# BACTERIOLCGICAL AND PHYSICOCHEMICAL ANALYSIS OF YAR DANTSI STREAM EFFLUENTS AND GUSAU DAM ZAMFARA STATE NIGERIA

BY

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NOVEMBER 2018

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MICROBIOLOGY

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## DECLARATION

I hereby declare that this project is written by me and it has not been presented before in any institution for a Bachelor Degree except for quotations and summaries which have been duly acknowledged.

Adamu Amratu Kanoma

13/02/2019
Date

## CERTIFICATION

This Project entitled "Bacteriological and Physicochemical analysis of Yar dantsi stream effluents and Gusau Dam, Zamfara State, Nigeria" meets the regulation governing the award of Bachelor of Science of the Federal University Gusau and is approved for its contribution to knowledge and literary presentation.

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# DEDICATION

This research work is dedicated to my parents Alh. Adamu Labbo Kanoma, Hajiya Tsahara Adamu Kanoma and my Husband, for their caring and support, may Allah make Jannatul Firdausi their final Home.

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## ABSTRACT

*There has been increasing rate of contamination and pollution of water bodies which are principally as a result of discharge of waste water from effluents containing microorganisms and all sorts of obnoxious matters into the natural water bodies thereby making it unsafe for human use. This study was conducted to assess the microbiological and physicochemical quality of Yar Dantsi waste water effluent of Gusau dam in Gusau, Zamfara state, Nigeria. This research was conducted during rainy season for the period of four (4) months (July- October) for which six (6) sampling points were designed; three in each sampling area at 500 meters intervals in both up and down streams of the effluent. A total of Twelve (12) one litre thoroughly washed plastic containers were used for sample collection.The bacteriological analysis was carried out using spread plate method while the physicochemical parameters such as pH, total dissolved solid (TDS), biological oxygen demand ($BOD_5$), Temperature, dissolved oxygen (DO), and electric conductivity were measured using standard methods as described.The results obtained reveals that E. coli. had the highest frequency of occurrence of 34% and 56% in Yar Dantsi effluent sample and Gusau Dam water sample respectively while Staphylococcus aureus had the least frequencies of occurrences of 2% and 6% each for Yar Dantsi effluent and Gusau Dam water sample respectively. The result obtained for physicochemical parameters was subjected to independent student t-test analyzed using Microsoft office excels and SPSS. The result showed the following Mean Variation of surface water pH (9.05±0.03-8.45±0.39),Temperature (27.00±0.00-27.33±0.33), Conductivity (142.33±2.18-46.67±10.33) Dissolved Oxygen (3.38±0.16-6.58±0.28), Biological Oxygen demand (1.88±0.04-2.88±0.19), and total dissolved solid (59.00±4.16-23.33±0.33).The result of this study showed that the parameters observed fall within recommended range set by World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ). It was concluded that, though most of the physicochemical parameters analyzed were within the acceptable range, the water is contaminated with pathogenic bacteria; drinking and swimming in such water untreated is therefore, highly discouraged. Continuous monitoring should be carried out to assess impact of anthropogenic inputs to Gusau Dam.*

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background of the Study

The bacteriological Analysis of water is performed routinely by water utilities and many governmental agencies to ensure a safe supply of water for drinking, bathing, swimming and other domestic and industrial uses. The study is intended to identify water sources which have been contaminated with potential disease-causing microorganisms. Such contamination generally occurs either directly by human or animal feces,. or indirectly through improperly treated sewage or improperly functioning sewage treatment systems. The organisms of prime concern are the intestinal pathogens, particularly those that cause typhoid fever and bacillary dysentery. Since human faecal pathogens vary in kind (viruses, bacteria, protozoa) and in number, it would be impossible to test each water sample for each pathogen. Instead, it is much easier to test for the presence of nonpathogenic intestinal organisms such as *Escherichia. coli* (*E. coli)* which is a normal inhabitant of the intestinal tract and is not normally found in fresh water. Therefore, if it is detected in water, it can be assumed that there has been faecal contamination of the water. In order to determine whether water has been contaminated with faecal material, a series of tests are used to demonstrate the presence or absence of coliforms (Agunwamba *et al.*, 2000).

Water has remained one of the prized natural resources of any nation and it occupies a permanent position among urban and rural dwellers. Water is the most important compound in the world; over 90% of the weight of any cell is composed of water and the chemical reaction associated with life is based on this compound (Ayode and Obasi,2001).

Water is a transparent and nearly colorless, odorless, and tasteless chemical substance that is the main constituent of earth's streams, lakes, and oceans, and the fluids of most living organisms. It covered about 70 percent of the human body, with chemical formula is $H_2O$, meaning that its molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Strictly speaking, water refers to the liquid state of a substance that prevails standard ambient temperature and pressure; but it often refers also to its solid state (ice) or its gaseous state (steam or water vapor). It also occurs in nature as snow, glaciers, ice packs and ice bergs, clouds, fog, dew, aquifers, and atmospheric humidity. Water covers 71% of the earth's surface (Agunwamba *et al.*, 2000).

### 1.2 Importance of Water

#### i. Water Helps Your Body Remove Waste:

Adequate water intake enables your body to excrete waste through perspiration, urination, and defecation. The kidneys and liver use it to help flush out waste, as do your intestines. Water can also keep you from getting constipated by softening your stools and helping move the food you've eaten through your intestinal tract (Ashbolt *et al.*, 2013).

#### ii. Water Prevents You From Becoming Dehydrated:

Your body loses fluids when you engage in vigorous exercise, sweat in high heat, or come down with a fever or contract an illness that causes vomiting or diarrhea. If you're losing fluids for any of these reasons, it's important to increase your fluid intake so that you can restore your body's natural hydration levels (Abida *et al.*, 2008).

### iii. Water Transports substances and Metabolisms:

Water is essential for proper digestion, nutrient absorption and chemical reactions. The carbohydrates and proteins that our bodies use as food are metabolized and transported by water in the bloodstream (Abolude,2007).

## 1.3 Water Borne Diseases

Many important human pathogens are maintained in association with living microorganisms other than humans, including many wild animals and birds. Some of these bacteria and protozoa pathogens can survive in water and infect humans. When water are used for recreation or are source of sea food that is consumed uncooked,an epidemic certainly exist (Prescott *et al.*, 2000).

### 1.3.1Water Borne Disease of Viral Origin

#### i. Hepatitis A (Infectious Hepatitis)

Usually is transmitted by faecal-oral contamination of food, drinks or shell fish that live in contaminated water and contains the virus in their digestive system (Prescott *et al.*, 2005). Once in the digestive system, the viruses multiply within the intestinal epithelium, usually only mild intestinal symptoms. Occasionally, viraemia (presence of virus in the blood) occurs and the virus may spread to the liver. The viruses reproduce in the liver, enter the bile and are released in to the small intestine. This explains why feaces are so infectious (Adeyemo *et al.*, 2008).

**ii. Poliomyelitis**

Poliomyelitis, polio or infantile paralysis is caused by the polio virus, a member of the family Picornaviridae (Prescott *et al.*,2005). The virus is very stable and can remain infectious for relatively long periods in food and water which are its main routes of transmission. Once ingested, the virus multiplies in the mucosa of the throat and/ or small intestine. From these sites, the virus invades the tonsils and lymph nodes of the neck and terminal portion of the small intestine. Generally there are either no symptoms or a brief illness characterized by fever, headache, sore-throat, vomiting and loss of appetite. The virus sometimes enters the blood stream and causes viraemia. In minority of cases (less than 1%), the viraemia persist and the virus enters the central nervous system and causes paralytic polio (Ayode and Obasi,2001).

**1.3.2 Water Borne Disease Caused by Protozoan Parasite**

**i.Giardiasis**

*Giardia lamblia*is a flagellated protozoan that causes the very common intestinal disease Giardiasis. *Giardia lamblia*is worldwide in distribution, and it affects children more seriously than it does adult. In United State, this protozoan is the most common cause of epidemic water borne diarrheal disease (about 30000 cases yearly). Approximately 7% of the population are healthy carriers and shed cysts in their faeces. *Giardia lamblia*is endemic in child day care centers in the United State.Transmission is most frequent with cysts contaminated water supplies. Epidemic outbreaks have been recorded in wilderness areas, suggesting that humans may be infected from clean water with giardia harbored by rodents,beers, cattle or household pets. As many as 200million humans may be infected worldwide (Prescott *et al.*,2000).

### ii. Cryptosporidiosis

Cryptosporidiosis is caused by *Cryptosporidium parvum* which is an intracellular parasite responsible for acute gastroenteritis and less frequently respiratory infection in humans. It is associated with giardia,the most commonly diagnosed gastro intestinal protozoan in the world (Guy *et al.*, 2003).

Ninety percent (90%) of reported outbreaks of these pathogenic protozoans occur through water while 10% are related to food. Giardia and cryptosporidium have the potential for zoonotic transmission. Water borne outbreaks are associated with drinking water,wells,rivers, lakes and recreational swimming pools. The reported frequencies of occurrences of contamination of surface water with Giardia, cryptosporidium are from 60-96% in the United State and from 20-64% in Canada (Guy *et al.*, 2003).

*Cryptosporidium parvum* is a threat to water supplies because it is resistant to chlorine disinfections and the parasite is small and thus difficult to filter, and harbored by many animal species (Abo *et al.*, 2005).

## 1.3.3 Water Borne Diseases of Bacterial Origin

### i.Gastroenteritis

*Escherichia coli* is undoubtedly the best studied bacterium and the experimental organisms of choice for many microbiologist. It inhabits the colon of humans and other warm blooded animals, and it is quite useful in the identification of faecal contamination of water. *E. coli* circulate in the resident population, typically without causing symptoms due to the immunity afforded by previous exposure. Because many cells are needed to initiate infection, contaminated food and water are the major means by which they are spread (Prescott *et al.*, 2011).

Although the vast majority of *E. coli* strains are non-pathogenic members of the intestinal microbiota , some strains cause diarrheal disease by several mechanisms: six categories or strains of diarrheagenic *E. coli* are now recognized : enterotoxigenic *E. coli* (ETEC), enteropathogenic *E. coli* (EPEC), enteroinvasive *E.coli* (EIEC),enterohemorrhagic *E.coli* (EHEC), enteroaggregative *E. coli* (EAEC), and diffuselyadhering *E. coli* (DAEC) (Prescott *et al.*, 2011).

**ii Cholera**

Cholera is an acute diarrheal disease caused by infection of the intestine with Gram negative, comma-shaped bacterium *vibrio cholerae.* It is transmitted by ingesting food or water contaminated by faecal material from infected individuals. The infection is usually mild or without symptoms in most healthy adults but sometimes can be severe. The disease is characterized by profuse watery diarrhea, vomiting and leg cramps (Prescott *et al.*, 2011).

**1.4 Water Pollution**

Water pollution refers to the contamination of water bodies often as a result of human activities. In defining pollution, we generally look at the intended use of water, how far it departs from the norm, its effect on public health, its ecological impacts .From public health or ecological view, a pollutant is any biological, physical or chemical substances that in identifiable excess is known to be harmful to other desirable living organism. Water pollutants include excess amount of heavy metals, certain radioactive isotopes, faecal coliform bacteria, phosphorus, nitrogen, sodium and other useful(even necessary) elements as well as certain pathogenic bacteria and viruses. In some instances, materials may be considered as pollutant to a particular segment of the population although not harmful to the segments. For example excessive sodium as a salt is not generally harmful, but it is to some peoples who must restrict salt intake for medical reasons (Prescott *et al*., 2000).

It is fundamental principle that the quality of water determines its potential uses. The major uses of water today are for agriculture, industrial processes, and domestic (household) supply. Water for domestic use must be free from constituents harmful to health, such as insecticides, pesticides, pathogens and heavy metals concentration, and should not damage plumbing or household appliances. The quality of water required for industrial purposes varied widely depending on the process involved.

Some process may require distilled water, others simply needed water that is not highly corrosive or that is free from particles that could clog or otherwise damage the equipment. Because most vegetation is tolerant to a wide range of water quality, agricultural water may vary widely in physical, chemical and biological properties (Botkin and Keller, 2001).

Many different processes and materials may pollute surface water or ground water. All segments of our society (urban, rural, industrial, and agriculture) may contribute to the problems of water pollution. Most of the sources result from runoff and leaks or seepage of water pollutants in to the surface water or ground water. Pollutants are also transferred by air and deposited in water bodies, increasing population also as well as placing more demands on our finite water resources As a result, it can be expected that sources of drinking water in some location will degrade in future (Prescott *et al.*, 2000).

Dam is a solid barrier constructed at a suitable location across a river valley to store flowing water. Or it is a barrier that stops or restricts the flow of water underground streams. Reservoirs created by dams not only suppress floods but also provide water for activities such as irrigation, human consumption, industrial uses, aquaculture, and navigability (Abdul-Rahim,2003).

One of the most efficient ways to manage water resources for human needs is by the construction of dams that create reservoirs for storage and future distribution (Fouzia and Amir, 2013). Water quality and the concentration of some metals usually vary in water with seasons according to changes in some parameters such as conductivity, pH, dissolved oxygen and total solids. Major metal concentrations are naturally variable from one season to the other in water according to changes in environmental conditions such as temperature, turbidity, dissolved oxygen and redox potential as well as increases in the decay of organic matter which cause the release of metals to overlying water (Fakayode, 2005).

Human beings and other living organisms require certain food substances in form of mineral salts or nutrients for their general well-being. These they get from the food they eat and water they drink. Properly planned, designed, cited, constructed and maintained dams contribute significantly towards fulfilling the water supply requirements, improves economy, and boost food production (Abdul-Rahim, 2003).

It is therefore important that studies are conducted to ascertain the quality of water which can affect the quality of plants grown around the dams and aquatic animals in the water in order to ensure the healthy growth of the citizenry.

Gusau Dam used in this study supply Gusau metropolises and its environs with potable drinking water. Some communities around the dam use the untreated water for drinking, laundry, local irrigation and other domestic purposes. The study was therefore conducted to assess the rainy season variations in some parameters in the water and to find out if the values are within the recommended values for drinking water in order to ascertain its safety or otherwise for domestic uses.

Increase farming activities, dumping of refuse and other anthropogenic activities in the catchment area of Gusau Dam is on the increase and could lead to changes in physico-chemical characteristics of the Dams.

The rate of water pollution of all types has increased much more as compared to other fields of pollution due to discharge of all sorts of obnoxious matter into it (Efe *et al.*, 2005).

Effluent is an out flowing of water or gas to a natural body of water, from a structure such as a wastewater treatment plant, sewer pipe , or industrial outfall. Effluent, in engineering, is the stream exiting a chemical reactor (Fakayode, 2005).

Effluent is defined by the United States Environmental Protection Agency as " wastewater treated or untreated - that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters " (Efe *et al.*, 2005). The Compact Oxford English Dictionary defines effluent as " liquid waste or sewage discharged into a river or the sea".( Fakayode, 2005). Effluent in the artificial sense is in general considered to be water pollution, such as the outflow from a sewage treatment facility or the wastewater discharge from industrial facilities. A effluent sump pump, for instance, pumps waste from toilets installed below a main sewage line. Similar to wastewater produced in different establishments, industries, and facilities. These waste water released can also accumulate and pollute the nearby communities and bodies of water,(Addisie, 2012). In the context of waste water treatment plants, effluent that has been treated is sometimes called secondary effluent or treated effluent .This cleaner effluent is then used to feed the bacteria in bio filters. In the context of a thermal power station, the output of the cooling system may be referred to as the effluent cooling water, which is noticeably warmer than the environment. Effluent only refers to liquid discharge. In sugar beet processing, effluent is often settled in water tanks that allow the mud-contaminated water to settle. The mud sinks to the bottom, leaving the top section of water clear, free to be pumped back into the river or be reused in the process again. (Fakayode,2005).

## 1.5 Statement of the Research Problem

Increased farming activities, dumping of refuse and other anthropogenic activities in the catchment of Gusau Dam is on the increase and could lead to changes in microbial population as well as the physico-chemical characteristics of the reservoirs. The point sources of Yar Dantsi water ways discharge their effluent into Gusau Dam during rainy season lodging a lot of garbage into the Dam and likely posing health hazards.

## 1.6 Justification of the Study

Being the major source of drinking water to Gusau metropolis, the Knowledge of bacteriological and physicochemical properties of Yar Dantsi stream effluents of Gusau Dam could serve as a tool for identifying the presence of indicators of water contamination and to determine its extent of pollution. The result of this work will be beneficial to water board management, environmental health officers, researchers and government in taking bold step to effectively curb the extent of contamination, pollution and prevention of species extinction in the dam as it harbors diverse aquatic life.

## 1.7 Aim and Objectives

The aim of this research is to determine the Bacteriological and physicochemical characteristics such as (pH, TDS, B.O.D, Temperature, dissolved oxygen (DO), and electrical conductivity) of Gusau Dam and Yar Dantsi effluent stream as indicator of Environmental Pollution.

The objectives of the study are:

1. To isolate and identify bacteria associated with Gusau Dam and Yar Dantsi stream effluents.

2. To determine the bacterial load of the identified isolates.

3. To determine the mean monthly variations in physicochemical parameters of Gusau Dam and Yar Dantsi stream effluents.

## 1.8 Hypothesis

1. There is no presence of bacteria in Yar Dantsi stream effluents.

2. There is low bacterial load in Yar Dantsi stream effluent of Gusau Dam

3. There is no significant difference in the mean monthly variations in physicochemical characteristics of Gusau Dam and Yar Dantsi stream effluents.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Overview

The health of any community fully depends on the accessibility of adequate and safe water. Hence, water is predominantly essential for life, health and for human self-respect. Therefore, in addition to community health benefits, all people have the right to safe and adequate water retrieved in equitable manner for drinking, cooking, personal, and domestic hygiene. In this case, both adequacy and safety of drinking water are equally important to reduce the incidence of water-related & water borne health problems especially diseases like diarrheal (Bharti and Katyal, 2011).

A possible contamination source that carries threats to drinking water quality are open field defecation, animal wastes, plants, economic activities (agricultural, industrial and businesses) and even wastes from residential areas as well as flooding situation of the area. Any water sources, especially older water supply systems, hand dug wells; pumped or gravity-fed systems (including treatment plants, reservoirs, pressure break tank, pipe networks, and delivery points) are vulnerable to such contamination. Particularly systems with casings or caps that are not watertight are most vulnerable. This is particularly true if the water sources are located close to surface runoff that might be able to enter the source. Additional way by which pollution reaches and enters a water supply system is through overflow or infiltration by flood water and inundation of water commonly contain high levels of contaminants (Haylamichael and Moges, 2012).

The fitness of community extremely depends on the availability of safe and adequate water for drinking, domestic use, and personal hygiene. If public health is to be improved and maintained through provision of safe and adequate water supply the major five key elements are vital which includes quantity, quality, cost, coverage, and continuity. Most of the time the occurrence of communicable diseases in the country is related with water supply conditions in the locality. Infectious diseases affected by changes in the water supply condition are categorized as follows (Addisie, 2012).

i. Those spread through drinking water (water borne diseases, such as typhoid, cholera, gastroenteritis etc.)

ii. Those transferred through aquatic vectors (water based diseases, such as schistosomiasis)

iii. Those spread by insects that depend on water (water related diseases, such as malaria and yellow fever)

iv. Those diseases produced by the lack of adequate water for personal hygiene (water washed diseases, such as scabies and trachoma.

Based on the morbidity records, there is still a high incidence of communicable diseases which most of the time is related to water supply conditions in the country among which about 60% of the top ten diseases are relate to poor quality and scarcity of household water consumption (UNICEF, 2008).

## 2.2 The Concept of Indicator Organisms

Faeces contain large number of organisms which include *Escherichia coli, Streptococcus faecalis*, (faecal streptococci) and *Clostridium perfringens*. The organisms form part of the normal flora of the intestinal tract (Cheesbrough, 2010).

A useful way, therefore of determining whether a water supply is faecally polluted and could possible contains enteric pathogens dangerous to health is to test for the presence of normal fecal organisms. To search directly in water sample for the presence of enteric pathogens is impractical for routine control purpose. Testing for normal fecal organisms as indicator for faecal pollution is not easy to do, but also a reliable way of determining whether water is bacteriologically safe to drink. If no faecal bacteria are detected in water sample, it is probable that enteric pathogens (usually present in much smaller numbers) are also absent (Cheesbrought, 2010).

Criteria for an organism to be used as indicator organisms for the analysis of water should include the following:

i. Present in faecal contaminated water when enteric pathogens are present but in greater numbers.
ii. Incapable of growth in aquatic environment but capable of surviving larger than pathogens.
iii. Equally or more resistance to disinfection rather than pathogens.
iv. Easily and accurately enumerated.
v. Applicable to all types of water.

vi. Absent from non-contaminated water and exclusively associated with animals and human faecal wastes.

vii. Density of indicator should be directly correlated with the degree of faecal contamination.

(Ashbolt *et al., 2013*).

### 2.3 Faecal Coliforms.

Coliforms are aerobic or facultative anaerobic, Gram negative, non spore forming, rods capable of fermenting lactose with production of acid and gas within 48hrs of being placed in appropriate media at $35^0$c.

The coliforms group of bacteria is used as an indicator of pollution and includes many environmental species of bacteria such as *Escherichia coli, Klebsiella pneumonia, Enterobacteraerogenes, Citrobacterfreundii and serratialiquifaciens*found in the soil, on fruits, leaves, grains and runoff water (Godfrey, 2003).

Coliform bacteria of faecal origin are referred to as faecal coliforms and grow at higher

temperature ($44.5^0$c). The detection of this group of organisms which could be found in faeces of humans, animals and birds, indicate contamination from faecal sources (Godfrey, 2003).

### 2.4 Bacteriological Testing Of Water

*Escherichia coli* count is the most useful test for the detecting of faecal contamination of water supplies in water quality analysis. Two principal techniques are available for counting coliforms (Cheesbrough, 2010).

### i. Membrane filtration techniques.

Membrane filtration test is a technique that, 100ml water sample or diluted samples is filtered through a membrane filter. The membrane, with coliform organisms on it, is then cultured on a pad of sterile selective broth containing lactose and indicator. After incubation, the number of coliforms colonies can be counted, this gives presumptive number of *Escherichia coli* in 100ml water sample (Cheesbrough, 2010).

### ii. Multiple tube/most probable number (MPN) techniques.

Multiple tube/most probable number (MPN) technique is technique that 100ml water sample distributed (five 10ml amounts and one 50ml amounts) in bottles of sterile selective culture broth containing lactose and an indicator. After incubation the number of bottles in which fermentation with acid and gas production has occurred is counted. The lactose fermented by the coliform in the water. By reference to probability tables, the most probable number of coliforms in the 100ml water sample can be estimated (Cheesbrough, 2010).

## 2.5 Assessment of Water Quality

The assessment of water quality lies on carefully examining the delicate interface between Physics, Chemistry and Biology. While the biological methods show the degree of ecological imbalance, the chemical methods measure the concentration of the pollutants (Ansari *et al.*, 2014). The assessment and evaluation, as well as devising methods for abatement of pollution, require a study of these three components (Bako *et al.*, 2014).

## 2.6 Water Quality

The science of aquatic ecology and hydrobiology has gained great significance these years. The freshwater systems – lakes and river systems – satisfy our domestic, industrial, transport, and sporting needs and the biotic community of these water bodies, both animals and plants, are intimately integrated associates in this process. Alternations in their relationship depend on changes in the physicochemical properties of the environment, illustrating the dynamic and delicate balance of these systems. The present fresh water regime is approximately 2.7 % of the total global water, of which rivers and lakes constitute only 0.01% (Dhoundial, 1993). Nature is some water effectively maintaining a balance in the population of animals through biological control, but the effectiveness of biological control of animal population nowadays is hampered by anthropogenic Interference.

Water quality study forms a very significant area of environmental studies, and the studies on the physicochemical characters of water bodies have been gained worldwide acceptance. The importance of the study of ecology of water resources in our country has been realized from the early years of the previous century. The various physicochemical characteristics, the dynamics of plankton population, the fishery potential and the methods of improvement of the water bodies formed a subject of detailed discussion by various scientists. In the early half of the last century various workers have thoroughly studied the different aspects of water bodies. (Addisie, 2012).

Rivers are natural body of water that flow in a channel with a defined banks, river are nourished by precipitation, by direct overland runoff, through springs and seepages or from melt water at edges of snowfields and glaciers (Ovrawah and Hymore 2011). In studying physical features such as temperature, conductivity, heat capacity, turbidity, depth and other vital features of water, like being it universal solvent can also harbor some harmful microorganisms that can be detected microscopically.

Water molecules exist in liquid form over an important range of temperature from 0-100 degree Celsius and this range allowed water to exist as liquid in most cases in our planet (Fakayode, 2005). The availability of good quality water is an indispensable feature for preventing disease and improving quality life. Study of physicochemical properties will also help in the identification of sources of pollution, water bodies are constantly used as receptacles for untreated waste water or poorly treated effluents accrued from industrial activities.

One of the most critical crises in developing countries is the lack of adequate portable water. The usual source of drinking water is from streams, rivers, wells and boreholes. In the Niger Delta region of Nigeria, the problem is getting portable water, because the environment is always polluted (Efe *et al*., 2005). Several studies in Nigeria had identified anthropogenic activities as easy source of water pollution (Ayoade and Obasi 2001). Though water is important to life, and it is one of the most poorly managed resources in the world (Fakayode. 2005). Environmental monitoring agencies seem and not to be too effective, so any abnormal changes in water quality is not promptly identified and dealt with except when there is epidemic. Polluted water bodies due to our action hindered aquatic ecosystem (Ekwenye and Oji 2008). Therefore, the nature and healthy of any aquatic community are an expression of quality of the water. In recent years, increase in human population, demand for food, land conversion, and use of fertilizer have led to faster degradation of many freshwater resources (Abo *et al.*, 2005). The discharge of urban, industrial, and agricultural wastes has added the quantum of various harmful chemicals to the water body considerably altering their inherent physicochemical characteristics (Kim *et al.*, 2011). The monitoring of such surface waters by estimating hydro biological parameters is among the major environmental priorities as it permits direct assessment of the status of ecosystems that are alteration in physicochemical parameters leading to eutrophication, which has become a widely recognized problem of water quality deterioration (Kumar *et al.*, 2009).

Water pollution is commonly defined as any physical, chemical or biological change in water quality which adversely impacts on living organisms in the environment or which makes a water resource unsuitable for one or more of its beneficial uses (UNICEF, 2008). Some of the major categories of beneficial uses of water resources include public water supply, irrigation, recreation, industrial production and nature conservation.

Occasionally, pollution may derive from natural processes such as weathering and soil erosion. In the vast majority of cases, however, impairment of water quality is either directly or indirectly the result of human activities (Addisie, 2012). Virtually all categories of water use contribute to pollution. Every time water is used, it acquires one or more contaminants and its quality declines. Whenever any resource is processed or consumed, some of it becomes waste and is disposed of in the environment. In a large number of cases the waste materials are or become water borne and contribute to water pollution.

Both the nature of a pollutant and the quantity of it are important considerations in determining its environmental significance (Abdulrahman, 2012). Generally, readily degradable substances are quickly broken down in the environment and are of great concern only when they are disposed of in sufficiently large quantities that a significant burden is placed on the natural purification processes.

On the other hand, industries produce and use a multitude of synthetic substances, a great many of which are non-biodegradable or degrade extremely slowly. Such recalcitrant substances persist in the environment for prolonged periods of time and may therefore become progressively more concentrated (Abdulrahman, 2012). Many of these substances are toxic or carcinogenic and may accumulate in the tissues of organisms. Such pollutants are particularly worrisome, as they tend to build up in successive trophic levels of a food web. When characterizing pollution and for formulating control and management strategies, it is useful to distinguish between "point" and "non-point" sources.

Point sources are discrete and readily identifiable and, as a result, they are relatively easy to monitor and regulate (Fakayode, 2005). Most sewage (wastewater of mainly domestic origin, containing among others, human excreta) from urban areas and industrial wastewaters are discharged from point sources.

Non-point sources, on the other hand, are distributed in a diffused manner. The location and origin of non-point sources are sometimes difficult to establish and they are therefore less amenable to control. Runoff from large urban or agricultural catchments carrying loads of sediments and nutrients, are examples of non-point sources of water pollution (Adeyemo *et al.*, 2008).

## 2.7 Physico-Chemical International findings.

Auro, (2013); studied the effects of leach from septic system on the quality of under lying shallow ground water in the vicinity of the septic systems were examined for two years in South Central Wisconsin. The increase in the electrical conductivity value and chloride concentration in the ground water sources with decreased distance from the drain suggested that these two parameters can be taken as indicators for detecting plumes of contamination from septic system. Ground water contamination was examined within a rural setting of the Inner Blue grass karst region of Central Kentucky, USA for major ions including nitrate and some species of bacteria by Kumar *et al.*, (2009). These bacteria were indicative of pollution from septic tank effluent, among other potential contamination sources. Along the stretch as reported by Hashemenzadeh *et al.*, (2012). By analyzing the physic Sengai Pertama a tributary of Sungi Perai Malaysia received domestic and agricultural effluents chemical parameters it was observed that the water unfit for the domestic use and fisheries. Rajasegar, (2000) studied various chemical and bacteriological parameters in the wells close to a feedlot and septic system of Audubon, USA. It was observed the concentration of nitrate and bacterial counts were more pronounced in the wells nearer the septic system. Efe *et al.*, (2005) reported the quality of well water from six regions of the kingdom of Saudi Arabia with respect to physic-chemical and bacteriological parameters. Sixteen percent of the wells crossed the WHO limit for ammonia.

From a study conducted by Fan, *et al,* (2015) on the assessment of the well water quality of Benghazi, Libya, recorded very high nitrate contents in some of the well waters, which are of concern. Arimoro *et al.*, (2007) observed that the major anthropogenic components in the surface and ground water include $K^+$, $Na^+$, $Cl^-$, $SO_4^{2-}$ and $NO_3$ with $Cl^-$ and $NO_3$ being the main contributors to ground water pollution in Guiyang ,China and its adjoining areas. The seasonal variations in concentrations of anthropogenic components demonstrate that the karsts groundwater system is liable to pollution by human activities.

Ansari *et al.*, (2014) conducted water quality assessment in the Densu basin of Ghana between July 2003 and March 2004 and identified human, animal and agricultural activities as the main source of pollution. The dominance of chloride over sulfate was probably due to household effluents, fertilizer use and other anthropogenic activities. Adakole *et al.*, (2003) found evidence of deterioration of groundwater quality due the nitrate contamination in agriculture-dominated watersheds of Palestine. Abbas *et al* (2002) studied data from numerous studies in Murgia Plateau and Salentine Peninsula in south-eastern

Italy. They concluded that the ground water pollution is quite absent only in the interiors of these areas that constitute the recharge zone and that groundwater flowing from these areas to the sea is progressively polluted. This pollution load discharges into the sea or into wetlands and lagoons, constituting a huge hazard for the ecological equilibrium. Hashemenzadeh *et al.*, (2012).

Anis *et al.*, (2013) observed that domestic sewage along with industrial effluents polluted the groundwater of Pedana town in Krishna district. Ashraf, (2005).studied the water quality parameters in the coastal towns of Andhra Pradesh to assess their suitability for domestic and other needs .The results clearly indicated that some towns were polluted either by industrial waste water or by sewage. Drinking water samples were analyzed in Gandhi gram, Arora *et al.*, (2008) to estimate the concentration of fluoride, iron, hardness and bacterial population. In most of the cases the concentration of iron, total hardness and bacterial count were found to be beyond tolerance limits.

A research carried out by APHA (2005), shows groundwater at 60 sampling points, over a period of six years. in Cuttack and found concentrations of ammonium, nitrates and sulphates were higher during the winters and lower during the rainy seasons and a negative correlation between flourides and sodium, nitrates, sulphates and phosphates were observed.

Athar *et al.*, (2003) examined the physico-chemical and bacteriological quality of groundwater in Tadepalli mandal of Guntur district. Investigation was aimed at assessing the impact of pollutants due to agriculture and human activities on water quality. The results indicated high levels of nutrient load and pollution in the hand pumps. Ground water with higher concentration of magnesium causes laxative effect to human beings and excess fluoride causes severe bonefluorosis.

Devangee, *et al.*, (2013) studied correlations among various groundwater quality parameters and data from 63 groundwater samples collected from Jeedimetla industrial estate in Hyderabad city. Monitoring of Sanganer nallah and surrounding tube wells was carried out during rainy season. The results reveals that the discharge of untreated industrial effluents and sewage in to nallah have contributed considerable pollution in the ground water in its vicinal areas, and is harmful for use in agriculture and drinking purposes. The levels of nitrate and fluoride concentration are high in tube well water samples, and need serious attention.

Kumar *et al.*, (2011) evaluated the effect of industrial effluents on the groundwater and surface water due to the steel plant and other major industries at Rourkela in Orissa. Their analytical data of physico-chemical parameters indicated that the groundwater of some the areas is contaminated due to municipal and industrial solid waste dumping.

Al-Qarooni (2011) carried out experiments on physico chemical and microbiological parameters of automobile wastewater in Nammakkal, Tamilnadu and found that the values for physico-chemical parameters were on the higher side of permissible limits of BIS and those bacteria were present at high concentrations .Correlations among various ground water quality parameters were made with the data of 63 ground water samples collected from the Jeedimetla Industrial Estate in Hyderabad city by Fan, and Shibata (2015). The correlations were highly significant (>85%) between the parameters pH and alkalinity as well as for pH and cadmium content, which agree with a 3rd degree polynomial. Similarly

EC and DS as well as EC and hardness agree with a power fit model EC and copper content with a sinusoidal model, hardness and calcium content with the saturated growth rate model. All physico-chemical parameters recorded in the study in sethiyathopearea in Cuddalore dist. taken up by Kumar *et al*,. (2009) showed higher values in summer season than in winter season, except fluoride content in ground water. Water samples were collected from wells, springs and rivers/streams during pre and post monsoon seasons to evaluate drinking water quality on the basis of BIS and irrigation water quality. the study showed alkaline nature of surface and ground water. Calcium and magnesium are dominating cations and bicarbonate is major anion in the study area. At some locations the concentration of TDS, Mg, Ca, total hardness, Fe, Mn and Cr exceeded the limits set up for drinking purposes.

# CHAPTER THREE

# 3.0 MATERIALS AND METHOD

## 3.1 Study Area

The Gusau Dam is located in Gusau Local Government Area of Zamfara State, located between latitude $11053^0$N and longitude $06039^0$E, and occupies an area of 3,364km$^2$ (1,298.8sqml) (Topographic-sheet, 1990). Based on the results of 2006 National Population Census, Gusau Local Government had a population of about 383,162 people Gusau.

## 3.2 Sample Collection

This research was conducted during rainy season for the period of four (4) months (July-October, 2018). Six sampling points were designed; three in each sampling area at 500 meters intervals. A total of Twelve (12) litre plastic containers were used for sample collection, all containers were washed with detergents and thoroughly rinsed with distilled water to ensure sterility. For each month, four (4) sterile containers were used to take water samples from the three points at regular intervals which were transported to Microbiology laboratory of Federal University Gusau for analysis.

## 3.3 Sample Analysis

Physicochemical parameters such as pH, total dissolved solid (TDS),biological oxygen demand ($BOD_5$). Temperature, dissolved oxygen (DO), and electric conductivity were measured using standard methods as described by(APHA, 2005).

Bacteriological analysis was done using spread plate method.

## 3.4 Determination of Physicochemical Parameters

Physicochemical parameters will be determined in accordance with the standard procedure for waste water assessment guidelines (APHA, 2005). pH, Temperature, Dissolved Oxygen (DO), Conductivity, Total Dissolved Solid (TDS) was determined at sampling sites, while Biochemical Oxygen Demand (BOD), was determined in the laboratory.

The procedure for determination of pH, Temperature, Transparency, Conductivity and Total Dissolved Solids (TDS) was done *in situ* in accordance with APHA (2005) guidelines and procedures for water and waste water examination as follow:The pH and temperature values was determined using Microcomputer pH meter (HI8424 HANNA instrument) as directed by manufacturer. PHOX 52 combined Conductivity and TDS meter was used in measuring conductivity and TDS *in situ* following manufacturer manual. The Dissolved Oxygen (DO) was measured with Jenway 970 Model waterproof DO meter in accordance with guidelines of APHA (2005). After five days, the Dissolved Oxygen content of the incubated sample was determined by measuring with the Jenway DO meter and recorded as the final ($DO_f$), while the total DO recorded in the field was considered as the initial DO ($DO_i$). Therefore, BOD was obtained by subtracting the initial DO from final DO (APHA, 2005).

## 3.5 Determination of Surface Water Physico-chemical Parameters

Surface water physico-chemical parameters viz; temperature, pH, total dissolved solids, electrical conductivity, dissolved oxygen, biological oxygen demand,and were determined by using methods described by UNICEF, (2008).

### 3.5.1 Surface water hydrogen ion concentration (pH)

The surface water pH was measured *in situ* using portable HANNA Combo pH/EC/Temp. metre/HI 98129. The metre was allowed to equilibrate before the pH was recorded.

### 3.5.2 Total dissolved solids (TDS)

The surface water TDS was measured *in situ* using portable HANNA Combo pH/EC/Temp. metre/HI 98129. The metre was allowed to equilibrate before the surface water TDS was recorded.

### 3.5.3 Surface water temperature

The surface water temperature was measured *in situ* using portable HANNA Combo pH/EC/Temp. metre model/HI 98129. The metre was allowed to equilibrate after which the value of the surface water temperature was recorded.

### 3.5.4 Electrical conductivity

The conductivity of the water samples was measured *in situ* using portable HANNA Combo pH/EC/Temp. metre/HI 98129. The metre was allowed to equilibrate before the value of the surface water conductivity was recorded.

### 3.5.5 Dissolved oxygen (DO)

Two hundred and fifty (250) ml of surface water sample was measured in duplicate in to BOD stoppered bottles and then fixed with 2ml of manganous sulphate solution; this was followed by addition of 2ml of alkali-iodide-azide reagent. The resulting solution was stoppered carefully to exclude air bubbles and mixed by inverting bottle a few times and then 2ml of concentrated sulphuric acid ($H_2SO_4$) was added, restoppered and mixed by inverting several times until dissolution was completed. Two hundred (200ml) was then titrated against sodium thiosulphate (0.002N) until a light yellow colour remained. At this point 1ml of starch (indicator) was added turning the sample dark blue. Titration continued until the disappearance of the blue colour by the complete reduction of iodine molecules by the thiosulphate. The volume of the thiosulphate used is equivalent to the volume of the dissolved oxygen per litre, as expressed in equation *ii*.

$DO = V$

**Where;** V = ml of titrant used

### 3.5.6 Biological oxygen demand (BOD5)

Two hundred and fifty (250) ml of duplicate surface water sample was collected in BOD5 stoppered bottles and incubated in the dark for five days at room temperature. On day five, 2ml of manganous sulphate solution was added followed by the addition of 2ml of alkali-iodide-azide reagent. The resulting solution was stoppered carefully to exclude air bubbles and mixed by inverting bottle a few times and then 2ml of concentrated sulphuric acid ($H_2SO_4$) was then added, restoppered and mixed by inverting several times until dissolution was completed. Two hundred (200ml) was then titrated against sodium thiosulphate (0.002N) until a light yellow colour remained. At this point 1ml of Starch (indicator) was added turning the sample dark blue. Titration continued until the disappearance of the blue colour by the complete reduction of iodine molecules by the thiosulphate. The volume of the thiosulphate used is equivalent to the volume of the dissolved oxygen (DO5) per litre as expressed by equation *iii*.

**Where;** DO1 = Dissolved oxygen of sample in day one (sampling day)

DO5 = Dissolved oxygen after 5 days of incubation

P = volumetric fraction of dilution

## 3.6 Media Preparation

### 3.6.1 Nutrient Agar

Nutrient agar medium was prepared according to manufacturer's instruction by weighing twenty eight (28g) grams of the powder using weighing balance, which was transferred into conical flask containing 1000ml of distilled water, covered with cotton wool and aluminum foil, shaken thoroughly and heated to dissolve completely. The solution was further autoclaved at $121^0C$ for 15 minutes, allowed to cool to $47^0C$ and poured into sterile plates to solidify (Cheesbrough, 2000).

### 3.6.2 Eosin Methylene Blue (EMB) Agar

Forty (40g) grams of eosin methylene blue agar was dissolve into 1000mls of distilled water. it was then heated and process for autoclaving at $121^0C$ for 15 minutes, the media was allowed to cool and dispense into clean petridishes to solidify. The solidified EMB plates were then subjected to sterility test by incubating inoculated and un-inoculated plates together at $37^0C$ for 24 hours (Cheesbrough, 2000).

### 3.6.3 Manitol salt Agar

Manitol salt agar medium was prepared according to manufacturer's instruction by weighing 20 grams of the powder using weighing balance, which was transferred into conical flask containing 1000ml of distilled water, covered with cotton wool and aluminum foil, shaken thoroughly and heated to dissolve completely. The solution was further autoclaved at$121^0C$ for 15 minutes, allowed to cool to $47^0C$ and poured into sterile plates to solidify (Cheesbrough, 2000).

## 3.7 Analysis of Water Samples

Spread plate technique was the method used for isolation and enumeration of microorganisms in this study. The mixed culture was spread evenly. The technique makes it easier to quantify bacteria in a solution.

### 3.7.1 Principle of Spread Plate Technique

The spread plate technique involves using a sterilized spreader with a smooth surface made of metal or glass to apply a small amount of bacteria suspended in a solution over a plate. The plate needs to be dry and at room temperature so that the agar can absorb the bacteria more readily. A successful spread plate will have a countable number of isolated bacterial colonies evenly distributed on the plate.

### 3.7.2 Procedures

i. Serial dilution of all the samples was prepared
ii. 0.1ml of sample was placed on to the center of the surface of an agar plate.
iii. The glass spreader was flame over the bunsen burner.
iv. The sample was spread over the surface of agar using the sterile glass spreader.
v. The plate was incubated at 37°C for 24 hours to observe the growth of colonies.
vi. The colony forming unit (CFU) value of the sample was calculated.
vii. And then the colonies obtained were subcultured on a plate containing Eosine Methylene Blue agar (EMB), Manitol salt agar and MacConkey agar.

### 3.8 Gram Staining

Gram staining procedures was carried out from the subculture of EMB, Manitol salt agar and MacConkey agar positive plate above as follows:
A thin smear of a colony was made with a drop of sterile distilled water on a previously cleaned microscope slide and allowed to air dry. The smear was heated, fixed by passing over the Bunsen burner flame 3 times. The smear was flooded with crystal violet dye and allowed to stand for one minute, after which the dye was rinsed off with slow running tap water. Gram iodine was added to cover the smear for another one minute and rinsed with slow running tap water. The smear was then decolorized with acetone briefly and then the smear was counter stained with safranine and allowed to stand for another one minute before rinsing with slow running tap water.

The stained smear was allowed to air dry and then observed using oil immersion objective lens x100. Gram negative spore forming rods indicate fecal coliform.

### 3.9 Biochemical Test

**i. Indole**

The colonies from the subculture nutrient agar slant was taken and inoculated onto prepared peptone water (5ml) in Bijou bottles and incubated at $37^0$c for 24hrs. After 24hrs of incubation 2-3 drops of Kovac's reagent was added and gently shaken. A positive reaction was indicated by the development of rose pink colour in the reagent layer above the broth within one minute. Negative reactions was indicated when the indole reagent retained its yellow colour. The test is based on the principle that if an organism elaborates the enzyme tryphtophanase, it should be indole positive when grown in a medium containing the amino acid tryptophan. Tryptophan is usually present in the digest of various proteins of animals and plants provided the process of digesting the protein does not destroy it. The enzyme tryptophanase split tryptophan into indole, pyruvic acid and ammonia. However the formation of indole is inhibited in the presence of fermentable sugar.

In addition of kovac'sindole reagent, the indole compound reacts with p- dimethyl amino benzaldehyde to form a red compound. P- dimethylaminobenzaldehyde is the active agent of the kovac'sindole reagents.

**ii. Methyl Red – Vogues-Proskauer Test**

5ml of methyl red- Vogues Proskauer Test (MR-VP) broth was inoculated with subculture Colonies and incubated for 48-72hrs at $37^0$c. After this period of incubation, 1ml of the broth was transferred to a small serological tube, to this small quantity, 2-3 drops of methyl red was added. The development of red colouration on addition of the indicator signified a positive result while a yellow colour shows a negative result.

To the rest of the broth in the original tube, 15 drops of 5% alpha- napthol in ethanol was added followed by 5 drops of 40% potassium hydroxide (KOH). This was mixed by shaking, the caps was placed in a slopping position. The development of a red colour starting from liquid- air interface within 1 hour would indicate VP positive test. No colour development occurred in VP negative tests.

### iii. Citrate Utilization Test

Simmon's citrate agar slant was prepared in bijou bottles in accordance with manufacturer's instruction and positive colonies obtained from the subculture NA slants was inoculated onto the slants and incubated at $37^0c$ for 24-48hr with the bijou bottles loosely capped. The development of a deep blue colour indicated positive result. The principle of this test is based on the fact the simmon's citrate agar medium contains the pH indicator bromothymol blue and sodium citrate as the sole carbon source. Only organisms that can metabolize citrate would grow in the medium since the medium has no other organic compound that can be readily used for growth.

However, the removal of citrate creates an alkaline condition in the medium and the indicator changes to its alkaline colour blue. The neutral colour of bromothymol blue is green hence the un inoculated medium and medium inoculated with citrate negative organisms would remain green.

### iv. Catalase Test

A drop of 3% hydrogen peroxide ($H_2O_2$) was placed on a clean glass slide and a bit of growth from the slant was taken aseptically with a sterile wire loop and emulsified with the $H_2O_2$ on the slide. A positive test result was indicated by bubbling and frothing signifying gas production while in the absence of these, it signifies a negative test result.

### v. Coagulase Test

A clean glass slide was divided into 2 parts with grease pencil/maker and a drop of physiological saline was placed on each part under aseptic condition. A colony of bacteria was picked and emulsified in each drop of saline and mixed with human plasma using a sterile wire loop. The slide was held up and tilted back and front for one minute. A positive test result was indicated by the presence of visible clumping and agglutination while in the absence of these, it signifies a negative test result.

# CHAPTER FOUR

## 4.0 RESULTS

The results of this research which was conducted during rainy season for the period of four(4)months (July-October, 2018), showed significant mean variation in some physicochemical parameter in gusau dam and Yar Dantsi effluent in (Table 1). The distribution of bacteria isolated from the study sites showed that *E.coli.* had the highest frequency of occurrence of 34% and 56% in Yar Dantsi effluent sample and Gusau Dam water sample respectively. *Staphylococcus aureus* had least frequencies of occurrence of 2% and 6% each (Table 2).

Table 4.1: Mean monthly Variation in Physicochemical parameters of Gusau Dam and Yar Dantsi channel source.

| Month | Sampling location | Parameters | | | | | |
|---|---|---|---|---|---|---|---|
| | | pH | EC | DO | BOD | TDS | T°C |
| July | Gusau Dam | 9.05±0.03a | 142.33±2.18a | 3.38±0.16b | 1.88±0.04b | 59.00±4.16a | 27.00±0.00a |
| | Yar Dantsi | 8.45±0.39a | 46.67±10.33b | 6.58±0.28a | 2.88±0.19a | 23.33±0.33b | 27.33±0.33a |
| Aug. | Gusau Dam | 8.30±0.03a | 147.67±9.33a | 3.80±0.26a | 1.98±0.12a | 27.00±4.00b | 28.00±0.00a |
| | Yar Dantsi | 6.33±0.02b | 64.33±2.96b | 6.17±0.98a | 2.20±0.00a | 70.00±10.60a | 27.33±0.33a |
| Sept. | Gusau Dam | 8.00±0.05a | 154.33±19.66a | 3.88±0.03a | 1.65±0.06b | 29.67±0.67b | 28.00±0.00a |
| | Yar Dantsi | 6.97±0.20b | 130.00±5.77a | 3.93±0.30a | 2.13±0.10a | 61.33±1.86a | 28.00±0.00a |
| Oct. | Gusau Dam | 7.63±0.03a | 130.00±577a | 3.93±0.30a | 2.13±0.10a | 61.33±1.86a | 28.00±0.00a |
| | Yar Dantsi | 7.58±0.07a | 118.67±10.09a | 3.52±0.09a | 1.67±0,04b | 48.67±10.39b | 28.00±0.00a |

Mean values with the same alphabets along column are not significantly difference, p- value >0.0

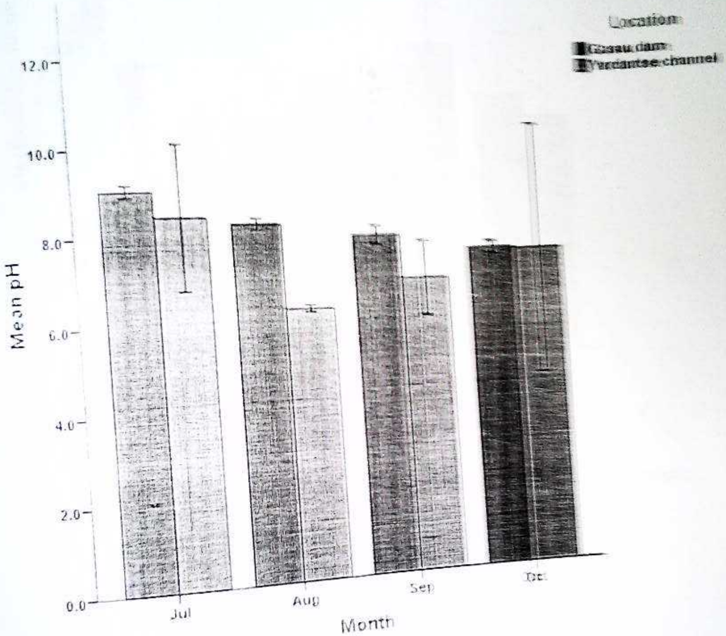


Figure1. Mean monthly relation of pH and samping points

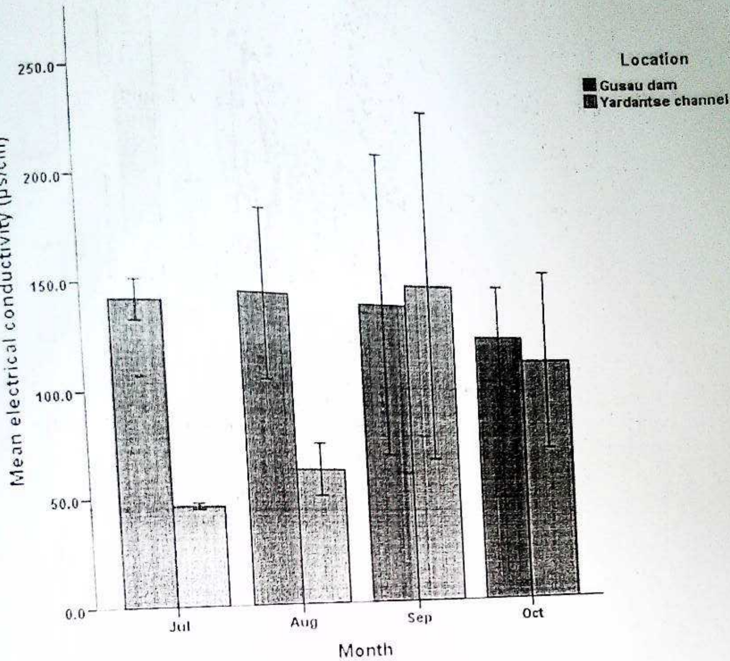


**Figure2. Mean monthly relation of electrical conductivity and sampling points**

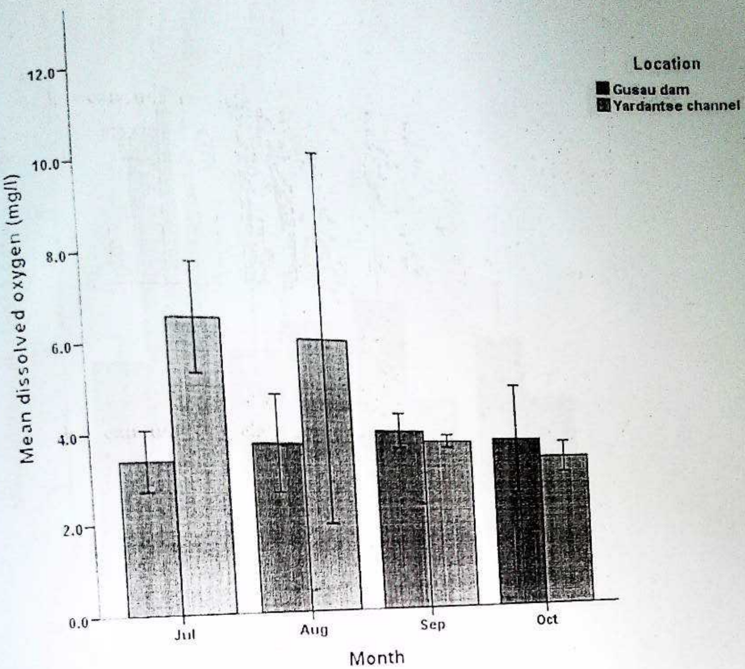


Figure3. Mean monthly relation of dissolved oxygen and sampling points

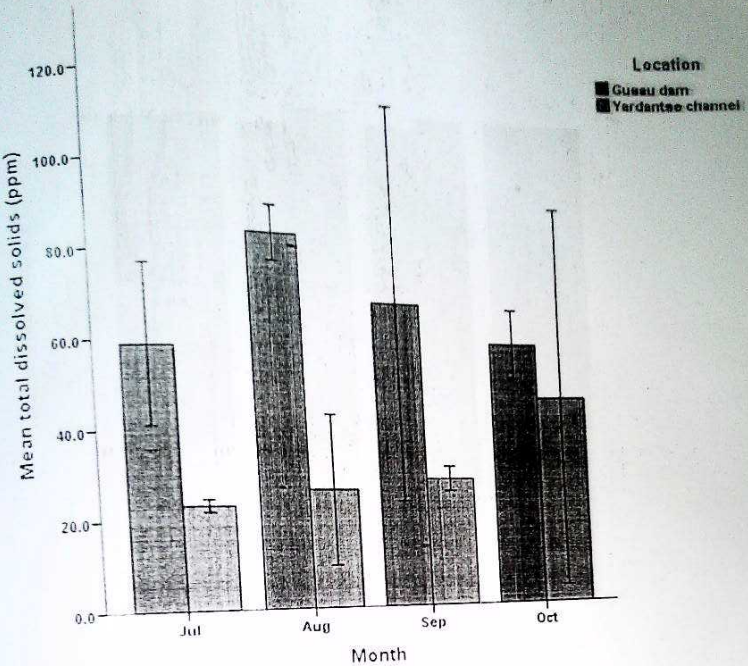


**Figure5. Mean monthly relation of total dissolved solid and sampling points**

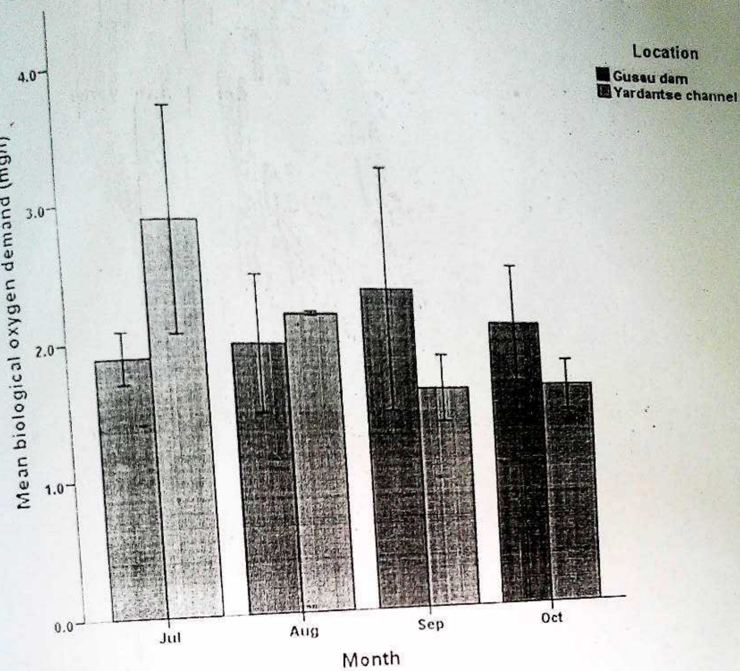


Figure4. Mean monthly relation of biological oxygen demand and sampling points

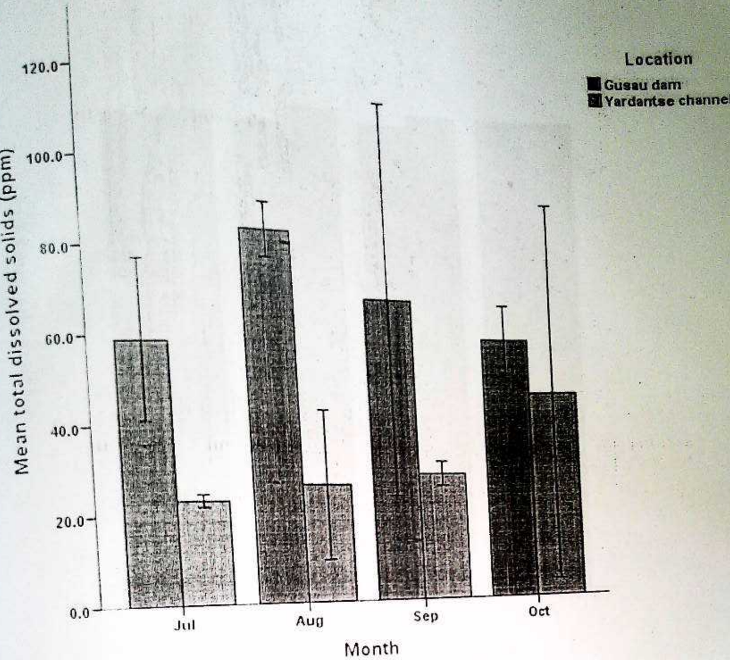


**Figure5. Mean monthly relation of total dissolved solid and sampling points**

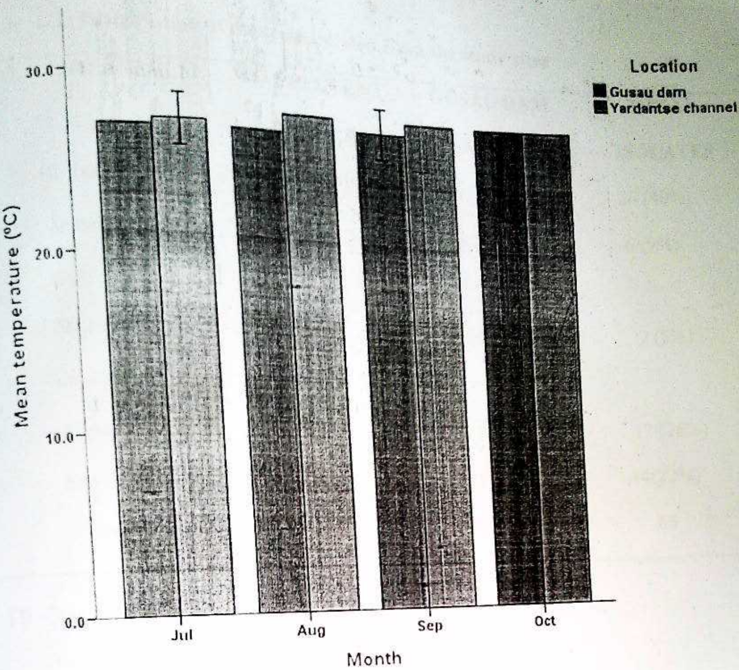


Figure6. Mean monthly relation of temperature and sampling points

**Table 4. 2: Distribution of bacteria isolated from the study sites**

| SNO. | ISOLATES | YD EFFLUENT SAMPLE | GUSAU DAM SAMPLE | TOTAL ISOLATES |
|---|---|---|---|---|
| 1 | *E. coli* | 16 (34%) | 10 (56%) | 26 (40%) |
| 2 | *Streptococcus spp* | 4 (8.5%) | 2 (11%) | 6 (9%) |
| 3 | *Staphylococcus aureus* | 1 (2%) | 1 (6%) | 2 (3%) |
| 4 | *Klebsiella spp* | 14 (30%) | 3 (17%) | 17 (26%) |
| 5 | *Entrococcus spp* | 12 (26%) | 2 (11%) | 14(22%) |
| | **Total** | **47 (72%)** | **18 (27%)** | **65** |

**YD =Yar Dantsi**

# CHAPTER FIVE

## 5.0 DISCUSSION

From the results obtained above there are reveals significant means variation in some physicochemical parameter in Gusau dam and Yar Dantsi effluent. The bacteria isolated include *E.coli, Streptococcus spp, Staphylococcus aureus, Klebsiella spp, Enterococcus spp*. The percentage frequencies of bacterial isolates from the water samples revealed that *E.coli* had the highest frequency of occurrence of 34% and 56% in Yar Dantsi effluent sample and Gusau Dam water samples respectively, *Staphylococcus aureus* had the least frequency of occurrence of 2% and 6% respectively.

Microbiological and physicochemical water quality indicators are the major parameters to be monitored in the rivers, dams or boreholes (Agunwamba *et al*.,2000) Sudden changes in the physicochemical parameters may be indicative of changing condition in the water; internal factors, on the other hand are within bacterial and plankton populations in the water body.(Agunwamba *et al*.,2000).

Temperature and pH are important factors that determine the density and distribution of microorganism in a particular environment. Most microorganisms require between 25 to 35oC as their optimum temperatures for growth and a pH of near neutral, although many others can strive in extreme environment. Temperature in surface water is influenced by the season and pH i+s influenced particularly by the change in temperature itself, the CO2 concentration, carbonate and bicarbonate in the water (Egereonu and Ozuzu, 2005). High values of temperature recorded can be associated with atmospheric temperature. (Efe *et al*., 2005 reported that there is a close relation between the atmospheric temperature and water temperature, air temperature is one of the most important ecological factors which control the physiological behaviour of the aquatic system and distribution of the microorganisms. For the pH, the values range from 8.3 to 8.4 which are all within the limit of W.H.O specification of 6.5-8.5. Similar result was found by Ajit and Padmake (Ajit, and padmaker 2012).

Most Dams and lakes are basic (alkaline) when they are first formed and become more acidic with time due to the build-up of organic materials. As organic substances decay, carbon dioxide ($CO_2$) forms and combines with water to produce carbonic acid, a weak acid, which lowers water's pH. Most fish can tolerate pH values of about 7.58 to 9.05. Although these small changes in pH are not likely to have a direct impact on aquatic life, they greatly influence the availability and solubility of all chemical forms in the Dams and may aggravate nutrient problems. The pH values for point S1- S6 were within the stipulated values of 6.0 - 9.0 for drinking water and water meant for recreation. Statistical analysis using t-test showed that there were significant differences between Gusau Dam and Yar Dantse pH as shown in Figure 1. The EU also sets pH protection limits of 6 to 10 for fisheries and aquatic life. The pH values obtained in this is also within this range. Therefore, the parameter does not give cause for concern in Gusau Dam.

The temperature value observed to be between (27.00 -28.00) in both Yar Dantsi point source and Gusau Dam, with no significance difference between the sampling points. The levels of temperature between the sampling points were relatively moderate; this might be due to the rainy season sampling periods (Devange *et al.*,2013).

## 5.1 Dissolved Oxygen

The levels of dissolve oxygen (DO) within the sampling point varied significantly in the month of July, from 3.38 – 6.58 mg/L, In general, DO levels less than 3 mg/L are stressful to most aquatic organisms. Most fish die at 1 - 2 mg/L. However, fish can move away from low DO areas. Water with low DO from 0.2 - 0.5 mg/L are considered hypoxic; waters with less than 0.5 mg/L are anoxic. The standard for sustaining aquatic life is stipulated at 5 mg/L a concentration below this value adversely affects aquatic biological life, while concentration below 2 mg/L may lead to death for most fishes. In comparison with the present findings, reported low DO 3.8 and 2.1 mg/L in upstream and downstream within the rainy season, which decreased to 1.7 mg/L in upstream and 1.2 mg/L in downstream within summer in Kathajodi River at Cuttack City. reported that the average DO concentration of Gomti River in its Pip-raghat region ranged from 0.00 to 5.4 mg/L, due to the flow of urban drains into the river, where as reported that the average DO concentrations were more than double, 7.2 ± 2.3 mg/L in upstream, than the downstream 2.4 ± 1.5 mg/L of Han River in Seoul, Korea The ranged of DO in the five sampling point (24.00 to 46.00 mg/L were above the. permissible limit of 4 mg/L and 5 mg/L. Therefore, the parameter does give cause for concern within this portion of Lake Chad.

### 5.1.1 Total Dissolved Solid

The levels of total dissolved solids fluctuate between 23.33 to 70.00 mg/L. The total dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates and possibly nitrates of calcium, magnesium, sodium, potassium, with traces of iron, manganese and other substances. The chemical content of water may be lowered artificially by dilution or raised by the addition of chemical wastes, dissolved salts, acids, alkalis, gas or oil-well brines or drainage waters from irrigated land. Excessive TDS can reduce water clarity, hinder photosynthesis, and lead to increased water permiatures. However, the TDS levels recorded in the entire sample points were below the WHO guideline of 1000 mg/L for the protection of fisheries and aquatic life and for domestic water supply.

Biochemical oxygen demand (BOD) of 1.67-2.88 mg/L was observed, with 2.88mg/L been maximum as shown in table 1.with significant mean variation between sampling point, this might be due the run-off from agricultural activities within this area of study. Biochemical Oxygen Demand is a measure of the quantity of oxygen consumed by microorganisms during the decomposition of organic matter. Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence. If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline. When BOD levels are high, dissolved oxygen (DO) levels decrease because the bacteria are consuming the oxygen that is available in the water. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. Generally, the BOD levels recorded in the entire sampling points were lower than the EU guidelines of 3.0 to 6.0 mg/L (BOD) indicating good oxygen composition for the protection of fisheries and aquatic life and for domestic water supply. Such increased is an indication of wastewater discharges from settlements along the Chari-Logone and Komadugu-Yobe River courses particularly from abattoirs, hotels and hospitals into the Lake, and also from surface and ground flows that carry chemicals directly from agricultural field into the Lake. The sample points variation in BOD could be in response to difference in microbial load This agrees with the findings of Shanur *et al.*, (2015), Magami *et al.*, (2014), Zelalem (2013), Adakole (1995), Balarabe (2000) in their studies on river Dakatia, Bangladesh, Shagari Reservoir, Lake Adale, Ethiopia, River Kubbani and Makwaye lake Zaria respectively.

### 5.2 Conclusion

Based on the results of this study, it was observed that the levels of pH, BOD, EC, T°C TDS, DO, in the water samples does not fall above the WHO standard limits. While the level of DO indicated high level of biological activity in the water. The findings clearly indicated that the Gusau dam is highly polluted due to discharge of uncontrolled municipal effluents from various point sources and animal waste leading to eutrophication. It is also clear from the above findings that the bacterial load is particularly worrisome as most of the bacteria isolated are highly pathogenic viz; *S. aureus* spp, *E. coli* spp, *psuedomonas* spp, *Entrococcus* spp and particularly *S. aureus*. It can therefore be concluded that the water is not microbiologically safe for consumption without further treatment.

## 5.3 Recommendation

1. It is recommended that government should provide enough facilities to water agencies so as to ensure the provision of safe and reliable drinking water.
2. Continuous monitoring has to be carried out to protect impact of anthropogenic inputs to Gusau Dam so as to ensure healthy aquatic life.
3. Effluent management system should be in place for management of all sources of contamination.
4. It is also recommended that laboratory workers should be encouraged to be attending seminar, workshop, retreat, e.t.c so as to improve their experiences.
5. Construction of boreholes, taps, and well should be done in accordance with world health organization recommendation with regards to their location and depth.
6. Legislations which regulate sewage disposal should be enforced to circumvent the effect of contamination of sub surface water by sewage.
7. Community should fully participated in community sanitation and encourage to participate workshop, seminars and public awareness on the danger associated with indiscriminate disposal of sewage and refuse.
8. The populace should be adequately informed on the need to protect potable water supply
9. The need to boil and filter water before consumption should be emphasized to prevent outbreak of waterborne disease.

10. Standard laboratories with mandate constantly testing water samples from these water sources should be set up.

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