the environment where they are produced by NAFDAC.
3. In addition, there is need for general awareness program to educate the people on the potential health implication associated with consumption of such product.

APPENDIX

DETERMINATION OF DISSOLVED OXYGEN

To determine the dissolved oxygen, a dilution of water was added to 1ml of each of the following reagent: phosphate buffer, magnesium sulphate, calcium chloride, and iron(III) chloride solution to 1litre of distilled water, and then aerated with a supply of clean compressed air (see appendix for detail procedure).

Several dilutions of the prepared sample so as to obtain drop in oxygen content. I put the prepared sample into a DO bottle ,filled to the brim.2ml MnSO4 solution and 2ml alkaline iodide reagent were added well below the surface of the liquid stopper with care to exclude air bubbles and mixed by inverting the bottle a number of times until a clear supernatant water is obtained.(if the reagent were added at the site of the sampling ,the solution may be left at this stage until it got to the laboratory)It was then allowed to settle for about 2min.I latter Add 2ml conc. H_2SO4 to the neck of the bottle stopper and then mixed by gentle inversion until dissolution is completed . I Add 1-2ml starch solution to ensure uniform solution before the quantity needed for titration was decanted. Na_2S_2O3 was then titrated with the solution and the colour changed from blue to original colour of sample

DETERMINATION OF CHEMICAL OXYGEN DEMAND

I Pippete10ml of water sample ; I measured 15ml of 0.025N potassium dichromate with a measuring cylinder. I latter add 15ml of concentrated sulphuric acid and diluted with 40ml of distilled water to get 70ml solution. 7 drops of phenolthroline ferrous sulphate indicator was added. This was allowed to cool.

Observation: the colour changed from greenish blue to orange colour, and then titration was done on the blank sample.

N.B: The titre value for the blank sample is higher than the titre value of the sample.

DETERMINATION OF BIOLOGICAL OXYGEN DEMAND

Procedure:

The five-BOD was computed from the DO value initial and 5-day,

For DO_5 Prepared duplicate sample and incubate in the dark at 20^0 for 5day.

The DO on day 5 in the incubated sample was determined thus.

BOD mg/l=$DO_0 - DO_5$

Where

DO_0,= dissolved oxygen on initial day

DO_5 =dissolved oxygen on day5.

DETERMINATION OF TOTAL HARDNESS

total hardness was achieved thorough shaking of sample and measuring 25ml into a cylinder which was top to 50ml with distilled water and then poured into conical flask. 2ml of buffer solution with a drop of erichrome black T indicator were added to it .The sample was gently shaken and was titrated with a solution of o.o2 EDTA as a titrant to a blue colouration as end point. The actual concentration of total hardness in mg/l as $CaCo_3$ was gotten using the formular given below

$$\text{Total hardness}(mgl^{1-}\text{as } CaCo_3) = \frac{A \times B}{z} \times 1000 \quad (3.2)$$

where : A=Ml of titrant used to reach end point

B= 2.5252

Z= ml of sample used for analysis (25ml).

DETERMINATION OF CHLORIDE

I measured 100ml of sample into a conical flask. I latter add 2ml of standard potassium chromate as an indicator and the solution was titrated with silver nitrate solution to a redish brown colouration as end point. Concentration of chloride in mg per liter is obtained.

DETERMINATION OF ALKALINITY

I measured 50ml of sample water into a conical flask, I latter add 2-3 drops of sodium thiosulphate to regulate or isolate the chloride in the water, I also add 2 drops of methyl orange as an indicator to give the initial colour, H2SO4 serve as titrant in the burrete .I thus titrate from yellow as initial colour to orange as final colour, the difference between the final reading and initial reading is called titre value. the titre value multiply by 20 is the alkalinity .

DETERMINATION OF SULPHATE

I determined the sulphate of the sample by transferring 25ml of water sample and 25ml of distilled water into 250 conical flask. I added one gram of barium chloride, I stirred and allowed to stand for 30minute, and the colour intensity was then measured at 430nm on Sherwood 175 colorimeter.

DETERMINATION OF NITRATE

I Poured 1001ml of water sample into a clean dry crucible and kept in an oven at 100c°till dryness.It was then removed and allowed to cooled after which 2ml of phenol disulphonic acid was added and swired round uniformly, after 10minutes, 10ml of distilled water was added in which 5ml of ammonial solution was added. Colour changes was read at 430nm on Sherwood 175 colorimetr.

REFERENCES

Adegoke, O. A., Bamigbowu, E. O., Oni, E. S. and Ugbaja. K. N. (2012). Microbiological Examination of Sachet Water Sold in Aba, Abia State, Nigeria. *Global Research Journal of Microbiology*

Ashaye, O. A., Couple, A. A., Afolabi O. O. and Fasoyiro, S. B. (2001) Physicochemical Properties of Pure Water Samples in South Western Nigeria. *Journal of FoodTechnology in Africa,* 4:119-120.

Ezeugwunne, J, P., Agbakoba, N. R., Nnamah, N. K. and Anahalu, I.C (2006). The Prevalence of Bacteria in Packaged Sachet Water Sold in Nnewi, South East, Nigeria. *World Journal.of Dairy and Food Science,* 4:19-21.

Federal Ministry of Water Resources (FMWR) (2000).National Water Supply and Sanitation Policy. First Edition – January, pp. 1-30

Frederiksen, H.D. (1996). Water Crises in Developing World: Misconceptions About Solutions. *Journal of Water Resource Planning and Management,* 122

Kalpana, S., Bagudo, A.I. and Aliero, A. A. (2011), Microbiological Analysis of Sachet Drinking Water Marketed at Two Sites in Aliero, Kebbi State, Nigeria. *Journal Microbiology,* 5 (1): 29 – 36.

Ngozi, A.F., Romanus, I.I., Azubuike, A.C., Eze, A.T., Egwu, O.A. and Collins, O.N. (2010).Presence of Coliform Producing Extended Spectrum Beta Lactamase in Sachet-Water Manufactured and Sold in Abakaliki, Ebonyi State, Nigeria. International Research Journal of Microbiology 1:32-36

Nwosu, J. N. and Ogueke, C.C. (2004).Evaluation of Sachet Water Samples in Owerri Metropolis.*Nigerian Food Journal.*22:164-170