

**EFFECTS OF ABATTOIR EFFLUENT ON IYIOKWU RIVER
QUALITY ABAKALIKI, EBONYI STATE**

BY

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20154947188

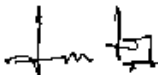
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CERTIFICATION

This is to certify that this thesis work "Effects of Abattoir effluent on Iyokwu River Abakaliki Ebonyi State" was carried out by Ogbonnaya Nneka G. with the Reg no: Futo/20154947188 in partial fulfillment for the award of the degree of M.Sc Environmental Management, School of Environmental Science, Federal University of Technology, Owerri, Imo State.



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DEDICATION

This work is dedicated to God Almighty and also to all the eco-friendly people who are dedicated to making our environment a sustainable and habitable place for our civilization.

ACKNOWLEDGEMENT

My gratitude transcends to God Almighty for his strength and inspiration throughout this work. My appreciation also radiates to my supervisor, Prof C.O Owuama, for his academic advice and commitment to the completion of this work. I humbly wish to thank Prof. C.O Nwoko whose part to the success of this work was invaluable. Similarly, my unalloyed appreciation goes to Dr C.E Njoku of Ebonyi State University for his immense contribution towards the success of this work.

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ABSTRACT

The study was conducted at Abakaliki, the capital city of Ebonyi state which aimed at assessing the effect of abattoir effluent on Iyokwu River in Garki mini market. The analysis was done at the beginning of rainy season (April, 2017). In order to achieve the set objectives, five sampling locations were chosen; they are: WQ₅₀, WQ₀, WQ₁₀₀, WQ₁₅₀ and WQ₂₀₀ respectively. Some parameters were selected based on their relative importance to abattoir effluent composition and analyzed for Physicochemical and Microbiological characteristics. These parameters were: Colour (pcu), Odour, Temperature(⁰C), Turbidity(NTU), Conductivity(μ s/cm), Total solid(mg/l), Total dissolved solid(mg/l), Total suspended solid(mg/l), pH, Cl⁻(mg/l), SO₄⁻²(mg/l), PO₄⁻³ (mg/l), P(mg/l), Ca⁺ (mg/l), Mg⁺ (mg/l), CaCO₃ (mg/l), NO₃⁻ (mg/l), NO₃N, Total Organic Carbon(%), NH₃(mg/l), NH₃N(mg/l), Pb (mg/l), Cu (mg/l), Ni(mg/l), As(mg/l), Fe(mg/l), Total Heterotrophic Bacteria Count (cfu), Total Salmonella Shigella count (cfu), Total Coliform Count (cfu), Total Heterotrophic Fungal Count (cfu) and Total Ecoli Count (cfu). The measurement location WQ₀ which is the point of discharge has the highest concentration of most of the parameters ranging from temperature as a physical characteristic, to chemical oxygen demand as a chemical characteristic and then to total coliform count as a biological characteristic. There was a gradual decrease in the concentration of the parameters from sample point WQ₀ downstream although this may be as a result of dispersion along the river flow path. At measurement location WQ₂₀₀ there was a sudden and sharp increase in some tested parameters such as SO₃, Ni, NO₃⁻, and NO₃N. This may be because of the waste dump site that runs off into Iyokwu River at this particular point. The tested result showed a statistical significant difference (P < 0.05) when Turbidity, Conductivity, TDS, TSS, Colour, Temperature, pH, Sulphate, Phosphate, Calcium, Magnesium, DO, E. coli, THFC, THBC, TSSC and TCC measurements at the discharge point (WQ₀) were compared with the measurement at the control point (WQ₅₀) and also with the WHO permissible limit. It is recommended that abattoir waste be segregated before discharging into the stream and advised that discharge point be avoided as it may be a source of domestic water supply for others downstream. The liquid waste can be a source of biogas while the solid waste can serve as manure.

Keywords: Abattoir effluent, Iyokwu River, Water quality, Pollutants, Environmental Problem.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Over the years environmental problems have increased due to poor management of water bodies. This has led to so many problems in the aquatic environment. Diseases such as dysentery, cholera, typhoid etc. are the major problems facing many countries of the world. The slaughtering of animals continuously and subsequent inappropriate disposal of their waste materials into water ways has contributed to bad odour and low quality of surface water (Akange *et al.*, 2016).

Abattoir houses or slaughter houses are usually located close to rivers in order to gain access to water either to wash slaughtered animals or to deposit waste generated directly into the water bodies. Meats from animals are essential food for daily living but the manner of disposal has tremendously reduced water quality (Sewyerr *et al.*, 2017). The terms slaughterhouse or abattoir are synonymous and used interchangeably (Cowi, 2001). Abattoir is a particular place or area set aside for slaughtering of animals whose primary purpose is for consumption and includes a slaughterhouse but does not include a place situated in a farm. Majority of abattoir houses generate waste water that is been channelled into the river without any form of pretreatment. As such water quality loses its value (Igbinosa and Uwidia, 2009).

Increase in population has led to increase in meat production. In order to meet protein needs of the population, a large number of animals are slaughtered daily and the waste deposited into water ways (Bala *et al.*, 2016). According to (Yusuf and Shualb, 2012), Water bodies have become the easiest means of eradicating waste materials without any form of treatment. People use streams, lakes and river as points of disposal. Degradation of water quality is as a result of discharge of waste generated from the slaughters house into water bodies; this discharge of waste materials can introduce enteric pathogens and excess nutrients into surface water (Batabyal and Chakraborty, 2015). The pollution of surface water body in any form is a critical issue in water resource because of aquatic organisms that

depend on water for their existence and the benefits that man derives from it. The moment water body is polluted; its quality will be degraded. However, reports have it that large numbers of water bodies in many countries of the world are grossly polluted. The water quality situation therefore becomes very critical and of great environmental and public health concerns (Ubani and Ozougwu, 2014). It has been estimated that ranges from 50-55% of animals slaughtered; 15% of it are wastes, and the remaining 30-35% of the animals are turned into byproducts such as leather, like bags, shoes etc. (Akang *et al.*, 2016). An abattoir waste contains solid, liquid and fats materials which can be highly organic, the solid parts are made up of the bones, undigested ingest, hairs, etc. The liquid aspect is made up of urine, blood, water and dissolved solids etc; while the fats materials are made up of fats and oil. The moment these waste materials are discharge into water bodies, the nature and the quality of the water changes starting by diminishing the dissolved oxygen (DO) available for fishes to survive (Omole *et al.*, 2018).

Excess nutrients from abattoir effluent could cause the water body to become choked with organic substances and organisms. When organic matter exceeds the capacity of the micro-organisms in water that break down and recycle the organic matter, it encourages rapid growth of algae leading to eutrophication. Equally, improper disposal systems of wastes from slaughterhouses could lead to transmission of pathogens to humans and cause gastroenteritis when consumed (Nazir *et al.*, 2015). Improper management of abattoir wastes and subsequent disposal either directly or indirectly into river bodies portends serious environmental and health hazards both to aquatic life and humans (Chukwu, 2005).

Many countries of the world like Norway, Sweden, Denmark, Netherlands and Romania in the late 18th century (Ogedenge, 2010) encouraged building of slaughtering house because slaughtering of animals for community consumption is inevitable.

In Nigeria, disposal of wastes are irritating, and requires immediate attention. Waste materials are usually exposed to the atmosphere where rodents, flies and other animals have access to it before disposal (Irshad, 2013). Abattoir wastes with

large quantities of animal faeces are often channelled directly into water bodies used for domestic purposes by human beings. The location and operation of abattoirs are generally unregulated, aside, they are usually located near water bodies where access to water for processing is assured. The animal blood is released untreated into the flowing stream while the consumable parts of the slaughtered animal are washed directly into the flowing water (Adelegan, 2002).

Bala *et al.*, (2016) identified improper management and supervision of abattoir activities as a major source of risk to public health in South Western Nigeria. Wastes from slaughterhouses typically contain fat, grease, hair, flesh, manure, grit and undigested feed, blood, bones and process water which is characterized with high organic level (Ibeh and Mbah, 2007) Coker *et al.*, 2001; Nafarnda *et al.*, 2006).

Dumping of solid and effluent waste discharge into water ways is a life style that many people have embraced regardless of the impact to human health, therefore the study focuses at assessing the water quality of Iyokwu River and the effect of abattoir effluents on its quality.

1.2 Objective

The main aim is to assess the effect of abattoir effluent on the Iyokwu River

The Objectives are as follows

- Determine water quality without abattoir waste
- Determine the composition of the abattoir waste water
- Analyze water quality downstream from waste discharge point.

1.3 STATEMENT OF THE RESEARCH PROBLEM

The major problem of Iyokwu River is deposition of waste materials from Garki abattoir, which is capable of transmitting zoonotic and pathogenic disease to human. Individuals involved in slaughtering animals dispose their effluent that

contains urine, blood, faeces and other organic pollutants from animals directly into the river without any form of treatment and slaughtered animals are washed with the same water. Uncontrolled discharge of effluent from abattoir has become a big challenge both to man and aquatic organisms.

Between 2004- 2007 there was an outbreak of disease such as cholera, which was linked to the consumption of water directly from this Iyokwu River. This led to loss of lives and degradation of water qualities. Children within the age of 6 – 9 years died as a result of cholera. Also in 2008 skin rashes were obvious. This is majorly from individuals who bath in this Iyokwu River. These problems caused by Iyokwu River as a result of human activities are now of great concern to the people of Abakaliki, Ogoja, Calabar and Nigeria in general. Studies have been conducted, seminars and workshops also held on the immediate and remote areas in response to causes of this water quality degradation. A number of measures have been taken to control this problem, but some of these measures did not work in full capacity and the abattoir discharge is still active.

1.4 SCOPE OF STUDY

This work was carried out in Iyokwu River in Abakaliki Ebonyi State; the work basically covers physical, chemical and bacteriological analysis. Samples were collected in five different locations: upstream, discharge point and downstream respectively.

1.5 Relevance

This study helps to inform the Government and general public the nature of Iyokwu River and quality of degradation that has taken place due to abattoir effluent. It equally helps to expose the enteric disease posed by the River as a result of abattoir effluent. The result obtained from this study helps people to know the adverse impact of abattoir in Iyokwu River. The study serves as a catalyst to both government and individuals to improve water management and quality conservation in order to save lives. The work deeply looks into some parameters that ascertain water suitability for consumption.

CHAPTER TWO

LITERATURE REVIEW

2.1 WATER IN NATURE

Water is a pre-requisite of life. Billions of lives that exist under the planet earth depend on water; the earth is the only planet where water molecules can exist in different forms. About 2.48 billion cubic meter of water covers the earth surface (Omole and Isiorho, 2011). Water is a natural substance that is colourless, odourless and tasteless. It is a molecule with a chemical formula of H_2O ; atoms of hydrogen and oxygen are the major chemical compounds known as water molecule (Mc Caffrey, 2011). According to (Mc Kean and Nagpal, 1991) water exists in three states which include liquid, solid (ice), and gas. Water equally occurs in nature as snow, glaciers, ice bergs, dew, aquifers etc.

As world population is constantly growing, the demand for water equally increases. Water is essential both inside and outside homes. Approximately 50% of water is used in the bathroom, toilet make up 26% while the shower and the sink use 23% domestically (Rajasooriyar, 2003). Outside the house 35% of water is use in agriculture, 55% is used in the industries while 10% runs to the streams and oceans respectively. Table 1 below shows the composition of surface water.

2.2 BASIC USES OF WATER

Water is a multiple use resource. It is one of the nature's most important resources to mankind. Its use has increased about twice as fast as population growth over the past century, which includes water as a recreational asset, stock and wild life watering, and water for agricultural use, principally irrigation, water as a raw material or coolant in industries, water as a power producer in hydroelectric power plants, Water as a supporting medium for ship and other commercial vessels (navigation)

2.3 Water Quality

Water resources deserve special attention because of their benefits. When water is not properly care for, it may lead to public health and environmental problem (Osemwota, 2010; Oyeleke, Dauda, Oyewole, Sumayya and Okoliegbe, 2011; Ubwa, Atoo, Offem, Abhand, Asemave, 2013). Precipitation carries along with it soil, rocks, organic debris, dissolved chemicals down to the surface water (Uchegbu, 2002).

Water quality comprises the physical, chemical and biological characteristics of water (Ubalua and Ezeronye, 2005). Water quality tries to describe or define how pure, wholesome and potable water is. Water is one of the raw materials the quality of which must be known and controlled. Aquatic organisms flourish at suitable condition and their population is significantly reduced when condition is poor or unfavourable (Wetzel, 2005); also human health is at risk when water is polluted. Important water quality parameters and they WHO permissible limit are present in table 2.0 below.

Table 2.0: Selected Water Quality and Their Standard Limit

PARAMETER	WHO
Temperature	25°C
Turbidity	5 NTU
Electric conductivity	500µs/cm
pH	6.5-8.5 mg/l
TDS	0.2 mg/l
TSS	20 mg/l
TS	150 mg/l
CHLORIDE	250 mg/l
SULPHATE	250 mg/l
PHOSPHATE	0.3 mg/l
NITRATE	50 mg/l
NITRATE NITROGEN	3 mg/l
IRON	0.3 mg/l
COLOUR	15 PCU
ODOUR	ODOURLESS

CALCIUM	300 mg/l
MAGNESIUM	150 mg/l
PHOSPHORUS	<5 mg/l
AMMONIA	-
AMMONIA NITROGEN	-
LEAD	0.01 mg/l
COPPER	2 mg/l
NICKEL	0.07 mg/l
ARSENIC	0.01 mg/l
E COLI	0 cfu
TOTAL COLIFORM COUNT	0 cfu
TOTAL SAMONELLA COUNT	0 cfu
TOTAL HETEROTROPHIC FUNGI COUNT	0 cfu
TOTAL HETEROTROPHIC BACTERIA COUNT	0 cfu

SOURCE: WHO Drinking Water Standard, 2017

2.4 SOURCES OF WATER

A particular place where water comes out from is the source. Human beings depend on water to survive. Without water it will be difficult for plant and animal to survive.

Three main sources of water are:

- Precipitation
- Surface
- Ground water

Surface Water:

Surface waters are bodies of water that are exposed to the atmosphere. It includes Lakes, Seas, Streams, Oceans, and Rivers etc. It is replenished mainly by precipitation and runoff. Surface water is easily accessible unlike ground water, and this is the major reason why surface water is easily polluted (Chukwu, 2008).

55% of human activities depend on surface water; such as agricultural activities, cooling of power plant in the industries and domestic activities. The disposal of waste materials into water bodies reduces the quality of the water (Bartram and Ballance, 1996); again states that pollutant may enter water bodies directly from agricultural site or from the processing biological materials such as food and textiles, etc. when unusually large concentrations of nutrients are present in water bodies, an excess growth of algae bloom appears. This produces an unsightly green slime layer over the surface of water body and subsequently leads to eutrophication. The slime layer reduces light penetration and atmosphere reoxygenation (Sangodoyin, 1991).

Ground waters:

Ground waters are gotten beneath the earth surface. Due to the geological and geometry of a particular environment it may be difficult to obtain water. Aquifer is an essential rock that holds enough water and transmits it rapidly enough to be useful as a source of water. When the aquifer is directly overlain only by permeable rocks and soil, it is describe as an unconfined aquifer. A confined aquifer is bounded above and below by low permeability rocks (aquitards) or impermeable strata and this makes it difficult to obtain waters (Cambers and Ghina, 2005).

Precipitation:

This is another form of water source that comes from the atmosphere. Precipitation is any form of liquid or solid water particles that fall from the atmosphere and reaches the surface of the earth; precipitation is the major supplier of water to both groundwater and surface water.

2.5 Water Pollution

Million (2008) defined pollution as any substances introduced into the environment directly or indirectly that may be harmful to living organisms, hazardous to human health, hindrance to marine activities, impairment of quality and use of water. It is a man-made or man aided alteration of chemical, physical or biological of the environment to the extent that is detrimental to the

environment beyond acceptable limit. Water pollution is one thing that is common in many countries of the world; any undesirable change in the characteristics of water amount to water pollution. Most Nigerian industries discharge their untreated effluent through drains or canals into the nearest water body, streams, rivers, estuaries and the seas; Thereby causing water pollution (Obi and Ibe, 2011). These effluents contain solid inorganic matter, organic matter, toxic substances, acids and alkali. Industries discharge hot effluent that may be dangerous to aquatic and marine life. Some of these polluted water bodies emit obnoxious fumes while others may contain oil-like and real floating oil from sources of discharge; this condition makes it unsavory to the eyes; and therefore unattractive for human recreation (Kalu and Achi, 2011). According to (Ibrahim *et.al*, 2012) rural areas water supply are not dependable. A particular River may be used for drinking and household activities at the same time. The effect of this ugly situation became more prominent as outbreak of cholera epidemics and other water borne diseases became associated. Surface and ground waters became poisoned with synthetic chemicals such as heavy metals, pesticides and recently acidification. Fishes are known to accumulate a lot of toxic metals pollutants in their organs which majority of Nigerians depends for their source of protein. Heavy metals caused by cadmium and mercury may lead to death (Scahill, 2003).

2.6 Sources of water pollution and its effect

The natural location of people is gradually being destroyed especially the water bodies due to development. The two main sources of water pollution are the point source and nonpoint source. The point source is easy to identify and eradicate because it comes out from a particular source unlike the non-point source that does not have a definite point of discharge.

Other sources include the following:

Sewage Waste:

The use of bucket latrine and channelling of sewage system into water bodies in some parts of the country create health hazards. In the urban areas the situation

is not much different; the effluents are usually disposed in water bodies and sewers within habitable premises, thus polluting the environment.

Chemicals Effluents:

Industries that produce chemicals such as pesticides, house hold detergent may contribute to the poor state or degradation of water quality. These may enter water body by the process of surface runoff, then pollute water and render them useless. Also toxic chemicals from municipal and leachate from landfill can spill into the ground and pollute water bodies (Ubani *et.al*, 2014).

Agricultural Sector Source:

In Nigeria farmers use Gammalin 20 for spraying of cocoa and other cash crop trees which finally drains to the sea. Also Federal Government Agriculture policies like Operation Feed the Nation (OFN) green revolution and food for all by the year 2000 became opportunities for high powered, chemical insecticide, pesticide, weedicide and fertilizer abuses. Over whelming evidence discloses that DDT and other related chlorinated hydrocarbons used as pesticides and herbicides threaten many species of flora and marine life (Ezemonye, 2009).These chemical when dangerously concentrated, progressively accumulate in land and sea animals moving up the food chain the effect has led to a ban of DDT. Reports have shown that Gammalin 20 and similar poisonous chemicals are used to kill fishes in rivers, lakes and even Streams which also serve as drinking water resources in these areas.

Oil and Gas Discharge

The case of dangerous liquids like oil and gas and other petroleum products that escape out of pipeline especially in Niger Delta should not be over emphasized. These oil and gas spillage find their way into water course, killing fishes and other marine lives and making the water unfit for consumption and unsafe for agriculture (Ezenwanji and orji, 2008).

Marine Transportation and Pollution of Water Ways and Seas

Marine pollution is as old as maritime trade and transport itself. Marine and fresh water environments are vital resources providing recreation and pleasure as well as being essential to the economy and the fishing industry. Protecting the quality of rivers, streams and ground water is essential not only to provide quality drinking water but water for industrial recreation and conservation (Wetzel, 2001).

Industrial Wastes:

This is also major source of water pollution. The ugly leftover of industrialization are resultant discharge of toxic industrial effects in water channels especially in urban neighbourhood (Million, 2008).

Heavy Metal

Heavy metals are natural components of the earth's crust which can be degraded or destroyed. It is a group of metals and metalloids with atomic density greater than 4g/cm^3 . Heavy metal according Nwoko (2007) has little to do with density but concerns chemical properties. However, lead, cadmium, mercury and arsenic are main threats to human health when exposed to them. Patin (1999) noted that heavy metals such as Cd, Ni, As, Pb poses a number of hazards to human. Environmental pollution by heavy metals is prominent in mining and old mine sites and pollution reduces with increasing distance away from mining sites. Water bodies mostly surface waters are most polluted with the help of agents of erosion such as wind, water etc. Metals are transported as either dissolved species in water or as an integral part of suspended matter causing the serious effects on the aquatic life.

In addition, to a small extent, the metals enter the human bodies via food, drinking water and air. Though some heavy metals (e.g copper, selenium, zinc) are essential to maintaining the metabolism of the human body, but concentrations above the desirable level can lead to poisoning. Heavy metals are dangerous because they tend to bio-accumulate. Bioaccumulation results when there is an increase in the concentration of a chemical in a biological organism over time, compared to the

natural concentration of chemicals in the environment. Heavy metals may enter a water supply by industrial and house hold wastes, or from acidic rain resulting in the disintegration of soils and releasing heavy metals into streams, lakes, and ground water (Ezenwaji, 2010).

2.7 WATER POLLUTANTS AND ITS CLASSIFICATION

The problem of water pollution due to discharge of domestic and industrial waste into aquatic systems has already become a serious problem in Nigeria. Nearly 7580% of Nigeria is exposed to unsafe drinking water (Ezenwaji and Orji 2010). As a result, enteric diseases, often reaching epidemic proportions, devastate several parts of the country. The rivers and lakes near urban centers emit disgusting odours and fishes are being killed in millions due to pollutant (Oliver and Fidler, 2001).

CLASSIFICATION OF POLLUTANT

- Oxygen demanding wastes
- Disease – causing agents
- Synthetic organic compounds
- Plant Nutrients
- Inorganic chemicals and minerals
- Sediments
- Radioactive substances
- Thermal discharge
- Oil

Biochemical Oxygen Demand

The biochemical oxygen demand (BOD) is a measure of the oxygen utilized by microorganisms during the oxidation of organic material. It is the most widely known measured for assessing the water pollution potential of a given organic waste. On an average, the demand for oxygen is directly proportional to the

amount of organic waste which has to break down. Hence BOD is a direct measure of oxygen requirements and an indirect measure of biodegradable organic matter.

Disease Causing Agents:

Water is a potential carrier of pathogenic microorganisms. These pathogens are carried into the water bodies by sewage and wastes from farms and various industries, especially meat processing industries (Rock and Rivera, 2014). Contact with pathogens can be made by drinking the water or through other activities involving contacts with water. Some bacteria are water borne and these include those responsible for causing cholera, typhoid, amoebic dysentery, and gastroenteritis (Lokhande *et. al* 2011). Viruses are also found in water including strains, which are responsible for polio, infectious hepatitis and fever (Rock and Rivera, 2014).

Water may also contain some animal parasites including the round worm. All this type of organisms occurs in faeces and so is present in the sewage. Water also plays an indirect but vitally important role in the transmission of diseases like malaria, yellow fever, filariasis and schistomiasis. The coliform groups of bacteria are considered reliable indicators of the hygienic quality of water. *Escherichia coli* (*E. coli*), belonging to the coliform group is essentially harmless bacteria found in large numbers in human faeces. Since pathogens leave the human body through body wastes and since *E. coli* is resident in large intestine as normal flora and as such found in significant concentration in faeces, the large concentration of *E. coli* in water indicates faecal contamination (Ostroumov, 2005)

Synthetic Organic Compounds

These include pesticides, synthetic organic chemicals and detergents. These compounds unlike organic waste are not biodegradable and may persist for long periods. These are of great concern to environmentalists because most of the synthetic organic compound are accumulative toxic poisons and ultimately may reach objectionable levels in water or in aquatic life.

Plant Nutrients

Nitrogen and phosphorus are essential elements which are required by plants and animals for maintaining their growth and metabolism. Small amount of nitrates and phosphates occur in all aquatic systems and are sufficient to maintain a balanced biological growth. In waste waters, these nutrients are present in abundance as phosphates, nitrates, ammonia or combined organic nitrogen.

These compounds may enter the water bodies directly from the manufacturing plant, use of fertilizers and from the processing of biological materials such as food and textile or via domestic sewage treatment plants. Thus, when unusually large concentrations of nutrients are present in water bodies, an excess growth of algae, known as an algal bloom appears and this may subsequently lead to eutrophication (Okereke, 2006). Reports have shown that diseases are contracted when infected water is used for domestic's purposes as cooking, bathing, and drinking water. Table 2.1 below summarizes the diseases and the causative organisms in polluted water.

Table 2.1: Diseases and causative organism Capable of being transmitted through the Ingestion of infected Water

Disease (Bacterial)	Causative organism
Cholera	Vibrio cholera
Bacillary dysentery	Shigella
Typhoid fever	Salmonella
Paratyphoid fever	Salmonella
Infective diarrhea	Proteus, Escherichia
Tularemia (rarely)	Pasteurella, tularensis
Anthrax (rarely)	Bacillus anthracis
Leptospirosis	Laptospira
Tuberculosis	Mycobacterium tuberculosis
Disease (Viral)	Causative organisms
Infectious hepatitis	Hepatitis virus A&B
Flourodyria	Coxsackie virus B

Poliomyelitis	Polivirus, type 1, 11,111
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Source: WHO, 2017

2.8 WATER QUALITY PARAMETERS

The choice of these water quality parameters (table 2.0) was guided by their relative importance in abattoir effluent composition. They are:

TEMPERATURE:

Temperature governs the type of organism that will live in water. Aquatic animals all have preferred temperature ranges in order to survive. As temperature increases above limit, aquatic organisms decrease until there are none. Cool temperature holds more oxygen than warm temperature. Warm temperature lacks enough oxygen for the survival of organisms (Wickham and Maclin, 2005).

TURBIDITY:

Turbidity is the measure of water clarity. Turbidity is inversely proportional to water clarity; Increase in turbidity indicates potential pollution, this may occur when suspended solid appears in a water body. Suspended materials can clog fish gills; reduce resistance to disease in fish (Shell petroleum Development Company, 2003). Turbid water may not be suitable for industrial use as the abundance of suspended solid may clog machinery. If turbidity is large due to organic particle, depletion in dissolved oxygen may occur. The excess nutrient available may encourage the growth of microbial breakdown, a process that required dissolved oxygen, thereby reducing oxygen availability in the water.

ELECTRIC CONDUCTIVITY:

Conductivity is a measure of the ability to conduct an electric current and is the opposite of resistance. The higher the concentration of ion in water, the more current the water can conduct. Conductivity is sensitive to the amount of dissolved

solid particularly mineral salts in the water, and also depends on the amount of electric charge of each ion (Smith, 2006).

pH

The pH of water is an important indicator of water that is changing chemically; the pH of water determines the solubility (amount of solute that can be dissolved in water) and the biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). High pH causes a bitter taste, water pipes and water using appliances becomes encrusted with deposit and it depresses the effectiveness of the disinfection of chlorines. Low pH will corrode or dissolve metals and other substance. pH is the acidity or alkalinity of water, the lower the pH the more acidic the water. Alkaline has a pH of 7 (neutral). Pollution can change water pH, which in turn can harm animals and plants living in water (Zarky, 2007).

Total dissolved solid (TDS)

This is the sum of the concentration of all dissolved solid chemicals in water. High levels of total dissolved solid and conductivity render water less suitable for drinking and irrigation (Smith, 2006). Total dissolve solids (TDS) content in water is used to measure for salinity. The common salt found in dissolved solids includes, carbonates, bicarbonates, chlorides, sulphate, phosphate and nitrates of calcium, magnesium, sodium, potassium and manganese etc. a high density of dissolved elements affects the density of water influence osmoregulation and reduce solubility of gases (Lokhandle, Singare and Pimple, 2011).

Sulphate

High concentration of sulphate in the water we drink can cause a laxative effect when combined with calcium and magnesium. The maximum level of sulphate suggested by the WHO (2004) for drinking water quality is 500mg/l. People not used to drinking water with high levels of sulphate can experience dehydration and diarrhea. Sulphate gives bitter or medicinal tastes to water if it exceeds

concentration of 250mg/l. High sulphate levels may also be corrosive for plumbing particularly copper piping.

Phosphate

High quantity of phosphate in water encourages eutrophication and depletes the water body of oxygen. This can lead to the death of aquatic organism such as fish. Large quantity as well accelerates algae and plant growth in natural waters. We have manmade sources of phosphate which includes human sewage, agricultural runoff from crops, sewage from animals' feedlots, etc.

Nitrate

Nitrates are not generally considered toxic but at high concentration the body may convert nitrates to nitrites. Excess amount of nitrate can cause methaemoglobinaemia in which there is inability to transport oxygen in the body. This might cause nausea and stomach aches for adults . The source of this pollutant is mainly from sewage, agricultural runoff containing chemical fertilizer and industrial waste.

Iron

Iron is the fourth most abundant elements by weight, in the earth crust. Iron is trace element required by both plants and animals. It is vital oxygen transport medium in the blood of all vertebrate and some invertebrate animals. Iron in domestic water supply system stains laundry. It appears to be more of nuisance than a potential health hazard (Oram, 2014). Iron compounds are formed as a result of reactions between air and water. It can cause hemochromatosis (in which the body absorbs four times more than what is required to absorb). Too much iron can lead to live threatening conditions such as liver disease, heart problem and general weakness.

Escherichia coli (E. coli)

E. coli are gram negative bacteria and are a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of E. coli in water is a strong indication of recent sewage or animal waste contaminations.

E. coli can cause gastrointestinal illness (diarrhea); other infection includes skin irritation, ear, nose, throat infection and respiratory infections (Rock and Rivera, 2014). Obi and Ibe (2011) reports that the health effects of presence of total coliform bacteria in water include urinary tract infection, bacteremia, meningitis, diarrhea (one of the main causes of morbidity and mortality among children)

Ammonia

Ammonia is a colorless gas with a strong pungent odour. It reacts with water to form a weak base. The toxic concentration of ammonia in human may cause loss of equilibrium, convulsion, coma and death. Ammonia levels in excess of recommended limit may harm aquatic life.

Dissolved Oxygen (DO):

Surface water of good quality should be saturated with dissolved oxygen. A fall in DO level is one of the indications that a water body is polluted by organic matter. The DO level in water depends on physical, chemical and biochemical activities present in water (Ubalua and Ezeronye, 2005). He also stressed that the presence of DO in good quality water will improve the water quality by rendering poisonous gases like hydrogen sulphide, ammonia, and others into their nonpoisonous form. Deaths of fish occur when they are exposed for a few hours to less than 3mg/l DO (Zaghloul and Elwan, 2011).

Biochemical Oxygen Demand (BOD)

The most acceptable measure of biodegradable organic content of waste water is the 5-day, 20°C BOD value (Okpokwasili and Olisa, 1991). Which is normally carried out after 5 days of incubating waste water in total darkness, the oxygen content will be measured.

Hard Water:

Simply contains excess amount of dissolved calcium and magnesium. When the concentration of calcium and magnesium exceed the range of 80 to 100ppm, the hardness may become objectionable. The most irritating problem with hard water is the way it reacts with soap, preventing the soap from lathering properly with water. Hard water can cause pipe to wrought or scale formation in pipe. According to national academy of science, hard water is not a health hazard rather contributes towards total calcium and magnesium in human dietary needs.

Chloride Concentration:

Chloride concentration if present in excess of 400ppm can be fatal to fresh water fish and it can equally lead to hyperchloremia (Cerebral dehydration, weakness of the body) (WHO, 2017).

Some heavy metals which have harmful effects on human health include:**Lead:**

Lead is another toxic metal which is significant from public health view point; it is usually present in natural water at a very low concentration. However if present in excess in water due to discharge of industrial effluents into water bodies, if containing high concentration of lead, it may develop lead poisoning (Nwoko, 2002). It poses a potential hazard to public health. The route of transmission of this pollutant was found to be in food chain. In excess this can attack the central nervous system.

Nickel:

Nickel is often present in water in concentration which ranges between 0.001 to 0.07 mg/L. Its toxicity depends on its chemical forms. Ingested nickel carbonyl is very toxic and carcinogenic. Hence knowledge about possible chronic effects of small quantity of nickel in water is very scarce (Nwuche and Ugorji, 2008).

2.9. CONCEPT OF ABATTOIR

Over the years abattoir effluent has been contributing to the degradation of water quality. Slaughter house or abattoir house is a place where animals are killed and the meat consumed (Bentram, 1996). In the tropics, abattoirs are usually located near water bodies. Waste from animals are deposited in this water without any form of treatment making the water to be choked with so many impurities such as urine, blood, bones and other animal carcass are present in the water. Water is a vital resource and its pollution or degradation could lead to health hazard (World Bank, 1998).

Proximity of abattoir house to residential areas may present some merit but the impact on the local built environment and health of residents in abattoir vicinity poses great risk (Bull *et al*, 1982; Coker *et .al.*, 2001; Nafardaet *al.*, 2006) It is difficult to have a suitable and efficient abattoir house because of the increase in population of humans that is leading to greater demand of meat for protein.

In Italy a law of 1980 requires that a public abattoir be provided in all communities of more than six thousand in habitant. This led to the construction of so many unregulated abattoir houses in the city (Emeka *et.al*, 2009). Abattoir houses which serves as a point of transaction where exchange of goods and services takes place was equally encouraged in Norway, Sweden, Denmark, Netherland, and Rumania (Gannon *et al*, 2004). Slaughtering of animal was equally encouraged in UK to purchase as many animals as possible from different location including farm and transform them into carcass meat.

In Nigeria abattoir houses are built unregulated. It is an individual's decision to build an abattoir house where he chooses without considering the nature of the environment. Abattoir houses are built on the street very close to drainage channels, in front of church promises, and small shops inside residential houses. Small communities less than five thousand are entitled to have as many abattoir houses as possible. The worst is rural area where animals are been slaughter at every corner of the house, with a nearby river where domestic activities and deposition of animal waste are taken place at the same time.

Akinro *et.al* (2009) stated that abattoir house should be built away from residential area and also said that a thorough investigation should be carried out before constructing abattoir house in order to protect our natural resources. Waste generated from abattoir house can be a source of contaminant to our water body. The waste materials such as blood, urine, hairs, faeces, etc discharged into water ways can pollute and degrade the quality of water. According to Akan *et.al* (2010) increase in the pollution of water depends majorly on number of slaughtered animals or amount of waste involved per day. Slaughtered animals produce at least 328.4kg of wastes including bone, horn and hoof, etc. (Sridhar, 1998). The abattoir house is an important component of the livestock industry providing domestic meat supply to over 150 million people and employment opportunities for teaming population. Facilities for the treatment of abattoir effluents are lacking, unlike in developed countries where these facilities are adequately provided. Potential health risks from waterborne pathogens can exist in water contaminated by abattoir effluents, runoff from feedlots dairy farms, grazed pasture, fallow, poultry litter, grassland treated with dairy manure, and sewage sludge treated land. Such contamination of water bodies from abattoir wastes could constitute significant environmental and public health hazards (Cunningham *et. al.*; 2008). This uncontrolled manner of slaughtering animals poses a significant threat to our water bodies. Animal welfare and animal rights groups should be encouraged to raise concerns about the methods of transport, preparation, herding, and killing within some slaughterhouses. The slaughter of animal is a haphazard and unregulated manner activity which may occur even in the open air.

2.9.1 Pollutants in Abattoir

Garki abattoir in Abakaliki is a small market where animals are supplied or slaughter for human consumption. The small channel that leads to Iyiokwu River is been deposited with a lot of impurities, thereby contaminating the water. Pathogens present in animal carcasses or shed in animal wastes may include: rotaviruses, hepatitis virus, Salmonella specie, E. coli. These zoonotic pathogen can exceed millions to billions per gram of feces, and may infect humans through

various routes such as contaminated air, contact with livestock animals or their waste products, swimming in water impacted by animal feces, exposure to potential vectors (such as flies, mosquitoes, water fowl, and rodents), or consumption of food or water contaminated by animal wastes. The consequences of infection by pathogens originating from animal wastes can range from temporary morbidity to mortality, especially in high-risk individuals. The bacteriological characteristics of abattoir wastewater and its possible effect on receiving water bodies are likely to cause pollution with intensified environmental and public health hazards (Adesemoye *et al*, 2006).

2.9.2 Slaughterhouse Wastewater Characteristics (SWW)

The main source of SWW is the feces, urine, blood, lint, fat, carcasses, and nondigested food in the intestines of the slaughtered animals, the production leftovers, and the cleaning of the facilities (Ezeoha and Ugwuishiwu, 2011). The SWW composition varies according to the industrial process and water demand. Nevertheless, they usually contain high levels of organics and nutrients, typically measured as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS), total nitrogen (TN), and phosphorus (TP). Slaughterhouse effluents are considered detrimental worldwide due to its complex composition of fats, proteins, and fibers, as well as the presence of organics, nutrients, pathogenic and non-pathogenic microorganisms, detergents and disinfectants used for cleaning activities, and pharmaceuticals for veterinary purposes therefore, the treatment and disposal of wastewater from slaughterhouses and meat processing plants are economical and public health necessity.

2.9.3 Effect of Abattoir on Water Quality

Water pollution is one of the main concerns of the world today. Many countries of the world have striven to find solutions to reduce this problem. A good number of pollutants threaten water supplies but the most wide spread especially in Nigeria is the discharge of abattoir effluent into natural water. This method of waste disposal is the most common in developing countries like Nigeria. The wastes such

as bone, blood, urine and faeces of animals have serious impacts on the water body and the environment at large. When waste from abattoir is not properly managed, it may lead to serious environmental and health hazards both animal life and humans (Akinro *et al*, 2009). Dung waste from abattoir can pollute the soil and release methane to the atmosphere (a greenhouse gas) from decomposing waste. Animal waste can serve as manure to growing crops and can degrade the quality of water because of the presence of trace heavy metals, salts, bacteria, virus and other microorganisms from it. Reports both in Canada (Mittal, 2004) and Nigeria (Adie and Osibanjo, 2007) have shown that abattoir waste has high contaminants which may be very hazardous to human beings and aquatic life.

2.9.4 Effect of Abattoir Effluent on Fishes

Aquatic organisms spend their entire life living in water. Water serves as a comfortable zone for aquatic organisms to survive, therefore for them to live for a long number of years, they need clean and unpolluted water. Research has shown that 60-70% of surface water is polluted more than ground water (Sumayya *et al*, 2013). Most processes in slaughter house require the use of water. This water and water used for general cleaning purposes will produce waste water. Pollution of water resources might lead to destruction of primary producers and reduce consumer population in water. The available dissolved oxygen (DO) in water can be depleted or reduced when biodegradable organic compounds are released into water. Microorganisms that depend on this kind of waste descend on it and degrade the available oxygen. When the oxygen is exhausted, anaerobic microorganisms come up; these are organisms that can survive in the absence of oxygen in water causing the water to have a foul smell. Again excess nutrients can lead to eutrophication and algal growth, and subsequent death of organisms in water. The resultant effect of this is reduction in fish yield and consequently human diet. When adequate amount of oxygen required for aquatic organisms to survive is reduced or depleted these microorganisms tend to die off or their reproductive life is impaired (Aina and Adedipe, 1991). Large amount of organic effluents in receiving water can reduce visibility and reduce light availability to photosynthetic

organisms and make water unsuitable for organism to survive (Montgomery, 2006)

2.9.5 Activities of Abattoir That May Contribute To Air Pollution

Air pollution is another challenging issue from abattoir house. Air which is a mixture of gases that fill the atmosphere, giving life to plants and animals that makes earth such a vibrant place: can equally be impacted by abattoir waste. This occurs when the air is mixed with extremely high concentration of gaseous chemicals. Within the range of 0.05 percent, there is no harm to the body but at 5-10 percent, is toxic and could kill in a matter of minutes. Abattoir activities can contribute to smog and odour in the environment (Igbinosa *et al*,2018) .

Potential sources of odour in abattoir operations are: The cooking and rendering process, Slaughter houses, Product storage and handling areas, Material drying areas, Waste disposal techniques such as burning dead stock, Animal holding pens, Odour from skin shed. Wing and Woof (2000) reported a health hazard issue among individual living close to abattoir houses; and stated that respiratory and mucous membrane effects were common with neighbours of intensive swine operation.

2.9.6 Effect of Abattoir Effluent on Soil

Soil is the material found on the surface of the earth that are made up of minerals, organic matter, water, air and countless organism that support life on earth. Soil is one of the three (3) major natural resources, alongside air and water. It is one of the marvelous products of nature and without which it will be difficult to survive. Despite all this benefit from soil, it is still being polluted by activities. Soil and water are the major or primary places where waste can easily be dumped (Nazir *et al*, 2015). Waste from abattoir houses are dumped directly on the ground (blood, urine and carcasses) Report from (Lombinet *al*; 1991) showed that waste from abattoir have the potential to affect soil productivity adversely and may cause land to become infertile. The use of organic manure from animals such as dung, poultry

droppings etc in excess amount can increase heavy metal content of the soil (Yasup and Oluwole, 2006).

Protecting the quality of rivers, stream, and groundwater is essential not only to provide quality water for consumption but water for industry, recreation and conservation. However, there should be a kind of pretreatment of waste materials before discharging them into the river.

CHAPTER THREE

MATERIALS AND METHOD

3.1 Brief history of Ebonyi State

Ebonyi state was created in 1996 from the part of Enugu, Anambra, and Imo state. The city is bounded physically to the east by Cross river state, to the north by Benue state and the south by Abia state. It is habited and populated primarily by Igbo. Its largest and capital city is Abakaliki. The people of Ebonyi State are predominantly farmers. The state is richly blessed with numerous solid minerals resources spread across all parts of the states.

3.2 Study Area

This study was carried out at the beginning of rainy season (April, 2017) in Abakaliki, the capital city of Ebonyi state in southern Nigeria. Its coordinate is between latitude $6^{\circ} 22' 26''$ N and longitude $8^{\circ} 6' 6''$ E. The location is traversed by a number of Rivers; Iyudele River, Iyiokwu River, Ebonyi River and Okpuru River respectively. The study took place at Iyiokwu River which is downstream Iyudele River in Garki abattoir Abakaliki. Iyiokwu River was used for this assessment because it is mostly affected by this abattoir effluent.

3.3 Climate

The climate is tropical and the rain fall pattern classified under savannah zone of Niger. The wet season occurs between April and October, and the dry season which takes place from November to March. The average annual rainfall varies from 1750mm to 2250mm (Ofomata, 2003).



Fig 1: Map of Nigeria showing the location of Ebonyi state

Source:

www.worldatlas.co



Fig 2: Map of Ebonyi State

Source: www.worldatlas.com

Vegetation

The vegetation is characterized by semi-savannah grassland with forests and swamps. It is dominated with planted forest of Melina. The predominant grasses are elephant grasses with perennial characteristics of sparse vegetation. The type of soil in that area is basically clayey loamy soil.

Population

The population of Ebonyi state is growing tremendously as a result of employment, migration and birth rate. The result of the 2006 national population and housing census exercise showed that the population of Ebonyi state was 1,739,136.

Temperature

The mean annual minimum and maximum temperatures are approximately 20.3°C to 34.9°C. The relative humidity of the study area is between 60 to 80% during rainy season (Apha, 1998).

3.3.1 Sources of Data

The data used in this research were obtained from both primary and secondary sources.

3.3.2 Primary Data

The primary data are the set of data collected from the study area through sampling and include those derived from observations made during sampling and laboratory work.

3.3.3 Secondary Data

Secondary data include all published materials used in this study. These are information and data from text books, monographs, lecture books, journals, internet and literature from other peoples work.

3.4 Materials

We use 50cl of plastic bottle and 20cl of BOD bottle to collect water sample after sterilizing them in the lab before taking them to the field. The water samples were collected very early in the morning around 7:30am to 11:05am when the effluent is washed into the channel that leads to Iyiokwu River.

3.5 Sample Point Collection

The samples were collected in five different points along the flow paths. One sample was collected upstream before the discharge point and other four were collected after the discharge point. The upstream was selected to serve as control, referred to in this work as WQ_{50} ; discharge point was referred to as WQ_0 while three other points represent the downstream section, which include: WQ_{100} , WQ_{150} , and WQ_{200} .

In each sampling point, three samples were collected making it a total of fifteen samples, which were used to analyze the physical, chemical and biological parameters of the water samples. During sampling, sample bottles were rinsed with the sampling water to maintain homogeneity and then filled to the maximum. The sample containers were well labelled and covered to protect them from contamination and were preserved with ice packs before transporting them to the laboratory same day. The locations of the samples collected in the field were presented in the Table 4 below.

Table 3.1: Sample Point Location and Co ordinate

S/N	NAME OF LOCATION	CODE	LATITUDE	LONGITUDE	ELAVATION (METERS)
1	H ₂ O quality before DP	WQ ₅₀	N06 ⁰ 19.233 ^l	E008 ⁰ 06.233 ^l	31.82
2	DP	WQ ₀	N06 ⁰ 19.163 ^l	E008 ⁰ 06.559 ^l	51.40
3	100m after DP	WQ ₁₀₀	N06 ⁰ 19.135 ^l	E008 ⁰ 06.543 ^l	44.39
4	150m after DP	WQ ₁₅₀	N06 ⁰ 19.067 ^l	E008 ⁰ 06.553 ^l	25
5	200m after DP	WQ ₂₀₀	N06 ⁰ 19.065 ^l	E008 ⁰ 06.599 ^l	44.42

Source: Field Work, 2017

Sampling depth for all measurement location: 0.16m

DP: Discharge Point

WQ: Water Quality

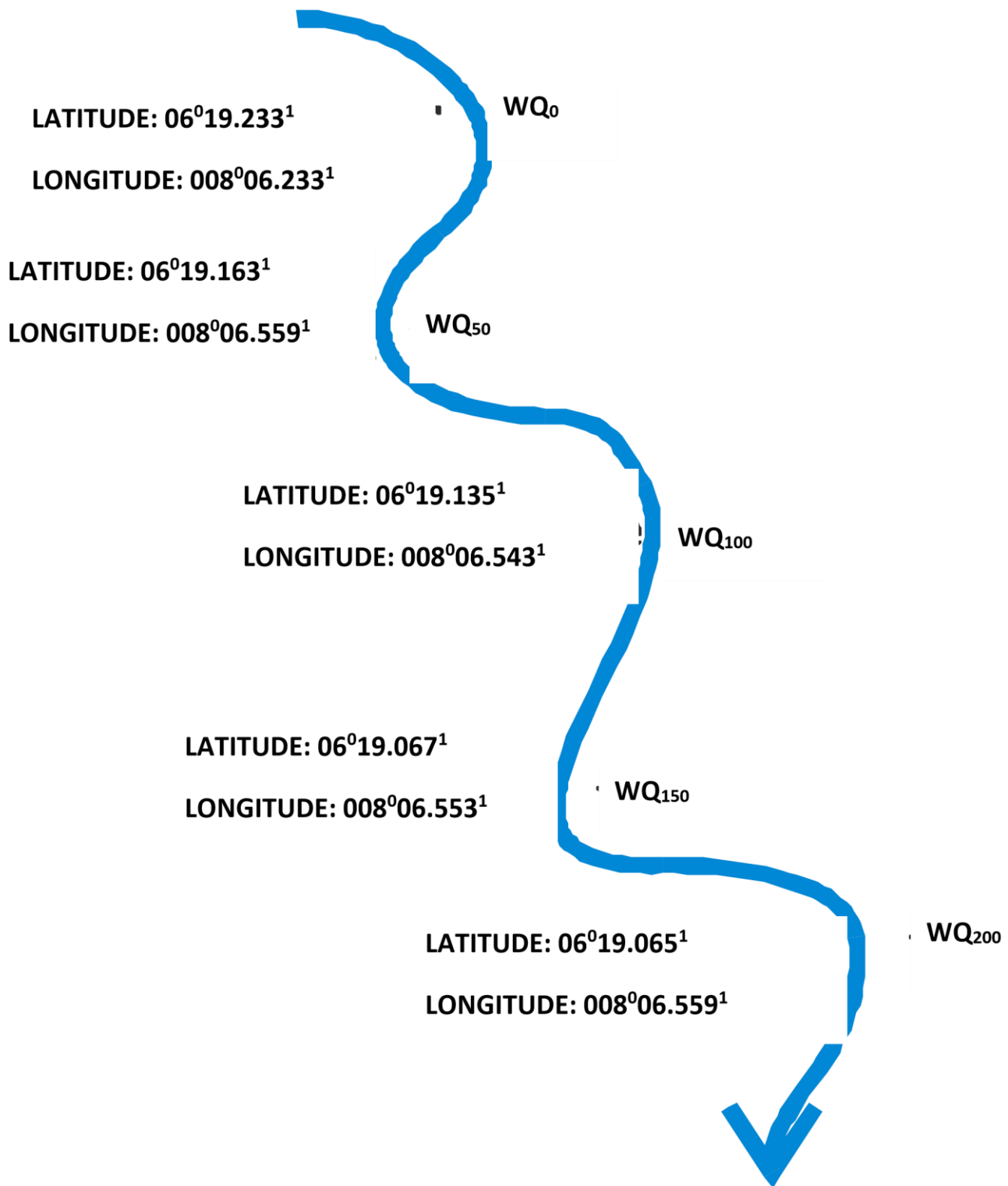


Fig3: sampling point illustration (Iyokwu River)

3.6 Laboratory protocol

3.7 Physical Properties Determination

The physical analyses of these water samples determined were colour, odour, temperature, turbidity, total dissolved solid (TDS), and total suspended solids (TSS), total solid (TS).

Colour determination

The colour of water sample was determined by colorimetric platinum cobalt method at 420nm with HI83200 model which displayed in PCU (Platinum Cobalt Unit).

Odour determination

Odour was determined by smelling the water sample through sensory evaluation panel according to the methods of (Apha, 1992).

Temperature determination

The water temperature was taken with the use of mercury thermometer calibrated in degree centigrade (Celsius) as described by the method of (Edma *et.al*, 2001).

Turbidity determination

The turbidity of the water sample was estimated by comparing the turbidity of the water with the ampoule of standard turbidity, by holding both ampoules side by side after thorough shaking as prescribe by the association of official analytical chemist (Bartram, 1996).

Total solids determination

Total solids were determined by measuring 50ml of water sample into the weighed beaker and heated to dryness, weighed after cooling. The difference in two weights gives the total solid (TS) (Bartram, 1996).

Total dissolved solid (TDS) determination

Total dissolved solids (TDS) were determined by measuring 50ml of the sample. The sample was filtered into a weighed beaker, and then heated to dryness. It was later cooled and re-weighed

$$\text{TDS} = \frac{\text{TSX1000 (mg/l)}}{\text{Vol. of sample}}$$

Total suspended solid (TSS) determination

The amount of suspended solid or particulate matter was determined by subtracting total dissolved solid from total solids, that is

$$\text{T.S.S} = \text{T.S} - \text{T.D.S}$$

3.8 Chemical parameter determination

Conductivity Determination

Conductivity of water samples was determined using the conductivity meter (Jenwaymodel 4520) according to (Edma, 2001).

Total hardness determination

Hardness in water is mainly due to Ca^{2+} and Mg^{2+} ions presence, 50ml of water sample was pipette into a conical flask and 1ml of 5% of Na_2SO_3 drops of Eriot black indicator was added, when the sample turned red, it was titrated with 0.01m EDTA until it turned blue (Apha,1992).

Calcium

50ml of the sample were measured into clean conical flask, then 10ml of distilled water was added, followed by 4ml of KOH solution, 0.3g of potassium cyanide, 0.3g of hydroxylamine hydrochloride and 5ml of mono ethane buffer and 2 drops of solochrome black- T or Erichrome T indicator. The solution was titrated against 0.01NEDTA (FME, 2001).

pH determination

The pH was determined by using a pH meter of an electric digestive glass dipped into 100ml of water sample measured into a beaker and allowed for some minute to detect the readings. (Jenway model 3510).

Chloride determination

The chloride content was determined by using titration method by measuring 10ml of water sample into 250ml conical flask and titrated against 0.1ml of silver nitrate (Apha, 1992).

Sulphate:

Sulphate was determined by turbid meter method using HI83200 multipara meter bench photometer at a wavelength of 466mm. 10ml of the sample was poured into two (2) separate sample cell bottles. One (1) sachet of sulphate reagent powder pillows was added to the second sample cell compartment and timed for

5 minutes. At the end of the countdown, the READ button was pressed to display the result in mg/l of sulphate (FME, 2001).

Phosphate determination:

Phosphate was determined by mixing 25cm³ of each sample with 4ml of molybdate reagent (ammonium molybdate in distilled water) acidified with H₂SO₄ and 10 drops of stannous chloride in glycerol and left for 10mins (Pansu and Gauthoyrou, 2006).

Ammonia

Ammonia is determined by Nessler method using the HI83200 multipara meter bench photometer at a wavelength of 420nm 10ml of the sample was poured into two (2) separate sample cell bottles. One (1) was used as blank to zero the photometer and then 4 drops of HI93715A-0 were added to the other cuvette and the solution, then the cuvette was re-inserted into the instrument and timed for 3 minutes 30 seconds. At the end of the countdown, the read button was pressed to display the result of NH₃-N and NH₄⁺ in mg/l

Nitrate Nitrogen Determination

This was determined from adaptation of the ferrous sulphate methods. 50ml of water sample was measured into a conical flask. 1ml of sodium arsenic was added and shaken thoroughly; 5ml was then taken from the solution into separate clean test tube. 10ml of brucine sulphate and 10ml of conc. H₂SO₄ was added to the solution in the test tube and thoroughly shaken for proper mixing, after which the remaining 45ml of the solution was added and allowed to stand for 30mins. The reading was taken at 410nm in spectrophotometer machine (Pansu and Gauthoyrou, 2006).

3.9 Determination of Heavy Metals

The heavy metals (pb, Cu, Fe, Ar, And Ni) were determined using the atomic adsorption spectrophotometer machine (AAS).

Dissolved Oxygen (DO₂):

The DO₂ was determined using DO₂ meter. The DO₂ meter was calibrated using 5% sodium sulphate solution. The probe of the meter was then inserted into the sample and the meter was put on for about 10 minutes. The reading was recorded in mg/l.

Biological Oxygen Demand (BOD)

The BOD's was determined using DO₂ meter which was calibrated using 5% sodium sulphate solution. The probe of the meter was then inserted into the sample after the meter was switched on for about 10 minutes. The reading was recorded in mg/l. The sample was then incubated in a 250ml wrinkle's bottle for a period of 5 days at 20°C. Then the DO₂ on the fifth day was recorded by inserting the probe again into the sample. The difference in the DO₂(5) and DO₂ (1) was recorded as BOD₅.

$$\text{BOD}_5 = \text{DO}_2 (1) - \text{DO}_2 (5)$$

Chemical Oxygen Demand (COD):

This was determined by measuring 10ml of the water sample into a 250ml conical flask, and then 5ml of 0.025N potassium dichromate solution (K₂C₂O₇) was added followed by 15ml of concentrated sulphuric acid. The solution in the conical flask was diluted with 40ml of distilled water to obtain a 70ml solution. Again 7 drops of phenylthiol ferrous sulphate indicator was added and thoroughly shaken for uniform mixing. The solution was titrated against 0.025N ferrous ammonium sulphate. The blank (distilled water) was also titrated against 0.025N ferrous ammonium sulphate (FME,2001).

3.9.1 Biological Properties Determination

The bacteriological parameters were determined using standard bacteriological technique (FME, 2001).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Presentation of results

The effect of abattoir effluent on water quality along the measurement positions is presented in tables 4.1, 4.2, 4.3 and 4.4. A discussion of each parameter follows the tables. The data were statistically analyzed using the analysis of variance (ANOVA) according to the procedure outlined by Steel and Torie (1980). Means were evaluated for significant difference using Hukey's method at the probability level of 5%. Also the result and the findings were presented in percentage, graph, and tables using Minitab version 16 and Microsoft excel.

Table 4.1: Abattoir Effluent on Physical Characteristics of Iyiokwu River

Parameters	WQ ₅₀	WQ ₀	WQ ₁₀₀	WQ ₁₅₀	WQ ₂₀₀	MEAN	WHO
Temp °C	25.50±0.265 ^C	29.90±0.551 ^A	27.50±0.100 ^{BC}	26.50±0.173 ^B	26.30±0.299 ^B	27.14	25
Colour (PCU)	29.00±1.73 ^E	1095.00±1.73 ^A	654.00±3.61 ^B	267.00±2.65 ^C	57.00±2.65 ^D	420.40	15
Odour	OB	OB	OB	OB	OB	-	UNOB
Turbidity(NTU)	9.640±0.164 ^C	87.550±9.097 ^A	49.500±6.144 ^B	45.550±6.466 ^B	37.200±0.436 ^C	45.88	5NTU
TS (Mg/l)	312.00±10.82 ^B	526.00±24.25 ^A	501.00±3.61 ^A	444.00±112.04 ^{AB}	399.67±10.69 ^{AB}	436.53	500
TDS(Mg/l)	273.33±16.07 ^D	427.67±6.81 ^A	417.00±2.65 ^A	373.00±2.65 ^B	334.67±16.04 ^C	365.13	0.2
TSS(Mg/l)	26.80±2.43 ^E	172.20±3.30 ^A	98.30±3.75 ^B	83.67±3.21 ^C	38.40±2.12 ^D	83.87	20

- PCU: Platinum Cobalt Unit
- NTU: Nephelometric Turbidity Unit
- µS/CM: Microsiemens per centimeter
- Mg/l: Milligram per liter
- TS: Total Solid, TSS: Total Suspended solid, TDS: Total dissolved solid
- OB: Objectionable and UNOB: Unobjectionable

Values bearing the same superscript letters are not significantly different (p<0.05).

Table 4.2 Abattoir Effluent on the Chemical Characteristics of Iyiokwu River

Parameters	WQ ₅₀	WQ ₀	WQ ₁₀₀	WQ ₁₅₀	WQ ₂₀₀	MEAN	WHO
pH(Mg/l)	3.8000±0.8185 ^{BC}	5.3000±0.2646 ^A	4.8000±0.1562 ^{AB}	3.6000±0.1000 ^C	5.1000±0.1732 ^A	4.52	6.5-8.5
Conductivity (µs/cm)	458.00±1.000 ^E	658.00±4.360 ^A	642.00±2.000 ^B	622.00±11.140 ^C	558.00±4.360 ^D	587.60	500
Cl ⁻ (Mg/l)	32.64±4.09 ^B	94.75±4.21 ^A	74.44±30.01 ^{AB}	52.55±32.64 ^{AB}	40.40±9.01 ^{AB}	58.95	250
SO ₄ ²⁻ (Mg/l)	758.81±60.79 ^{AB}	353.07±52.13 ^C	648.52±42.56 ^B	669.10±59.95 ^B	825.47±23.53 ^A	650.99	250
PO ₄ ³⁻ (Mg/l)	2.7000±0.8185 ^{BC}	6.9333±1.1372 ^A	4.3000±0.2646 ^B	2.7000±0.8185 ^{BC}	2.3000±0.2646 ^C	3.78	0.3
P (Mg/l)	0.9000±0.3606 ^B	2.3000±0.2646 ^A	1.4000±0.3516 ^B	0.9000±0.3606 ^B	0.7333±0.2082 ^B	1.24	<5
NO ₃ ⁻ (Mg/l)	10.800±1.058 ^C	22.000±0.436 ^B	22.000±0.436 ^B	22.400±0.529 ^B	39.200±1.082 ^A	23.28	50
NO ₃ -N (Mg/l)	2.5200±0.4508 ^C	5.0000±0.4359 ^B	4.9800±1.0813 ^B	2.7200±0.6490 ^C	8.9000±1.1533 ^A	4.82	3
Carbon (Mg/l)	3.9800±1.288 ^B	6.6300±0.5474 ^A	6.6800±0.06053 ^A	6.8200±0.8054 ^A	4.6400±0.5769 ^B	5.75	5
NH ₃ (Mg/l)	0.5600±0.2883 ^A	0.8800±0.0755 ^A	0.8700±0.0755 ^A	0.8400±0.0346 ^A	0.5200±0.1200 ^A	0.73	-
NH ₃ -N (Mg/l)	0.4300±0.0265 ^A	0.7300±0.2166 ^A	0.7300±0.2166 ^A	0.7000±0.2000 ^A	0.4700±0.0624 ^A	0.30	-
CaCO ₃ (Mg/l)	600.00±39.3 ^C	941.43±39.3 ^A	780.47±78.3 ^B	612.19±10.8 ^C	663.41±62.2 ^{BC}	719.5	1000
Ca ⁺ (Mg/l)	211.00±2.65 ^B	324.33±25.58 ^A	269.00±8.54 ^{AB}	228.76±70.90 ^B	206.69±2.52 ^B	247.94	300
Mg ⁺ (Mg/l)	80.64±3.80 ^D	156.67±4.73 ^A	124.33±2.08 ^B	93.72±3.27 ^C	65.84±5.76 ^E	104.24	150
BOD(Mg/l)	1.000±0.4583 ^{BC}	5.3000±0.2646 ^A	3.6000±0.5292 ^{BC}	3.5000±0.4000 ^B	2.9000±0.1732 ^C	3.26	6.5-8.5
COD(Mg/l)	5.7600±0.9180 ^C	8.4800±0.5012 ^A	8.0000±0.8718 ^{AB}	6.4000±0.3464 ^{BC}	4.6400±0.5769 ^C	6.65	6.5-8.5
DO(Mg/l)	5.4000±0.3464 ^A	3.1000±0.3606 ^C	3.6000±0.5292 ^C	4.1000±0.3606 ^{BC}	5.1000±0.3606 ^{AB}	4.28	6.5

Values bearing the same superscript letters are not significantly different (p<0.05).

COD: Chemical Oxygen Demand

BOD: Biochemical Oxygen Demand

DO: Dissolved Oxygen

Table 4.3 Abattoir Effluent on the Heavy Metal

Parameters	WQ ₅₀	WQ ₀	WQ ₁₀₀	WQ ₁₅₀	WQ ₂₀₀	MEAN	WHO
Lead(mg/l)	0.02333±0.00577 ^C	0.15667±0.00577 ^A	0.06333±0.01528 ^B	0.06000±0.01000 ^B	0.04000±0.01000 ^{BC}	0.06	0.01
Copper(mg/l)	0.0667±0.01528 ^A	0.15000±0.03606 ^A	0.14333±0.02082 ^A	0.12667±0.06028 ^A	0.09667±0.9292 ^A	0.11	2
Nickel(mg/l)	0.03333±0.02517 ^{AB}	0.00000±0.00000 ^B	0.00000±0.00000 ^B	0.00000±0.00000 ^B	0.07333±0.03055 ^A	0.02	0.07
Arsenic(mg/l)	0.03333±0.02517 ^A	0.07333±0.02082 ^A	0.06000±0.02646 ^A	0.05333±0.03055 ^A	0.02333±0.01828 ^A	0.04	0.01
Iron(mg/l)	1.37667±0.1250 ^A	1.7600±0.1386 ^A	1.7733±0.1617 ^A	1.6067±0.1935 ^A	1.5500±0.1323 ^A	0.61	0.3

Values bearing the same superscript letters are not significantly different (p<0.05).

Table 4.4: Abattoir Effluent on Biological Characteristics of Iyiokwu River

Parameters	WQ ₅₀	WQ ₀	WQ ₁₀₀	WQ ₁₅₀	WQ ₂₀₀	MEAN	WHO
THBC	1.5600±0.2163 ^C	7.8000±0.7632 ^A	2.9000±0.3606 ^B	1.8000±0.1732 ^C	1.6000±0.2000 ^C	3.13	0
T ECOLI	1.0000±0.7894 ^D	9.0000±0.4583 ^A	7.0000±0.4583 ^B	3.2000±0.2646 ^C	2.0000±0.4583 ^{CD}	4.44	0
T SSC	1.0000±0.4583 ^C	4.0000±0.4583 ^A	3.0000±0.4583 ^{AB}	3.0000±0.4583 ^{AB}	2.0000±0.4583 ^{BC}	2.60	0
TCC	1.100±0.346 ^C	5.000±3.579 ^A	2.400±0.458 ^B	2.000±0.458 ^B	1.450±0.118 ^C	2.39	0
THFC	1.0000±0.7894 ^D	9.0000±0.4583 ^A	3.2000±0.2646 ^B	3.0000±0.4583 ^{BC}	1.2000±1.0859 ^{CB}	3.48	0

Values bearing the same superscript letters are not significantly different (p<0.05).

- THBC: TOTAL HETEROTROPHIC BACTERIA COUNT
- T ECOLI: TOTAL E COLI COUNT
- TSSC: TOTAL SAMONELLE SHIGELLA COUNT
- TCC: TOTAL COLIFORM COUNT
- THFC: TOTAL HETEROTROPHIC FUNGAL COUNT

4.2 DISCUSSION

From the analysis above, **temperature** value of the sample showed a statistical significant difference ($p < 0.05$) among samples as seen in table 4.1. The highest temperature was recorded at the point of discharge which is WQ_0 (29.90°C). This observed temperature value was higher than WQ_{50} , WQ_{100} , WQ_{150} , and WQ_{200} by 14.28%, 8.02%, 11.37% and 12.04% respectively. The higher temperature observed at the point of discharge could be as a result of the decomposition of animal waste from the slaughtered house. The rise in temperature at WQ_0 may also be as a result of the turbulent movement of water at that point. However, the study corresponded with the findings in previous studies (Ubwa *et al*, 2013) and (Paul, 2011). The rate of chemical reaction can increase tremendously when the temperature increases and in turn reduce the available oxygen in water leading to the death of microorganism. The temperature recorded from WQ_0 , WQ_{100} , WQ_{150} , and WQ_{200} are higher than the required 25°C temperature of water quality recommended by (WHO, 2017).

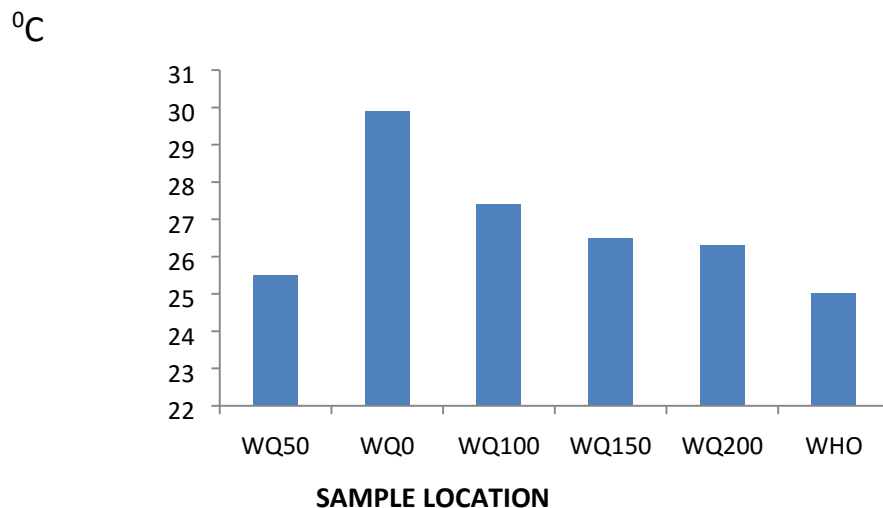


FIG 4: Effect of Abattoir Effluent on the Temperature of Iyiokwu River

The highest **colour** change was recorded in WQ_0 and the lowest at WQ_{50} . The value at WQ_0 is greater than WQ_{50} by 97% which is highly statistically significant as seen in table 4.1.

From WQ₀ downstream the colour change progressively decreased. The colour change in water could have been as a result of dissolved and suspended materials from animal waste such as blood mixed with urine and the skin of the animal deposited on the water. The values obtained in all the measurement locations were higher than the recommended 15pcu of WHO standard. However, this observed colour change was in line with an earlier study (Coker *et.al*, 2001). The colour change is presented in the fig.5 below

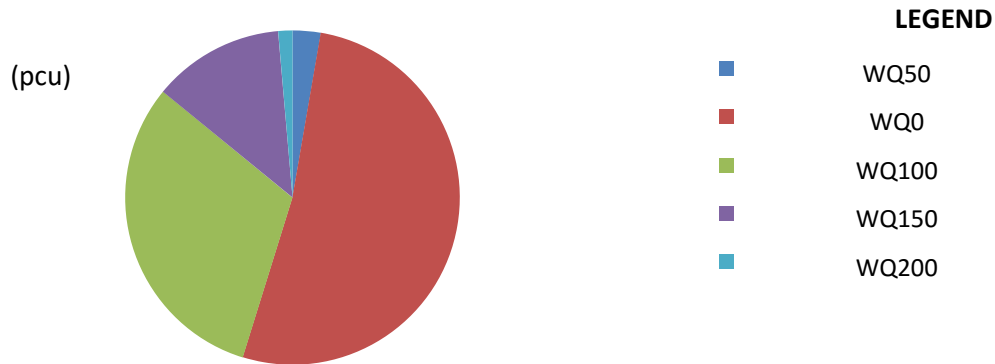


Fig5. Effect of Abattoir Effluent on the Colour of Iyokwu River

The **turbidity** value at the measurement position WQ₀ was higher than WQ₅₀, WQ₁₅₀, and WQ₁₀₀ by 57.50%, 43.46%, and 47.97% respectively; and this is statistically significant as seen in table 4.1. The high values of turbidity in the measurement location WQ₀ could be attributed to high suspended matter. Water quality in relation to turbidity can be classified as highly polluted when compared with recommended 5NTU standard of WHO. This result is similar to the study carried out in Minna (Abdulgafar, 2006).

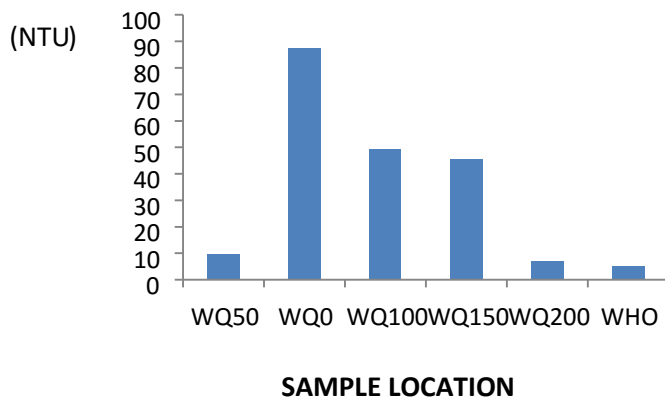


Fig 6. Effect of Abattoir Effluent on the Turbidity of Iyokwu River

The **Conductivity** of the sample ranged from 65.00 to 658.00 $\mu\text{s}/\text{cm}$ with the highest value recorded at the measurement location WQ_0 . The recorded conductivity value of WQ_0 was higher than WQ_{50} , WQ_{100} , WQ_{150} , and WQ_{200} by 30.39%, 2.43%, 5.47% and 15.19% respectively, and this is statistically significant. The highest conductivity was observed at the WQ_0 (discharge point) which indicate that Iyokwu River has a considerable loading of dissolved salts. The values at all the points are above the acceptable level that is 500 $\mu\text{s}/\text{cm}$ stipulated by WHO except the value at measurement location WQ_{50} which is the control point. This result corresponded with the study of (Rabah *et.al*, 2008) in Sokoto state and also with (Nwanta, 2010) research work at Nsukka in Enugu state.

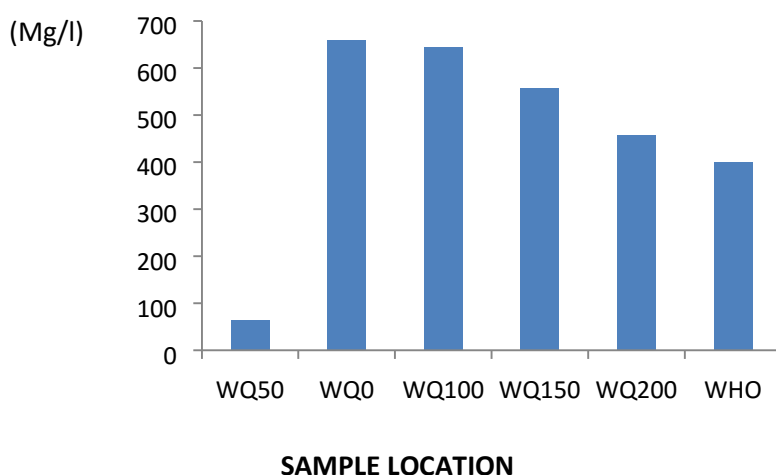


Fig 7. Effect of Abattoir Effluent on the Conductivity of Iyokwu River

The **Total Solids** result showed that there was a significant statistical difference ($P < 0.05$) among samples collected. The highest value of Total Solids (TS) was recorded at WQ_0 . The value at WQ_0 is greater than those at points WQ_{50} , WQ_{100} , WQ_{150} , and WQ_{200} by 23.95%, 3.61%, 4.75%, and 40.68% respectively. Sample locations WQ_{50} , WQ_0 , WQ_{100} , and WQ_{150} , had higher solids values than WHO standard of 150mg/l. At sample location WQ_{200} there was a notable decrease in TS levels. This could be as a result of dispersion mechanism within the river

downstream. The high value recorded in the measurement location WQ₀ might be as a result of higher quantity of waste deposited on the water body without separating the solid wastes from the liquid waste before discharging. A higher concentration of total solids will make drinking water unpalatable and might have an adverse effect on people who are not used to drinking such water. This is similar to an earlier study carried out by (Sumayya *et.al*, 2013).

The lowest value of **Total Dissolved Solids** (TDS) was recorded in WQ₅₀ and the highest value was recorded at point WQ₀. The value at WQ₅₀ was lower than WQ₀ by 36% which is statistically significant as demonstrated in table 4.1. From WQ₀ downstream, the values are noted to significantly decrease possibly due to dispersion along the river's flow path. A similar pattern was also noted in the measurement of **Total Suspended Solid** (TSS).

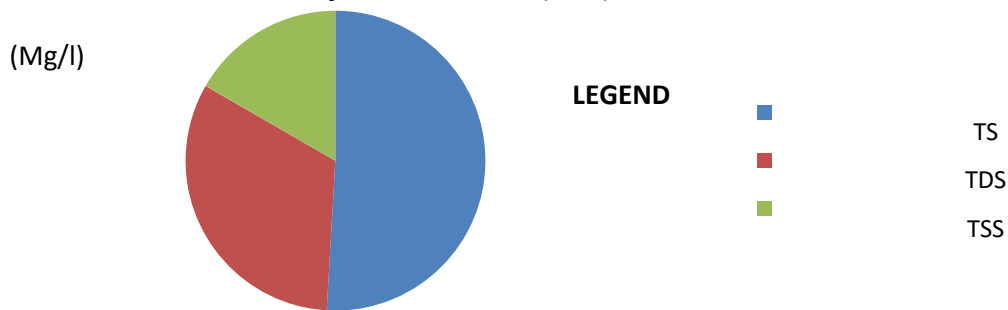


FIG 8. Total solid, Total dissolved solid and Total suspended solid

The **pH** of Iyokwu River is acidic. The pH at WQ₅₀ was 3.8mg/l but increased by 28% at point WQ₀. This was statistically significant as seen in table 4.2. This high value at the point of discharge could be attributed to the urine and the intestinal contents of the animals which would increase the pH of the river. From the discharge point downstream the pH gradually reduced but then suddenly increased to a near similar value with the discharge point at WQ₂₀₀. This could be as a result of the waste dump site that runs off into the river at point WQ₂₀₀. This corresponded with the research work carried out by (Saldu and Musa, 2012). Also the value obtained from the analysis is lower than the recommended 6.5-8.5 of WHO standard.

The measurement value of **chloride** at WQ_0 was greater than the value at WQ_{50} by 65% which is statistically significant as seen in table 4.2. The high value of chloride in WQ_0 could be due to the presence of soluble salts (NaCl and KCl) from blood discharged into the effluent and salt used in skin processing (Lawal and Mahielbwala, 1992). From WQ_0 downstream, the value of chloride gradually decreased possibly due to dispersion. The value obtained from this study was lower than the WHO standard.

Sulphate values ranged from 353.07 to 825.47mg/l. The value of sulphate was lowest at the discharge point (WQ_0). The value at WQ_0 was lower by 54%, 46%, 47% and 57% compared to WQ_{50} , WQ_{100} , WQ_{150} and WQ_{200} respectively. This is statistically significant as seen in table 4.2. WQ_0 has the lowest value which could be attributed to the presence of bacteria in the water sample which tends to deplete the sulphate. The highest value was recorded in measurement location WQ_{200} and this could be attributed to the waste dump site that is channelled from a particular point into the River at this location. This particular dump site might have less of bacteria that deplete sulphate. The values obtained from all the measurement locations are higher than the recommend WHO standard and did not correspond with the study carried out by (Coker *et.al*, 2001).

The value of **phosphate** from WQ_{50} to WQ_0 increased by 61% which is statistically significant as seen in table 4.2. Downstream from WQ_0 (the discharge point), the value of phosphate gradually decreased. There was a similar pattern of measurement in **phosphorus** values. Agarwal (1991) reported that the concentration of phosphate (PO_4^{3-}) above 0.5mg/l was an indication of pollution; and based on the recorded results of phosphate, there is an indication of pollution in all the samples analysed. This result corresponded with an earlier study by (Tritt, 1992).

Nitrate (NO_3^-) is the most available form in which nitrogen exists for plants. The result revealed that there was a 51% increase in the value of NO_3 between the WQ_{50} (the control) and the WQ_0 (the point of discharge). This could be attributed to high concentration of additional nutrient into the river at the discharge point. This change in the value of NO_3 was statistically significant as seen in table 4.2. The value

remained fairly constant until at point WQ₂₀₀ where the value of nitrate was 44% greater than WQ₀. This is possibly because of the dump site that runs off to this measurement point (WQ₂₀₀).

Nitrate nitrogen (NO₃N) is found in the cells of living things and is a major component of proteins. The value of nitrate nitrogen increased by 50% from WQ₅₀ to WQ₀, obviously, as a result of the discharge of abattoir effluent into the river. This is statistically significant as seen in table 4.2. Moving downstream from WQ₀ to WQ₁₀₀ and WQ₁₅₀, the measurement of nitrate nitrogen progressively decreased possibly because of dispersion. However, the measurement from WQ₀ to WQ₂₀₀ increased by 44%, possibly because of the aforementioned dump site that is channelled into the river at that point (WQ₂₀₀). Nitrate can quickly be converted into nitrite in the presence of bacteria that produce methemoglobin which destroys the ability of red cells to transport oxygen.

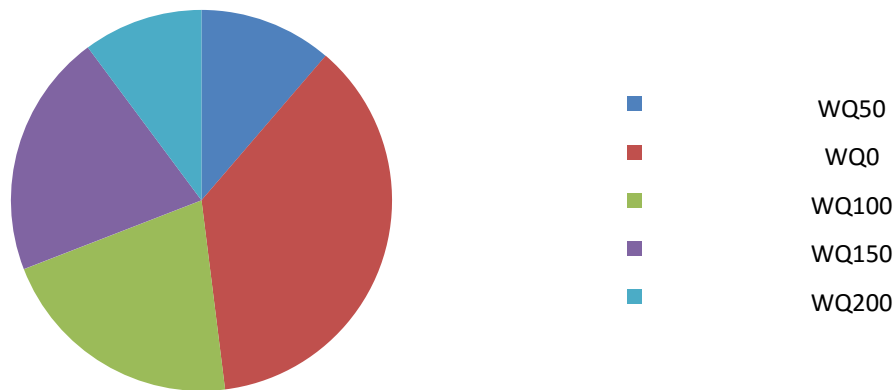


FIG9: Effect of Abattoir on the Concentration of Nitrate In Iyokwu River

Total Organic Carbon increased from WQ₅₀ to WQ₀ by 40% which is statistically significant as seen in table 4.2. From WQ₀ the change in value was not statistically significant until WQ₂₀₀ where the value of total organic carbon significantly reduced may be due to dispersion.

Ammonia is a colourless gas with a strong pungent odour. The value of ammonia was highest at the point of discharge (WQ₀) but the values across all the point were not statistically significant. This pattern of measurement was similarly replicated in

ammonia nitrate (NH_3NO_3). Although there is no stipulated value recommended by WHO.

Calcium value at WQ_{50} was 211mg/l and increased by 35% at the discharge point (WQ_0) to 324mg/l. This is statistically significant as seen in the table 4.2 above. From WQ_0 downstream the value of calcium gradually reduced. This may be due to the effect of dispersion. The value of calcium at the discharge point is well above 300mg/l which is the upper limit of WHO recommended standard. There was a similar trend in the measurements of **Calcium carbonate** (CaCO_3) and **Magnesium**. A similar result was also reported in an earlier study by (Nwanta *et.al*, 2010).

In the case of Lead (Pb), the highest value was recorded at WQ_0 , and was higher than WQ_{50} by 85% which is statistically significant as seen in table 4.3. From the WQ_0 downstream the values significantly decreased possibly due to dispersion. However, all the recorded values were above the WHO standard. This is in line with the work carried out by (Yusup and Oluwole, 2009).

There was no trace of **Nickel** from WQ_0 to WQ_{150} while there was a trace of Nickel at WQ_{50} and WQ_{200} . This means that other elements discharged into the river might have had a negative effect on Nickel measurement and that could explain why it was found at the control sample and the most downstream sample WQ_{200} .

The highest value of **Iron** was recorded at the discharge point and this might be because of the presence of bones, blood and other remains of the animals which were not separated before being dumped into the water. However, the values throughout the different points did not show any statistical significant difference as seen in table 4.3. This is similar to the measurement value of **Arsenic**, and similarly did not show any significant difference. Iron concentration was higher throughout the measurement locations when compared with WHO standard but corresponded with a previous study carried out by (Yusuf and Osibanjo, 2006).

There was a similar trend of change in the value of **Copper**, but even though the highest value was found at the discharge point, there was no statistical significant difference in the values in all the samples. This was similarly reported in an earlier

study by (Yusup and Oluwole, 2009). The copper values were however, within the WHO recommended Standard of 2mg/l.

Chemical oxygen demand (COD) indicates the amount of oxygen that can be consumed by reaction in a measured solution (Apha, 1992). The COD value at WQ_0 was highest at the discharge point (WQ_0) and it was higher than WQ_{50} by 32% which is statistically significant as seen on table 4.3. From WQ_0 downstream, the value of COD progressively decreased, possibly due to dispersion effect. The higher level of COD at WQ_0 might be because of effluent discharge. There might be the presence of chemical oxidants in the effluent and low COD indicates otherwise. Higher COD level means a greater amount of oxidizable organic materials in the sample; which will reduce dissolved oxygen levels and thereby threatening aquatic lives (Chukwu, 2005).

The lowest value of **Dissolved oxygen (DO)** was recorded in WQ_0 , while the highest value was recorded in WQ_{50} . The value at WQ_0 is lower than the value at WQ_{50} by 43% which is statistically significant as seen in table 4.3. From WQ_0 downstream, the value of DO gradually increased possibly as a result of dispersion. The recorded values of DO are all below the WHO standard of 30mg/l. A low DO level makes water taste flat. DO is a vital indicator of the health of aquatic ecosystem. Another important factor that could contribute to the reduction in DO of the water sample may be the temperature of the effluent. This is because cold temperature holds more oxygen in solution than warm water. Therefore, since the effluent is always warm at the point of discharge, the DO will be low and this can affect the life of aquatic organism; a moderately high DO content will be good (Chukwu *et. al*, 2007).

The highest **Biochemical oxygen demand (BOD)** was recorded at WQ_0 and lowest at WQ_{50} . The value at WQ_0 is greater than WQ_{50} by 81% which is highly statistically significant as seen in table 11. From WQ_0 downstream, the BOD progressively decreased. The greater the BOD, the more rapidly the oxygen is been depleted in the river. This means less oxygen is available for aquatic life. Thus, the consequences of high BOD may lead to aquatic organisms in Iyiokwu River becoming stressed, suffocating and dying. This result corresponded with the study carried out by (Lokhande *et. al*, 2011).

The **Total Heterotrophic Bacterial Count** (THBC) measurement value was highest at the discharge point and lowest at the point of control (WQ₅₀). The value of THBC at WQ₀ is higher than the value at WQ₅₀ by 80% (Rock and Rivera, 2014). This is highly statistically significant as seen in table 4.4. From WQ₀ downstream, the values are noted to significantly decrease. Similar results are replicated in **Total E.coli Count, Total Salmonella Shigella Count, Total Coliform Count** and **Total Heterotrophic Fungal Count**. This may be as a result of the deposition of these microorganisms from the animal remains into the river through the discharge point; and the values decrease downstream possibly due to dispersion. This is similar to the results reported in earlier studies by (Adesemoye *et .al*, 2006) and (Abiade paul *et al*. 2005)

CHAPTER FIVE

5.0 SUMMARY

This research work has revealed the pollution of Iyokwu River due to abattoir effluent. *Escherichia coli*, *Salmonella* and other coliforms are all a group of bacteria known as enterobacteriaceae and as such are found in the large intestines in varying amounts. An overgrowth of any of these pathogenic organisms in the large bowel will result in gastroenteritis.

If any of these organisms is abnormally found in any part of the gastrointestinal tract, as can be seen following the ingestion of water contaminated by abattoir effluent, gastroenteritis with its attendant sequelae will result. The physiochemical and microbiological analyses carried out showed that some tested parameters were higher than WHO permissible limit, and as such Iyokwu River should not be used for domestic or irrigation purposes. Parameters such as Conductivity, Turbidity, phosphate, Sulphate, *E coli*, and Coliform count had more than 50% contribution to the pollution load of the Iyokwu River. Parameter such as Nickel was noticed to be in trace amount at WQ₅₀ but became undetected following the discharge of the abattoir effluent (WQ₀, WQ₁₀₀ and WQ₁₅₀).

Usage of this river by the inhabitants will predispose them to typhoid, dysentery, cholera, diarrhea, as the *E coli* and fungi Count were observed in significant amount in all the measurement locations tested.

5.1 Conclusion

The study has shown that the discharge point revealed a significant rise in many of the parameters measured; which means that effluent from abattoir is highly loaded with contaminants that pose an environmental risk to the receiving Iyokwu River.

The dissolved oxygen (DO) value obtained from the discharge point WQ₅₀ to WQ₂₀₀ downstream is below WHO permissible limit this indicates that the lives of aquatic organisms are in danger. Also biochemical oxygen demand (BOD) and chemical

oxygen demand (COD) which are important parameters for testing water quality were higher at the discharge point; this implies that there is high depletion of available oxygen which could lead to reduction in available aquatic organisms and foul smell of Iyokwu River. Another point of concern is at the measurement location WQ_{200} where some parameters increased as a result of waste dump that was channel into the river from another source.

5.2 Recommendations

The discharge of untreated abattoir effluent increased the level of some parameters; thus the following recommendation:

- There should be a proper separation between the solid and liquid waste generated from the abattoir house. The liquid should be collected with a tank and undergo some pre - treatment before discharging it into Iyokwu River while the solid may be used as manure in farming activities.
- Liquid waste generated from the abattoir should be explored for biogas production.
- Inhabitant should be educated on the danger of using the water for domestic purposes and strongly advised to avoid the point of discharge.

5.3 Limitation

- Water sample were collected and analyzed only during rainy season.
- There was no comparison between the rainy season and dry season to know the significant difference.
- The samples were collected during a rainfall and this might affect the temperature, pH and other parameters of interest.
- There are some analytes and microorganisms that were not analyzed which might still have some negative impact on the water sample.

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Appendix 1:

PARAMETER	WQ ₅₀			WQ ₀			WQ ₁₀₀			WQ ₁₅₀			WQ ₂₀₀		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
TEMPERATURE	25.20	25.70	25.30	29.10	30.20	29.60	26.10	25.90	26.00	26.30	26.60	26.60	26.10	26.20	26.66
COLOUR	30.00	27.00	30.00	1093.00	1096.00	1096.00	657.00	655.00	650.00	264.00	269.00	268.00	54.00	59.00	58.00
TURBIDITY	7.00	6.90	7.70	80.00	85.00	97.65	45.00	47.00	56.50	40.00	44.00	52.65	9.60	9.50	9.82
CONDUCTIVITY	457.00	459.00	458.00	655.00	656.00	663.00	640.00	644.00	642.00	624.00	610.00	632.00	555.00	556.00	563.00
Ph	2.90	4.50	4.00	5.10	5.20	5.60	3.50	3.70	3.60	4.90	5.20	5.20	4.70	4.72	4.98
CALCIUM	210.00	214.00	209.00	322.00	300.00	351.00	260.00	270.00	277.42	228.00	300.00	158.28	204.00	209.00	207.00
MAGNESIUM	60.00	66.00	71.52	155.00	162.00	153.00	122.00	126.00	125.00	90.00	95.00	96.16	78.00	85.00	78.92
TOTAL DS	255.00	280.00	285.00	420.00	430.00	433.00	420.00	415.00	416.00	375.00	370.00	374.00	350.00	336.00	318.00

TOTAL SOLID	300.00	315.00	321.00	500.00	530.00	548.00	500.00	505.00	498.00	500.00	315.00	517.00	388.00	402.00	409.00
TOTAL SS	24.00	28.00	28.40	170.00	176.00	170.60	94.00	100.00	100.90	80.00	85.00	86.00	36.00	40.00	39.20
DISSOLVED OXYGEN	5.00	5.60	5.60	3.00	3.80	4.00	4.00	4.50	3.80	3.00	3.50	2.80	5.00	5.50	4.80
BOD	5.00	5.50	5.40	3.00	3.80	4.00	4.00	4.40	3.60	3.00	2.70	3.00	5.00	5.40	5.50
COD	5.00	5.50	6.78	8.00	9.00	8.44	7.00	8.40	8.60	6.00	6.60	6.60	4.00	4.80	5.12
TOTAL CHLORIDE	30.00	36.20	37.66	90.00	98.00	96.25	90.00	95.00	88.33	40.00	46.00	45.19	30.00	35.00	27.91

TOTAL HARDNESS	558. 00	606.0 0	636.0 0	900.0 0	946.0 0	978.3 5	700.0 0	785.0 0	856.4 4	600.0 0	616.0 0	620.5 7	600.0 0	666.0 0	724.2 3
NITRATE	10.0 0	10.40	12.00	38.00	39.50	40.10	21.80	22.50	21.70	21.80	22.60	22.80	21.80	22.50	21.70
NITRATE NITROGEN	2.00	2.80	2.76	8.00	8.50	10.20	4.80	5.50	4.70	4.00	4.80	6.14	2.00	2.90	3.26
PHOSPHATE	2.00	2.50	3.60	6.00	6.50	8.20	4.00	4.50	4.40	2.00	2.50	3.60	2.00	2.50	2.40
PHOSPHORU S	0.50	1.00	1.20	2.00	2.50	2.40	1.00	1.66	1.54	0.50	1.00	1.20	0.50	0.90	0.80
SULPHATE	300. 00	355.0 0	404.2 1	800.0 0	830.0 0	846.4 1	700.0 0	755.0 0	821.4 3	600.0 0	700.0 0	707.3 0	600.0 0	666.0 0	679.5 6
ORANIC CARBON	3.00	3.50	5.44	6.00	6.90	6.99	6.00	6.88	7.16	6.00	6.85	7.61	4.00	4.80	5.12
AMMONIA	0.30	0.51	0.87	0.80	0.86	0.86	0.80	0.86	0.95	0.80	0.89	0.95	0.40	0.52	0.64
AMMONIA NITRATE	0.40	0.44	0.45	0.50	0.93	0.76	0.50	0.93	0.76	0.50	0.90	0.70	0.40	0.49	0.52
LEAD	0.02	0.03	0.02	0.16	0.16	0.15	0.08	0.06	0.05	0.05	0.07	0.06	0.04	0.05	0.03
COPPER	0.07	0.08	0.05	0.19	0.12	0.07	0.18	0.16	0.11	0.16	0.12	0.15	0.07	0.02	0.20
NICKEL	0.08	0.10	0.04		ND			ND			ND		0.06	0.03	0.01
ARSENIC	0.02	0.04	0.01	0.06	0.08	0.02	0.06	0.03	0.01	0.05	0.09	0.08	0.04	0.09	0.05
IRON	1.32	1.50	1.29	1.60	1.84	1.84	1.60	1.80	1.92	1.50	1.83	1.49	1.40	1.60	1.65
TOTAL HET BAC COUNT	1.40	1.80	1.60	6.92	8.20	8.28	3.00	2.50	3.20	1.60	1.90	1.90	1.50	1.80	1.38
TOTAL ECOLI	0.09	1.50	1.41	8.90	9.50	8.60	6.90	7.50	6.60	3.00	3.50	3.10	1.90	2.50	1.60

TOTAL SAMONELLA	0.90	1.50	0.60	3.90	4.50	3.60	2.90	3.50	2.60	2.90	3.50	2.60	1.90	2.50	1.60
TOTAL COLIFORM	0.90	1.50	0.90	6.90	7.50	6.60	2.28	2.46	2.46	1.90	2.50	1.60	1.48	1.55	1.32
TOTAL HERT FUNGALCOU NT	0.09	1.50	1.41	8.90	9.50	8.60	3.00	3.50	3.10	2.90	3.50	2.60	0.09	1.25	2.26