BACTERIOLOGICAL AND PHYSICOCHEMICAL QUALITY OF GROUNDWATER IN THE SURROUNDING ENVIRONMENT OF SOLOUS LANDFILL, IGANDO

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF BIOLOGICAL SCIENCES AND BIOTECHNOLOGY, COLLEGE OF PURE AND APPLIED SCIENCES, CALEB UNIVERSITY, IMOTA, LAGOS STATE, NIGERIA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (B.Sc.) IN MICROBIOLOGY AND INDUSTRIAL BIOTECHNOLOGY FROM THE DEPARTMENT OF BIOLOGICAL SCIENCES AND BIOTECHNOLOGY, CALEB UNIVERSITY,

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DECLARATION

I, AGBONHESE NATSHA ISEDUAL, do hereby declare that this project work entitled "Bacteriological and Physicochemical Quality of Groundwater in the Surrounding Environment Of Solous Landfill, Igando" is a record of an original work done by me, as a result of my research effort carried out in the Department of Biological Sciences and Biotechnology, Caleb University Imota, Lagos.

Students signature and Date

CERTIFICATION

This is to certify that this project titled Bacteriological And Physicochemical Quality Of Groundwater In The Surrounding Environment Of Solous Landfill was carried out by AGBONHESE NATASHA ISEDUAL with matric number 18/4928 in the Department of Biological Sciences and Biotechnology, College of Pure and applied sciences, Caleb University, Imota, Lagos Nigeria.

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TABLE OF CONTENT

LIST OF TABLES

ABSTRACT

Groundwater contamination occurs from urban activities, industrial discharges, agricultural activities, landfill leachates, and effluent from wastewater treatment plants that have progressed over time without any regards for environmental consequences .The quality of groundwater around Igando area, Lagos State, Nigeria was investigated with the aim of detecting possible influence of solous dumpsite on Bacteriological and Physicochemical quality of groundwater in surrounding environment. Twenty-one (21) samples from 19 borehole taps and 2 wells were collected from different distances from the landfill site. sampled. Physicochemical and bacteriological parameters of the water samples were analysed using standard procedures. Total heterotrophic coliforms and fecal coliforms counts were carried out using standard microbial procedures. The distance of groundwater samples to the landfills in these studies were between 10-1027m. The colour ranged from colourless, yellowish to brownish. The pH, temperature, conductivity, total dissolved solids (TDS) and salinity which ranged from 4.025-6.77, 28.4-29^{0}C, 27-10,030, 30.9-7,165mg/l and 0.5-5450ppt, respectively. Total heterotrophic counts ranged from 1-316cfu/ml while coliforms counts ranged from 0-1800cfu/ml. Fecal coliforms detected were in 11(52%) of the samples, cadmium contents ranged from 0.909-9.673ppm while magnesium was not detected in any of the water samples. This study shows that 76%, 23%, 85%, 81% and 85% of the groundwater samples do not meet up with the World Health Organization standards for pH, colour, conductivity, Total dissolved solids and salinity respectively. Conclusively groundwater obtained from solous landfill environment are contaminated and therefore, not fit for human consumption

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Groundwater refers to water which originates from the infiltration and percolation of precipitation through the soil profile and accumulates below the earth's surface in a porous layer commonly referred to as the aquifer. It forms part of the hydrologic cycle and the quantity and quality of water stored in the aquifer is a function of factors such as type of rocks, rainfall amounts, topography, surface cover and the state of the environment (Salami, 2012).When precipitation finds its way into a landfill, it causes the extraction of water soluble compounds from the decomposed wastes thus forming garbage juice commonly called the leachate (Salami, 2012). The leachate then percolates to groundwater aquifers thus causing groundwater pollution.

Groundwater is increasingly becoming one of the most important valuable renewable resources for human life in economic development. A number of people and institutions are exploiting groundwater as a result of the absence of surface sources or in some cases due to contamination of the surface sources (Abolfazl and Elahe, 2008). Globally, groundwater is threatened by the unlined and uncontrolled landfills used for solid waste disposal. Migration of leachate from landfills to groundwater limits the quality of this valuable renewable resource especially in areas closer to landfill sites. Areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site, Such contamination of groundwater resource poses a substantial risk to local resource user and to the natural environment.

1.2 Statement of Problem.

The city of Lagos with its teeming population has less than 50 Water Supply Boards to cater to it in terms of water treatment and distribution and this is nothing compared to the population. Residents therefore, rely majorly on boreholes and hand dug wells for its water needs. The major environmental problem experienced around the Solous landfill areas is the contamination of groundwater via discharged leachate. Areas near landfills have great a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local resource users and to the natural environment

1.3 Justification For Study

Due to inefficiency in Lagos State Water Corporation activities and water supply in Lagos State, majority of the residences rely mostly on boreholes and hand-dug wells for its water needs, including residents living in the surrounding environments of landfills and dumpsites, Some physical parameters like taste, colour and odour are the main indicators of water contamination to the residents without taking into consideration the other physical, chemical and biological variables of water. It is therefore important to study the water quality in areas around the landfill sites to examine its impact on groundwater quality.

1.4 Aim and Objectives

The main purpose of this research is to determine the bacteriological and physicochemical quality of groundwater in environments solous landfill environments.

Objectives of research include:

- To determine the bacteriological quality of groundwater samples.
- To determine the physicochemical quality of groundwater samples.

- Compare the difference in the quality of sampled water with World Health Organisation (W.H.O) water quality standards.

CHAPTER TWO

LITERATURE REVIEW

2.1 Water

Water is an abundant environmental resource on earth but its accessibility is based on quality and quantity, as well as space and time. It may be available in various forms and quantity but its use for various purposes is the subject of quality. About 70% of the human body and about 60-70% of plant cells is made up of water (Smith and Edger, 2006). It is one of the determinants of human settlement ,existence and activities on the earth. Its quantity is fixed but dynamic in formation and storage. Of all the environmental concerns that developing countries face, the lack of adequate, good quality water remains the most serious (Markandya, 2004). Once contaminated, groundwater may forever remain polluted without remedy or treatment. Water is one of the determinants of human earth system. Diseases may spring up through water pollution, especially groundwater contamination, and rapidly spread beyond human expectation because of its flow mechanism (Afolayan *et al.,* 2012). One of the major factors that make the earth habitable for humans is the presence of water. Forming the major component of plant and animal cells, it is the basis of life and therefore the development of water resources is an important component in the integrated development of any area. Water is critical to our daily lives and is an extraordinary compound in nature. It covers 71% of Earth (USGS, 2014) Water is the most important resource of a country, and of the entire society, since no life is possible without water. It has this unique position among other natural resources, because a country can survive in the absence of any other resource, 2 except water (Garg, 2009). According to the National Water Policy (2002), in the planning and operation of systems, water allocation priorities should be broadly as follows: drinking, irrigation, hydropower, ecology, agro-industries and non-agricultural industries, navigation and other uses. There are mainly three main sources of water, and this includes groundwater, surface water and rainfall**.**

2.1.1. Surface Water

The quality and quantity of surface water varies from one place to another and over time, due to factors such as geology, climate and surrounding land use. The variable quality of surface water means it has to be treated to make it safe for domestic consumption. The quantity of water in rivers and lakes varies with rainfall and there can be wide fluctuations at different times of year. To ensure year-round supply, dams can be constructed to create reservoirs from which water can be extracted prior to treatment.

2.1.2. Rainwater

Rainwater harvesting system can be easily constructed and maintained at low cost. Although In regions where rainfall is abundant and frequent, rainwater can be a good source of water supply for individual families and small communities. The storage of rainwater is particularly important in areas with a long dry season, or where groundwater or surface water is difficult to obtain or polluted.. It is free, relatively clean and usually reliable, even if it rains only once or twice a year, and a mainly found in rural areas, rainwater harvesting can also be useful in an urban situation.

2.1.3. Groundwater

Groundwater is water that exists in the pore spaces and fractures in rocks and sediments beneath the Earth's surface. It originates as rainfall or snow, and then moves through the soil profile into the groundwater system, where it eventually makes its way back to surface streams, lakes, or oceans. It is naturally replenished from above, as surface water from precipitation, streams, and rivers infiltrate into the ground. Groundwater is a long-term storage of the natural water cycle as opposed to short-term water reservoirs like the atmosphere and fresh surface water. The pore spaces within which the groundwater is contained are referred to as aquifer. There are two different types of aquifers based on physical characteristics: if the saturated zone is sandwiched between layers of impermeable material and the groundwater is under pressure, it is called a confined aquifer; if there is no impermeable layer immediately above the saturated zone, it is called an unconfined aquifer. Groundwater table is the surface of the groundwater exposed to an atmospheric pressure above the surface of the saturated zone (aquifer). Water tables may therefore vary in elevation from the surface and the depth to groundwater affects its vulnerability to contamination (Bakis and Tuncan, 2010).

2.2 Groundwater Contamination

Groundwater contamination is the introduction or presence of organic, inorganic, biological, radiological or physical foreign substances in water that tend to degrade its quality. Most concern over groundwater pollution has centred on pollution associated with human activities like haphazard dumping of wastes followed by incineration of the wastes This practice is meant to reduce the volume of the waste so as to increase the lifespan of the dumpsite but instead it increases contamination risk to groundwater and constitutes potential environmental and public health problems. It also destroys the organic components and oxidizes the metal wastes and, in the Process, enriches the ashes left behind in metal. Odukoye *et al.,* (2001) pointed out that leachate from such dumpsites constitutes major sources of heavy metal pollutants to both soil and aquatic environment. Depending on the environmental conditions, such pollutants reach groundwater aquifers through the infiltrating and percolating water. The degraded environment thus increases groundwater pollution.

Saltwater encroachment associated with over drafting of aquifers or natural leaching from naturally occurring deposits is considered under natural sources of groundwater pollution and is equally important. The types and concentrations of natural impurities however; depends on the nature of the geological material through which the groundwater moves and the quality of the recharge water. For example, groundwater moving through sedimentary rocks may pick up a wide range of compounds such as magnesium, chlorides and calcium while some aquifers naturally have strong concentrations of arsenic, boron and selenium (Weiner and Mathews, 2007). Agricultural pesticides, fertilizers, herbicides and animal wastes are potential groundwater contaminates depending on how they are handled, stored and used. Examples of these include: using chemicals uphill a few meters of a well; storage of agricultural chemicals near conduits to groundwater, or storage in surface depressions where pounded water is likely to accumulate; storage of chemicals in uncovered areas unprotected from wind and rain or in locations where the groundwater flows from the direction of the chemical storage to the well while industrial sources include manufacturing and service industries (Jorgensen and Johnson, 1989). industrial sources of contamination include cleaning off holding tanks or spraying equipment on the open ground, disposing of waste in septic systems or dry wells, and storing hazardous materials in uncovered areas or in areas that do not have pads with drains or catchment basins (Odukoye *et al.,* (2001).

Residential wastewater system remains one of the major sources of a number of categories of contaminants, including bacteria, viruses, and nitrates from human waste as well as organic compounds like the Bio-oxygen demand (BOD. Poor disposal of household chemicals such as paints, synthetic detergents, solvents, oils, medicines, disinfectants, pool chemicals, pesticides, batteries, gasoline and diesel fuel can lead to severe groundwater contamination (Osu and Okoro, 2011). When stored in garages or basements with floor drains, spills and flooding may introduce such contaminants into the groundwater. When thrown in the household trash, the products will eventually be carried into the groundwater because community landfills are not equipped to handle hazardous materials. Similarly, wastes dumped or buried in the ground can pollute the soil and leach into the groundwater (Buckingham, P.L. and Evans, J.C. 2003).

2.3 Landfills as a Source of Groundwater Quality Contamination

Landfill is a piece of land where by-product materials are disposed, eliminated or discarded. The untreated waste products being placed in the landfill cavity comprises of biodegradable waste such as; green waste, recyclable waste, food waste or organic waste, Solid waste such as; plastics, textiles, paper, yard wastes, wood, glass, metals and other unclassified wastes initiate a threat to groundwater quality. Contamination may occur through a leakage, which happens when rain water penetrates the dumpsite and dissolves the solute fraction of the waste and the solvable products produced as a result of biochemical and chemical processes occurring within the decomposing wastes**.** Leachate is a common term in environmental sciences and it is associated with liquids constitute of harmful dissolved substances such as industrial waste, heavy metals, highly concentrated organic contaminants, ammonia, toxic materials, refractory compounds and inorganic materials. Landfills contain varieties of leachate components considered as highly toxic, acidic, corrosive environmental pollutants. Landfill leachate contains dissolved and suspended materials. Through leaching, contaminants are transferred from a stabilized matrix such as waste dumpsite to a liquid medium such as water. Landfills leachate are major sources of contamination to groundwater. Chemical compounds present in significant amounts in domestic waste water and mainly come from human excreta and detergents. They easily contaminate groundwater through migration of leachate (Osu and Okoro, 2011).

Studies have shown that impact assessment of contamination sources of groundwater, have been receiving major attention both now and in the past (Ebong *et al.,* 2007 and SiaSu, 2008). Sources of major concern to groundwater contamination include leachate from pit latrines, solid waste dumpsites, industrial effluents, domestic wastes, sea water intrusion, agricultural chemicals, and oil spillage. These sources can generate many types of pollutants including heavy metals, nitrogen species, chlorinated hydrocarbons phenols, cyanides, and bacteria among others (Yusuf, 2007).

2.4. Groundwater Quality

Groundwater quality comprises the physical, chemical, and biological qualities of ground water. Temperature, turbidity, colour, taste, and odour make up the list of physical water quality parameters. Since most ground water is colourless, odourless, and without specific taste, we are typically most concerned with its chemical and biological qualities. Although groundwater products are often sold as "pure," their water quality is different from that of pure water. Naturally, ground water contains mineral ions. These ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. They are referred to as dissolved solids. Some dissolved solids may have originated in the precipitation water or river water that recharges the aquifer. A list of the dissolved solids in any water is long, but it can be divided into three groups: major constituents, minor constituents, and trace elements. The total mass of dissolved constituents is referred to as the total dissolved solids (TDS) concentration. In water, all of the dissolved solids are either positively charged ions (cations) or negatively charged ions (anions). The total negative charge of the anions always equals the total positive charge of the cations. A higher TDS means that there are more cations and anions in the water. With more ions in the water, the water's electrical conductivity (EC) increases. At a high TDS concentration, water becomes saline. Water with a TDS above 500 mg/l is not recommended for use as drinking water (EPA secondary drinking water guidelines). Water with a TDS above 1,500 to 2,600 mg/l (EC greater than 2.25 to 4 mmho/cm) is generally considered problematic for irrigation use on crops with low or medium salt tolerance. Except for natural organic matter originating from topsoil, all of these naturally occurring dissolved solids are inorganic constituents: minerals, nutrients, and trace elements, including trace metals. In most cases, trace elements occur in such low concentrations that they are not a threat to human health. In fact many of the trace elements are considered essential for the human metabolism. In Europe, water from springs and wells with certain levels of trace elements has long been considered a remedy for ailments. High concentrations of trace metals can also be found in ground water near contaminated sources, however, posing serious health threats. Some trace constituents that are associated with industrial pollution, such as arsenic and chromium, may also occur in completely pristine ground water at concentrations that are high enough to make that water unsuitable as drinking water Microbial matter is also a natural constituent of ground water. Just as microbes are ubiquitous in the environment around us, they are very common in the subsurface, including ground water. Hydro geologists increasingly rely on these, for instance, for subsurface bioremediation of contaminated groundwater.

2.4.1. Physicochemical Quality Analysis of Groundwater

Physical characteristics of waste water are the solid contents, colour, temperature and odour. Domestic water is usually grey to yellow–brown depending on the time of the day (Gray, 2009). Waste water temperatures do vary with season and the source but generally they are warmer than the air temperatures except for very warm months, since the specific heat capacity of water is much greater than that of air. Raw sewage is turbid and has small but visible particles of organic material which settles readily from the suspension. Total solids include those materials that are left behind in a container when water evaporates usually at a temperature of 103-105^{0}c (Weiner and Mathews, 2007). The total solids consist of insoluble and suspended solids and soluble compounds dissolved in water. In waste water about 40 percent of the solids are suspended. Heavy metals accumulate in the environment in different geochemical forms that is; water soluble, exchangeable carbonate-associated, Fe-Mn oxide-associated, organic- associated and residual forms (Osu and Okoro, 2011). Measurements of metal in aquatic environments are an important monitoring tool to assess the degree of contamination (Sangarika, *et al.,* 2010).The toxicity and mobility of heavy metals in soils depend not only on the total concentrations but also on their specific chemical form, binding state, metal properties, environmental factors and soil properties like pH and organic matter content (Osu and Okoro, 2011).

Exposing an individual to concentrations beyond permitted threshold limits normally leads to toxicity. The World Health Organization Standards(W.H.O,2006), established a concentration of 1,000, , 500, ,100mg/L, (6.5-8.5) as permissible for electric conductivity, total dissolved solids , magnesium, and pH respectively. The physical parameters temperature, pH and electrical conductivity were measured and compared with the Standards (W.H.O, 2006) guidelines in order to determine the safety of groundwater within the igando environment.

2.4.2. Microbiological Quality Analysis of Groundwater: Bacteriological Quality Analysis

The determination of microbiological quality of water is essential. Simple routine testing of the bacteriological quality of drinking water is designed to detect the presence of coliform bacteria and virological assessment is to detect the presence of enteric viruses, especially hepatitis A virus (HAV). Bacteriological quality is one of the important parameters of water portability. It is measured by the presence of a pollution indicator of organisms, in particular, total germs and fecal coliforms (*Escherichia coli*). Total bacterial count represent the density of the bacterial population in drinking water. This measure allows a global assessment of the pernicious nature of water, without determining the sources of contamination *E. coli* is one of the most determined bacteria that indicates fecal contamination (Edberg et al.2000). Total germs and *E. coli* are used as indicators to measure pollution level and water quality.

2.5. Microbial Quality Indicator Organisms

These are organisms in which their presence and concentrations in water indicates the presence of fecal coliforms. The Escherichia coli (E.col) originate from intestinal tract of warm blooded animals and are usually an indicator of the presence of pathogens in water. The presence of coli forms in water does not necessarily mean that pathogenic organisms are present in the water but is an indicator that such pathogens might be present (Weiner and Mathews, 2007). An assured indicator organism must be widely present in the faeces of humans and other warm-blooded mammals, it must be easily detected by simple methods, it must not grow in natural water, the general environment, or in water distribution systems, and lastly, the degree to which it is removed by water treatment must be comparable to other pathogens of concern.

2.6 Water Purification Processes

Water purification, process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from water. That process also includes distillation (the conversion of a liquid into vapour to condense it back to liquid form) and deionisation. One major purpose of water purification is to provide clean drinking water. Water purification also meets the needs of medical, pharmacological, chemical, and industrial applications for clean and potable water. The purification procedure reduces the concentration of contaminants such as suspended particles, parasites, bacteria, algae,viruses and fungi. General steps in purification of water includes:

1. Aeration: Raw water is first collected in large aeration tank and the water is aerated by bubbling compressed air through perforated pipes. Aeration removes bad odours and CO2. It also removes metal such as iron, manganese by precipitating then as their respective hydroxides.

2. Storage or settling: Aerated water is then placed in settling tank and stored for 10-14 days. During storage about 90% of suspended solids settle down within 24 hrs and the water becomes clear. Certain heavier toxic chemicals also settle down during storage. Similarly pathogenic bacteria gradually die and bacterial count decreases by 90% in first in first 5-7 days of storage. During storage organic matter present in water is oxidized by microorganisms.

3. Coagulation: Water from storage tank is then placed in coagulation tank and then some precipitating agents such as alum, lime etc are added in water and mixed. These precipitating agents form precipitate of Al(OH)3 when dissolved in water. Suspended solids absorb on the surface of precipitate, so gradually mass of precipitate becomes heavier and finally settle down. This technique is used to remove very light suspended solids that do not settle by themselves during storage. Furthermore, if negatively charged colloidal impurities are present, they are neutralized by Al+++ ions and settle down.

4. Filtration: Partially clarified water is then passed through sand gravity filter which removes 98-99% of microorganisms and other impurities. There is a collection tank at the bottom of the filter bed to collect filtered water. During filtration filter bed soon gets covered with a slimy layer called vital layer. Vital layer consists of thread like algae, diatoms and bacteria .During filtration microorganisms presents in vital layer oxidize organic and other matter present in water. If water contains unpleasant odour, activated carbon may be placed in filter bed that removes bad odours

5. Disinfection: The filtered water is finally purified by using disinfectants. After disinfection water is pumped into overhead tank for subsequent domestic distribution.

Regular household methods such as boiling water or using an activated-carbon filter can remove some water contaminants.

2.8 Water Borne Diseases

Water borne diseases are conditions that have adverse effects on human health such as death, disorders, illnesses or disability caused by pathogenic microorganisms transmitted in water. This diseases includes,polio, malaria, cholera, dengue, scabies, typhoid, anaemia, botulism, fluorosis, trachoma, hepatitis, diarrhoea, giardiasis, ascariasis, trichuriasis, arsenicosis, malnutrition, lead poisoning, ringworm or tinea, cyanobacterial toxins.

Table 2.1. Water Borne Diseases, Causative Organisms and Prevention

	Causative organisms	Diseases	Preventive measure
Viruses	*Norovirus*	Gastroenteritis	• Chlorination • Reverse Osmosis • Ultra-Violet Light
	HAV (Hepatitis A Virus)	Hepatitis A	• Iodine Treatment • Solar Purification • Boiling
Protozoa	*Cryptosporidium*	Cryptosporidiosis	• Specified Filters • Boiling • Distillation
	Giardia	Giardiasis	• Chlorination • Iodine Treatment • Boiling
Bacteria	*Campylobacter Jejuni*	*Campylobacteriosis*	• Solar Purification • Boiling • Distillation
	Legionella	Legionnaires' Disease	• Solar Purification • Boiling • Distillation
	Shigella	Shigellosis (Dysentery)	• Distillation • Chlorination • Reverse Osmosis
	Salmonella	Salmonellosis	• Specified Filters • Iodine Treatment • Solar Purification
	Salmonella Typhi	Typhoid	• Chlorination • Reverse Osmosis • Ultra-Violet Light
	Vibrio Cholerae	Cholera	• Chlorination • Reverse Osmosi • Violet Light
	Escherichia Coli	Verotoxic E. Coli	• Chlorination • Reverse Osmosis Ultra-Violet Light

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The Soluos Landfills are located at the extreme end of the east-west area metropolitan Lagos in Alimosho Local Government. These landfills are amongst the five (5) active landfills currently being operated by Lagos Waste Management Authority (LAWMA). Stated in the monthly report, it is reported that solous 2 and 3 dumpsite collected about 81,388 metric tonnes of MSW out of the total 239,282 metric tonnes deposited in December, 2011.

Locatios

Solous Dumpsite (A): it encompasses an area of 7.5 hectares and located on N06^0 34. 307', E0030 15. 211'. It is the oldest of the sites. It began operation in 1993 and closed in 2006 .

Solous (2) Dumpsite (B): The site (N060 34. 286', E0030 15. 146') spreads over an area of 7.8 hectares and is almost filled up. It started operation in 2008 and on an average about 2,250m3/day of waste is dumped at the site.

Solous (3) Dumpsite (C): This site (N060 33. 897', E0030 15. 082') started operation in 2008 and is estimated to receive about 2,250m3 in a day. It is divided into cells with access roads. It is the largest of the three sites, spreading over an area of 12 hectares with a large portion of it yet to be filled up.

3.2 Groundwater Sample Collection

Twenty-one samples were collected, comprising of 19 boreholes and 2 hand dug wells which were randomly collected in two sets into clean and sterile bottles. One set of the samples for bacteriological analysis and the other for physicochemical analysis. The mouths of the taps were left to run for about 2 minutes before the collection of each of the groundwater samples. Global positioning system (GPS), was used in determining the coordinates of each of the water samples collection location. Upon collection, water sample will be labelled and transported to the laboratory for further investigations and analysis

3.3 Bacteriological Quality Analysis of Water Sample

This requires the isolation and identification of microorganisms in water samples. Samples for bacteriological analysis were collected into sterile universal bottles. Three (3) tests were conducted and data was analyzed.

Total Bacterial Count (TBC)

The total bacteria count gives a quantitative estimate of the number of microorganisms present in a given sample., For the purpose of this research pour plate technique is used. Firstly, the nutrient agar is prepared accordingly to the manufacturer's given standard and sterilized in the autoclave and then allowed to cool, it is then poured into each Petri dish already containing 0.5ml of water sample inoculated using a 5ml sterile syringe and then gently rocked and allowed to sit and solidify, incubated at 37°c for 24 hours. Grown colonies are counted and reflected by the number of the colony-forming bacterial units (CFU) per gram (or millilitre) in the sample

Total Coliform Count

The term "faecal coliform" is being used in water microbiology to detect. coliform organisms which grow at 44 or 44.5°C and they ferment lactose and give off acid and gas. The already collected water samples were submitted to the most probable number technique (MPN) to qualify the water samples, Firstly, single strength and double strength MacConkey broth is prepared, the already prepared broth is the dispersed (10) ten test tubes and the single strength broth is also dispersed into (5) five test tubes, Durham's tubes is placed into the test tubes in an inverted position and the test tubes are then placed into the autoclave for sterilization at 121°C for 15 minutes. Water to be tested was then inoculated into the test tubes using a sterile syringe, 10 mL,1ml and 0.5ml of water sample were inoculated into the 15 tubes containing the medium and the tubes were rocked to mix and then incubated at 37°c for 48 hours.

Test for Confirmation of Fecal Coliforms

Coliforms if present in the water sample utilizes the lactose present in the medium to produce gas and acid. The change is colour represents the presence of acid while the presence of gas will be detected by the gas bubbles collected in the inverted Durham tube present in the medium. All positive tubes are selected for further testing for presence of Escherichia coli. The agar Eosin Methyl Blue agar is prepared according to the manufacturer instructions, sterilized in the autoclave and allowed to cool down. it is then plated in a Petri dish after cooling, allowed time to solidify and then labelled. An inoculating loop is used to scoop a loop full from the positive tubes and streaked appropriately on the agar plate and incubated at 43°c for 48 hours. The presence of metallic green colonies is recorded as positive. Results were recorded and the data was analysed.

3.4 Physicochemical Quality Analysis

Temperature: The temperature of the water samples were determined at the site during collection using a mercury-in-glass thermometer.

Colour: The colour of the water samples were determined visually.

Total dissolved solids , salinity, and conductivity: The Ionix pc 50 meter was used in determining the chemical parameters.

The heavy metals: This parameters were determined using the atomic adsorption spectroscopy. The samples were first digested using the digestion methods 0.2gms of the sample taken in the 100ml volumetric flask and 4ml of HNO_3 was added and the solution was allowed to sit for a few hours, before getting carefully heated over the water bath till red fumes coming from the flask completely ceased. Flask was allowed to cool and 4ml of perchloric acid added and flask was heated again to evaporate till a small portion was then filtered through a whattman filter paper and made up the volume using distilled water till 100ml. The hollow cathode lamps for cadmium and magnesium were used as radiation sources and fuel was acetylene.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Data presentation and analysis.

The sources of the sampled groundwater, location and distance to the landfill were shown. Six physicochemical parameters were examined in relation to the twenty-one groundwater samples collected namely; colour, pH, temperature, conductivity, and total dissolved solids (TDS) and salinity which ranged from colourless-yellowish and brownish, 4.025-6.77, 28.4 - 29^0c, 27-10,030ml, 30.9-7,165mg/l and 0.5-5450ppt respectively. (Table 4.1)

The bacteriological quality parameters of the groundwater samples, location and distance to the landfill were shown. The total coliform, fecal coliform test and total heterotrophic count test were all carried out and the results ranged from 1cfu to 316cfu, 0- 113cfu, and 1-316cfu and 1-315cfu respectively. (Table 4.2)

The concentration of heavy metals in the groundwater samples were shown. The lowest and highest concentration of cadmium is 0.909-9.673 respectively, The presence magnesium was not detected and it is denoted by (ND) in all the groundwater samples.(Table 4.3)

Table 4.1 Physicochemical Quality Analysis

Sample Code	Water Source	Nearest Distance To The Dumpsite (M)	Temperature	Colour.	Conductivity	PH	Total Dissolved Solids.(Mg/L).	Salinity (Mg/L)
W.H.O Standards.			20-30	colourless	1000	6.5 - 8.5.	500	600
S1	Borehole	190	29.05	colourless	213	5.35	149.5	110
S2	Borehole	140	29	colourless	370	5.92	260	185
S3	Borehole	80	28.4	colourless	135	5.26	97	60
S4	Borehole	180	28.75	colourless	76	4.84	53.4	30
S5	Borehole	190	29	yellowish	476	4.26	33.8	23
S6	Borehole	190	29	yellowish	367	5.66	260.5	175
S7	Borehole	210	29	colourless	170.4	5.2	160	80
S8	Borehole	200	28.85	colourless	146.3	4.71	158	10
S9	Borehole	10	29.3	colourless	66	4.85	59.55	40
S10	Borehole	70	29.15	colourless	27	4.82	30.9	20
S11	Borehole	50	28.9	yellowish	10030	7.31	7165	5450
S12	Borehole	110	28.95	colourless	44.5	5.06	31.25	20
S13	Borehole	90	29	colourless	134	4.68	93.75	60
S14	Well	100	28.7	colourless	1725.5	6.73	1255	880
S15	Well	150	28.55	colourless	1768.5	6.74	1240	875
S16	Borehole	110	28.55	yellowish	303	6.77	215.5	155
S17	Borehole	180	28.7	brownish	311	6.41	221.5	156
S18	Borehole	190	28.7	colourless	340	4.04	243	0.165
S19	Borehole	260	28.45	colourless	343.5	4.025	242.5	0.175
S20	Borehole	350	28.4	colourless	215	4.225	152	0.5
S21	Borehole	1027	28.5	colourless	216	4.235	154	0.11

Table 4.2 Bacteriological Quality Analysis

Sample code.	Source.	Distance to the dumpsite	Total heterotrophic (cfu/ml)	E.coli count(cfu/ml)	Fecal coliform presence.	Most probable number.	Total coliforms(cfu/ml)
W.H.O Standards.			100	0	-	0	0
S1	Borehole	190	221	113	+	(5-5-5)	1800
S2	Borehole	140	31	0	-	(4-0-0)	13
S3	Borehole	80	15	0	-	(5-0-0)	25
S4	Borehole	180	197	86	+	(5-5-5)	1800
S5	Borehole	190	1	0	+	(4-5-5)	55
S6	Borehole	190	99	0	-	(0-0-0)	0
S7	Borehole	210	281	87	+	(5-5-5)	1800
S8	Borehole	200	65	66	-	(5-5-3)	900
S9	Borehole	10	33	0	-	(5-2-1)	70
S10	Borehole	70	18	0	-	(4-0-0)	13
S11	Borehole	50	53	11	-	(1-0-0)	2
S12	Borehole	110	8	0	-	(5-2-1)	70
S13	Borehole	90	3	14	-	(5-3-2)	1400
S14	Well	100	2	0	-	(4-5-5)	55
S15	Well	150	14	10	+	(5-5-3)	900
S16	Borehole	110	316	78	+	(5-5-3)	900
S17	Borehole	180	23	18	-	(4-5-5)	55
S18	Borehole	190	44	O	-	(1-0-0)	2
S19	Borehole	260	280	72	+	(5-0-0)	25
S20	Borehole	350	98	0	+	(5-5-5)	1800
S21	Borehole	1027	64	24	+	(5-5-4)	55

Table 4.3: Heavy Metals Concentration Of Groundwater Samples

Sample code.	Source	Cadmium (ppm)	Magnesium (ppm)
W.H.O Standards		**1.4**	**0.5**
S1	**Borehole**	**9.673**	**ND**
S2	**Borehole**	**1.455**	**ND**
S3	**Borehole**	**2.080**	**ND**
S4	**Borehole**	**2.255**	**ND**
S5	**Borehole**	**2.347**	**ND**
S6	**Borehole**	**2.040**	**ND**
S7	**Borehole**	**3.387**	**ND**
S8	**Borehole**	**3.620**	**ND**
S9	**Borehole**	**3.683**	**ND**
S10	**Borehole**	**0,909**	**ND**
S11	**Borehole**	**5.746**	**ND**
S12	**Borehole**	**5.241**	**ND**
S13	**Borehole**	**8.036**	**ND**
S14	**Well**	**8.892**	**ND**
S15	**Well**	**7.055**	**ND**
S16	**Borehole**	**7.170**	**ND**
S17	**Borehole**	**0.909**	**ND**
S18	**Borehole**	**0.909**	**ND**
S19	**Borehole**	**8.511**	**ND**
S20	**Borehole**	**8.140**	**ND**
S21	**Bolehole**	**0.909**	**ND**

KEY: ND- Not Detected.

CHAPTER FIVE

DISCUSSION CONCLUSION AND RECOMMENDATION.

5.1 Discussion.

This research examined the quality of groundwater around the three dumpsites in solous in order to compare the concentration of the examined variable with the WHO (2004) standard limits. The results for the physical test were significantly lower and differ from the result work on The Effects Of Landfill Sites On The Groundwater Quality In Igando, Alimosho Local Government Area, Lagos State carried out by ifeoma (2014), this may be as a result of seasonal difference and time and distance from the landfills as this research was conducted during the raining season. The presence of dissolved organic matters and the presene of algae may have influenced the colour from colourless to yellow or reddish coloration the groundwater (Moshin *et al*,2013). The chemical and results were significantly higher compared to the research done on The Impacts of Dumpsite and Domestic Waste Leachate on Groundwater Quality in Kilifi Town, Kilifi Country, Kenya By Thomas (2014). 76% of pH is not in conference with the World Health Organization standards recorded to be between 6.5-8.5 and this may be resulting due to the availability of decaying organic matter in soils which causes pH levels in groundwater to drop to as low as 4.0 judith *et al.*, (2009). The pH is the only parameter with the highest rate of interaction through analysed correlation coefficient because it synergistically influenced both chemical and heavy metals.

Conductivity and salinity were not in conference to the W.H.O standards, 85% of each parameters were significantly higher. This may be as a result of dissolved salts and other inorganic chemicals available in the landfill leachates which increases the salinity levels, and conducts electrical currents. Therefore as rate of salinity increases so does conductivity, Concentration of chemical parameters were more available in groundwater around solous 1 than in solous 2 and 3. Results also indicated that groundwater within the range of solous 1 landfill had less bacteriological concentration.

Monitoring microbial presence, especially that of fecal coliform bacteria determines the quality of water. 52% of the samples had the presence of fecal coliforms.26% of the samples had varied number of bacteria count. However, the bacterial load count will not be of concern if E.coli was not detected in the water samples. *E.coli* was detected in 9 of 21 groundwater samples that is 43% of the samples in this research. The results also showed no significant variation in water quality with increasing distance from the dumpsite. Findings also indicated that the groundwater around solous 1 was of better quality for domestic use than groundwater around solous 2 and 3 due to the temporal reduction of contaminant concentration over time. Results were compared to that of previous researcher to observe temporal variation of water quality parameters. The analysis indicated a significant depletion of heavy metals over time.

5.2 Conclusion

Although both surface and groundwater may be available in large quantity in Igando owing to the geographical location but purpose and accessibility to it is limited in terms of quality. groundwater was found to contaminated with chemical, heavy metals and coli forms. The presence of *E.coli* forms suggests the possibility of pathway for pathogens or faecal contamination to the groundwater, making the groundwater unsuitable for domestic use. The tests indicates higher concentration of bacteriological contamination around solous 2and 3 while, chemical contamination was higher around solous 1, Concentrations of some variables were also not detected. This indicates the impact of time in parameter reduction.

Correlation analyses suggests that groundwater contamination is affected by distance between boreholes, wells and the source of contamination namely, the landfills.

5.3 Recommendations

i. Toward the control of groundwater vulnerability to contamination through landfills, there is need for adequate and proper planning, designing, and construction of strategic management disposal of waste.

ii. Detailed analysis of hydrogeology and groundwater flow direction in the environment is highly required to safeguard the exploration and exploitation of groundwater.

iii. Government agencies such as Lagos State Environmental Protection Agency (LASEPA) and Lagos State Waste Management Authority (LAWMA) should engage in more research to monitor contaminant levels and plan migration strategies.

iv. To reduce the incidence of water borne diseases, appropriate water resource management strategies need to be applied. Portable water from government/public water works should always circulate to the affected and likely affected environments as at when needed.

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