HAZARDOUS EFFECT OF ABATTOIR WASTE EFFLUENT ON THE CHEMICAL PROPERTIES OF NTAK INYANG STREAM, ITU LOCAL GOVERNMENT AREA, AKWA IBOM STATE

By

Prof. Godliness Okokon Umoh
Ibom Metropolitan Polytechnic
Uyo, Akwa Ibom State
Nigeria,

Sunday Daniel Gregory Ph.D
Ibom Metropolitan Polytechnic
Uyo, Akwa Ibom State
Nigeria

And

Akintude, Oluwaseyi Olusina Ph.D
Icof Colleges and Universities,
Kentucky (Nigerian Campus)

ABSTRACT

The study examined hazardous effect of abattoir effluent on the chemical properties of Ntak Inyang Stream in Itu L.G.A., Akwa Ibom State, Nigeria. The objective investigated the chemical properties and hazardous effect of abattoir effluent on Ntak Inyang stream. Samples were taken from the abattoir and water samples from Ntak Inyang stream. Both samples were taken for analysis to determine pH, dissolved oxygen, BOD, acidity, COD, Chloride, Nitrate, Phosphate, Sulphate, Magnesium, Calcium. It was discovered that waste water effluent contains high amount of heavy metals which has degraded the quality of stream water in Ntak Inyang, this may cause health hazard in the community stream. It was recommended that spilling of abattoir into the stream be prohibited so as to safeguard the quality of water the health standard of the community and an appropriate disposal system be provided for abattoirs.

KEYWORDS: Hazardous Effect, Abattoir Waste Effluent, Chemical Properties, Ntak Inyang Stream, Itu Local Government Area and Akwa Ibom State

INTRODUCTION

Water generally is known as a universal solvent and it is one of the abundant available substances in nature. It is also an essential constituent of all animal, plants and vegetable matter and forms about 75% of the earth's crust. Water is also seen as an essential ingredient of animal and plant life, which is naturally distributed in many forms such as rain water, river water, spring water and mineral water.

Unfortunately, the global problem of water pollution involves the discharge of dissolved or suspended substances into ground water, streams, rivers and oceans (Alao *et al.*, 2014). In developing countries of the world such as Nigeria, water pollution occurs due to improper management of vast amount of wastes generated by various anthropogenic activities. Most challenging is the unsafe disposal of these wastes into fresh water reservoirs which are used primarily for drinking and other house hold activities (Alao *et al.*, 2014; Kanu and Achi, 2011; Ekhaise and Anyansi, 2015).

Pollution of freshwater bodies (rivers, lakes, pond and streams) by nutrients is mostly experienced as a result of industrial discharge, municipal domestic sewage disposals, surface runoff from agricultural kinds, underground water and salt-water intrusion and inundation (Xiao *et al.,* 2019). Dissolved nutrient in natural waters are usually low (Lin, *et al.,* 2022) and composition of surface waters is derived from the atmosphere, soil and rock sources. The relative contribution to surface waters from each of those sources is a function of the climate being modified increasingly by human activities.

Pollution of the aquatic environment has been defined by UNESCO/WHO/UNEP as the direct or indirect introduction of substances or energy into the marine environment by man which results in such deleterious effects as harm to the living resources, hazards to human health, hindrance of marine activities including fishing and impairment of quality for use of sea water. In other words, water is polluted when its acceptable quality has been altered by man's activities through anthropogenic imputes such that its intended usage for commercial or domestic purpose is hampered (Akaninwor *et al.*, 2007).

Though abattoir has played an important role in the economy of the country, effluent from slaughterhouses has also been known to contaminate both surface and groundwater because during abattoir processing, blood, fat, manure, urine and meat tissue are channeled to the wastewater streams (Chukwu *et al.*, 2011). Pollution arises from activities in meat production as a result of failure in adhering to Good Manufacturing Practices and Good Hygiene Practices (Akinro *et al.*, 2009). Consideration is hardly given to safety practices during animal transport to the abattoir, during slaughtering and dressing (Singh and Neelam, 2011).

In Nigeria, many abattoirs dispose their effluents directly into streams and rivers without any form of treatment and the slaughtered meat is washed by the same water. Leaching into groundwater is a major part of the concern, especially due to the recalcitrant nature of some contaminants (Muhirwa *et al.*, 2010).

STATEMENT OF THE PROBLEM

In Nigeria, surface water bodies have long been considered limitless dumping ground for wastes such as industrial effluents, raw sewage, garbage, and oil spills. For example abattoirs as recorded in 1989 are known to consume about 5.8 million cubic metres of water and approximately, 84 % of this water is discharged as wastewater containing high organic loads including suspended matter. This affects the properties of the water source, thus renders the water non-potable. Ntak Inyang abattoir is located near a surface water source. The water is used by the goat and cattle traders domiciled in shanties in the abattoir environment. Hence, this research is aimed at evaluating the effects of abattoir effluent discharged into Ntak Inyang stream, Itu Local Government Area, Akwa Ibom State, Nigeria on the chemical properties of the stream water.

OBJECTIVES OF THE STUDY

The objectives of the study are to:

- Examine the chemical properties of waste water effluent from Ntak Inyang Abattoir at Itu Local Government Area.
- Assess the chemical properties of Ntak Inyang stream water located near an abattoir at Itu Local Government Area.
- Determine the hazardous effect of the abattoir waste water effluent on the chemical quality of Ntak Inyang stream water.

SCOPE OF THE STUDY

This study which is aimed at investigating the effect of abattoir effluent discharge on the chemical properties of a stream water near the abattoir will limit the properties to pH, turbidity, total dissolved solids (TDS), biochemical oxygen demand (BOD) chemical oxygen demand (COD), acidity, chloride, sulphate, nitrate as well as the presence of metals such as magnesium, copper, nickel, cadmium, sodium, potassium, calcium, zinc and Iron. The World Health Organization (WHO) standard will be used for comparing the level of the stream water potability and suitability for domestic and other industrial usage.

LITERATURE REVIEW

- **Water and its Quality**

Water is a chemical compound of hydrogen and oxygen with the formula H_2O. It is also a common but unusual substance which has the ability to exist in all three states of matter within the range of temperature and pressure found on earth (Redmond, 2008). Water covering about 71% of the earth crust and being the life wire of every human can is expected to have good quality, depending on the presence or absence of material in solution or suspension (Udoessien, 2003). It is naturally supposed to be an odourless, tasteless liquid (Redmond, 2008). Contamination of streams, lakes, underground water, bays, or oceans by substances is harmful to living things since water is necessary to life on earth. All organisms contain water; some live in it while some drink it. Plants and animals require water that is moderately pure, and they cannot survive if their water is loaded with toxic chemicals or harmful microorganisms. If severe, water pollution can kill large numbers of fish, birds, and other animals, in some cases killing all members of a particular species in an affected area. Pollution makes streams, lakes, and coastal waters unpleasant to look at, smell, and to swim in. Fish and shellfish harvested from polluted waters may be unsafe to eat. People who ingest polluted water can become ill, and with prolonged exposure, may develop cancers or bear children with birth defects (Alexandrou, *et al.,* 2018). Water sources ranging from atmospheric to ground water and do have different pollution sources due to the differences in their mode of existence, exposure to environmental hazards/pollutants and consequent harvesting techniques. The existence of these pollutants which may be measured from the water quality analysis, such that if confirmed, forms an important baseline for control and preventive measures to be put in place. Thus, the first requirement when dealing with any given water is the quality. Lack of personal hygiene and contamination in water areas with inadequate supply of water have caused many people to suffer from water-borne disease such as typhoid fever, cholera, dysentery etc. These diseases are caused by the presence of pathogenic bacteria such as protozoans, worms, and viruses. Many other parasitic diseases of the tropics are related to the sources and storage of water. Water of bad quality promote the growth of intermediates hosts of parasites or encourage the breeding of vectors of diseases (Johnson *et al.,* 2021).

According to Diersing (2009), water quality is generally the physical, chemical and biological characteristics of water. It is the measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose (Johnson et al, 1997). Water quality is most frequently used by reference to set standards against which compliance can be assessed and the combined assessment of the physical and chemical properties of water is termed physiochemical analysis of water.

Water quality can be assessed using a number of lines of investigation, namely chemical, biological and bacteriological (Willkinson *et al.,* 2022). Each line has its own uses and yields information which are not otherwise obtainable. Chemical investigation of the water quality of some Nigerian rivers (Evans *et al.,* 2018) reveals that water that was once an abundant natural resource is rapidly becoming scarce in quantity (high demand) and the quality is deteriorating in many places, owing to population increase, rapid industrialization and rural/urban migration. Almost all water used by man is returned as wastewater and requires proper disposal to prevent it from reaching and contaminating water resources. In most cases, this is not in practice due to lack of technical know-how and treatment plant (Xiao *et al.,* 2019). Standards for water quality are obtainable from the World Health Organization (WHO), Nigerian Standard for Drinking Water Quality (NSDWQ), Standard Organization of Nigeria (SON) and Environmental Protection Agency (EPA), etc

- **Chemical Properties of Water**

Chemical properties of water constitute Dissolved Oxygen (DO), Electrical conductivity, Hydrogen ion concentration (pH), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD) Chemical Oxygen Demand (COD) Total Hardness, Acidity, Alkalinity, Chloride, Sulphate, Nitrate as well as the presence of metals such as Magnesium, Copper, Nickel, Cadmium, Sodium, Potassium, Calcium, Zinc and Iron. Biological Oxygen Demand (BOD) is widely used to determine the rate of pollution of domestic and industrial waste in terms of the oxygen that they require if discharged into natural waters in which aerobic conditions exists. The higher the BOD the more polluted the water sample is. Hydrogen ion concentration (pH) value of a stream is an essential index of acidity or alkalinity and is the resulting value of the acidic or basic interaction of a number of its mineral and organic components.

The alkalinity of a water body is a measure of its capability to neutralize acids. In natural streams it is generally due to the presence of carbonates, bicarbonates and hydroxide ions. The acidity of water is the capacity of some substance contained there to bind an equivalent amount of a strong base. Acidity in unpolluted water is usually from dissolved carbon dioxide which produces weak carbonic acids. Carbonate and bicarbonate of calcium and magnesium causes hardness of water. Hard water requires more soap to form lather than soft water. Hardness may cause scale formation pipes and filling (Lentch, 2014).

Chemical oxygen demand is fundamental for plant and animal life in a given water environment. The chemical oxygen test of any water body is dependent on the temperature of that water. High temperature results in low DO level. The total suspended solids (TSS) is the sediment regardless of origin that at any given time is maintained in the suspension in the water, the nature of the soil traverse is a factor that determines the quantity of suspended solids in water (WHO, 2011). Chloride is always responsible for brackish taste in water and is an indication of sewage pollution because of chloride content of urine. Compounds of chloride with other elements are present in nearly all natural water but most combinations are with sodium (Nacl, i.e common salt). Chlorides are derived from natural mineral deposits, sea water, agricultural discharges, sewage and industrial effluent. Water polluted by nitrate is generally hazardous to health (Evans *et al.,* 2018) but when in low concentration helps to stop algae growth. One of the principal uses of nitrates is as fertilizer which finds its way into river through agricultural run-off. According to (Hall, 1994) high nitrates indicates the presence of organic pollution.

Increase in sulphate concentrations in water may be related to pollution of the body of water by run-off water which contains relatively large quantities of organic and mineral compounds of Sulphur whereas low concentration has no significant effect on the growth of aquatic organisms (Evans *et al.,* 2018).

- **Related water quality studies in Akwa Ibom state**

Consequent upon the degradation in quality of most water sources especially from mobile streams, much research has been channeled towards the assessment of the portability of the water sources, to help in the administration of treatment measures to safeguard the health of Akwa Ibomites. World Health Organization (WHO), Federal Environmental Protection Agency (FEPA), and Nigerian Standard for Drinking Water Quality (NSDWQ) are the common guidelines to which the water qualities were assessed.

Eyo (2012) carried out a research on the Physiochemical study of surface water in Nsit Atai Local Government Area. the results revealed that the samples were good while the level of physical and chemical attributes were within the range of internationally acceptable standard for domestic use. The water from this stream were said to be good, safe and suitable for cooking, drinking and other domestic purposes with reference to the World Health Organization (WHO, 2017) water guidelines.

Alexandrou (2018) presented a baseline study on stream water quality Ikot Abasi local government area, Akwa Ibom State. Samples were taken from stream, well and marine waters, and analyzed for possible inorganic pollutant and characteristic water parameters such as metal content, bio-chemical oxygen demand (BOD), Dissolved Oxygen (DO), conductivity, temperature, alkalinity, chloride, nitrate, sulphate, free CO_2, phosphate, depth, calcium hardness, magnesium and suspended solid. The study was successful in obtaining, the water environmental data for Ikot Abasi and its environs. The figures obtained for the said parameters were within the WHO standard and they classified Ikot Abasi as water environmental pollution free area. The water in the area is suitable for domestic and industrial use. The author recommended that any incoming industry should try to preserve reputable water quality by adopting environmental conscious policies (Alexandrou, 2018).

Uko (2012), embarked upon a chemical analysis and characterization of water from three streams in Abak Local Government Area using standard analytical procedures. The analysis covered the determination of pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD); conductivity, hardness, Alkalinity, phosphate, nitrate, sulphate, total suspended solids (TSS), total dissolved solids (TDS). Based on the result in comparison with WHO and FEPA standards, on the average, the stream were acidic with a mean pH (6.70+0.2). Total solid level was high (375.8, 425.0 and 509.3) respectively, indicating high load of solid material in the stream. The oxygen content was also high (mean DO, +0.20). The Calcium hardness value was given as 15.4mgdm^{-3}. However, phosphate, Nitrate, and Sulphate values gotten were 0.025mgdm^{-3}, + 0.05mgdm^{-3}, 30.054mgdm^{-3}, + 0.006mgdm^{-3}, 4.5mgdm^{-3} and + 1.0mgdm^{-3} respectively. Generally the chemical analysis showed that the stream is of high quality.

- **The Abattoir Industry**

Abattoir otherwise known as a slaughterhouse is a facility where animals are killed for consumption as food products (Torres, 2007). However, some abattoirs facilities are used to process meat not intended for human consumption and are referred to as Knacker's yards or Knackeries (Torres, 2007). According to Torres (2007), the abattoir industry processes both red (beef, mutton and pork) and white meat (poultry). The annual water consumption of the red meat industry, as recorded in 1989, is approximately 5.8 million cubic metres and approximately 84 % of this water is discharged as wastewater containing high organic loads including suspended matter. The waste water quality from red meat abattoirs could be broadly summarized as follows: pH 5,7 to 8,4; COD 2380 to 8942 mg/L; suspended solids 189 to 3330 mg/L; TDS 595 to 2805; Total Nitrogen 0,71 to 24 mg/L (Torres, 2007).

Whereas abattoirs require high quality water due to the processing of a material destined for human consumption (especially abattoirs exporting), discharges from these facilities significantly contributes to the organic load of raw sewage. Sources of waste (solid waste and waste water) in red meat abattoirs could be categorized as: Lairagus and animal pens; Bleeding and stunning; Carcass processing and cleaning; Offal processing; and By-products processing. Types of solid waste resulting from pre-treatment could be summarized as: dewatered solids mainly hair, stomach fibres and residues; Fat and oil skimming's; Blood solids, normally converted into blood meal and Hides. Other waste includes animal trimmings, feeds, and animal head and condemned (Torres, 2007).

The Environment Conservation Act, 1989 (Act 73 of 1989) defines waste as any matter, whether gaseous, liquid or solid or any combination thereof, which is from time to time designated by the Minister by notice in the Gazette as any undesirable or superfluous by-product, emission, residue or remainder of any process or activity. Thus, Abattoir waste can be defined as waste or waste water from an abattoir which could consist of the pollutants such as animal faeces, blood, fat, animal trimmings, paunch content and urine.

Abattoir waste just like any other waste can be detrimental to humans and the environment if definite precautions are not taken. In the Nigerian livestock industry, slaughter houses are littered with non-meat products and wastes that need to be recycled into useful by-products for further agricultural and other industrial uses (Osibanjo and Adie, 2007). This constitutes public health risks and nuisance in most slaughter houses spread across Nigerian markets, producing air, soil, and water pollution as well as infestation of flies and other disease vectors. For hygienic reasons abattoirs use large amount of water in processing operations; this produces large amount of wastewater.

Chukwu, Adeoye and Chidiebere (2011) in an effort to evaluate the abattoir waste generation and management in Minna, North Central Nigeria collected samples from water sources in the abattoir for assessment of the physico-chemical composition. From the survey, it was observed that a total of 289 and

382 cows and goats respectively are slaughtered daily in Minna abattoirs. This generates 3.92ton of blood, 2.9ton of intestinal content, 4.2ton of bone and 2.2ton tissues as abattoir waste daily. All the abattoirs visited use nearby streams and ponds as means of discharging these wastes slurry thereby giving rise to offensive odour, contribute to the organic and nutrients loads of the streams leading to eutrophication. The action was found to be unhygienic, uneconomical and dangerous to human health (Chukwu *et al.*, 2011). There seems to be no sufficient measures or facilities to treat abattoir wastewater for environmental safety in Minna and high microbial load in the abattoir wastewater further confirmed the need to treat this wastewater rather than discharging it to the environment (Chukwu *et al.*, 2011).

- **Industrial Effluents and Surface Water Quality**

Several studies have been made to investigate the effects of the effluents from various industries on the quality of water sources. Most of these investigations had it that industrial effluents have significant effects on the quality of a nearby water source, where there are no appropriate systems to manage the waste water. According to Otukunefor and Obiukwu (2005), the presence of pollutants in natural waters alters the quality and often poses serious threats to aquatic life. Previous observations suggested a correlation between contaminants of water and sediments with aromatic hydrocarbons from refinery effluents and compromised fish health (Lin *et al.,* 2022). Some of the studies have been cited and discussed below.

Uzoekwe and Oghosanine (2011) investigated the effect of refinery and petrochemical effluent on water quality of Ubeji Creek, Warri. Water and sediment samples were collected from upstream and downstream sections of the creek. Physicochemical parameters and concentrations of heavy metals of the receiving water body (upstream and downstream) were compared with that of the treated effluent. Recorded mean pH values of the effluent, receiving water body and sediment were 6.26 ± 0.04, 6.90 ± 0.06 (upstream), 6.87 ± 0.01 (downstream) and 6.54 ± 0.44 respectively (Uzoekwe and Oghosanine, 2011). This study revealed that there have been an improvement in the treatment of Warri Refinery and Petrochemical effluent before it is been discharge compared to the studies conducted in the recent past (Achudume, 2009; Nduka and Orisakwe, 2009; Ogunlaja and Ogunlaja, 2009). Efforts made to collect untreated effluent sample from the plant were unsuccessful, though it was found that some of the physicochemical parameters of effluent discharged into this creek is within the limit set by Federal Ministry of Environment Nigeria (FMEnv) while some of the parameters determined for the receiving water body renders Ubeji Creek water unsuitable for domestic use. The study suggests other sources of pollution beside refinery effluents which may be responsible for elevated levels of some physicochemical parameters in the studied area. The study also indicates the need for continuous monitoring of surface water especially in rural community with high industrial activities.

Alao, Arojojoye, Ogunlaja & Famuyiwa (2010) studied the impact of brewery effluent on water quality in Majawe. Water quality assessment was carried out on samples collected at 4 different sampling points; effluent discharge point, 500 meters away and two other discharge points downstream. The physicochemical parameters analysed were pH, temperature, alkalinity, electrical conductivity, TSS (total soluble solids),TDS (total dissolved solids), BOD (biological oxygen demand), COD(chemical oxygen demand),DO (dissolved oxygen), and concentration of chloride, iron, magnesium, calcium, cadmium, lead, arsenic and mercury. The pH of samples ranged from 6.56 to 7.17, temperature ranged from 24.5^{o}C to 27^{o}C (Alao *et al.*, 2014). The physicochemical parameters studies shows that surface water and brewery effluent deviated from the WHO and FMENV standards but ground water sample was in line with the standards. Taken together these findings show that there is contamination of surface water by brewery effluent, however groundwater was non-toxic and therefore safe for drinking purposes.

Similar to Alao et al (2012), Ekhaise and Anyasi (2005) investigated the influence of breweries effluent discharge on the microbiological and physicochemical quality of Ikpoba River, Nigeria. The bacteriological parameters analyzed were total microbial population counts, which had values ranging from 1.0 x 103 to 4.8 x 103 cfu/ml and 1.3 x 107 to 5.7 x 107 cfu/ml for the fungal and bacterial isolates respectively. Total coliform counts ranged from 4.3 x 10 MPN/100 ml to 38.0 x 10 MPN/100 ml. Microorganisms isolated include *Sacchromyces cereviceae*, *Aspergillus niger*, *Penicillium sp.*, *Geotrichum sp. Candida sp.*, *Proteus* *sp*. *Staphylococcus sp*, *Escherichia coli*, *Streptococcus faecalis* and *Bacillus sp* (Ekhaise and Anyasi, 2005). Physicochemical parameter studies revealed that Ikpoba River though show some parameters whose values are higher than the WHO tolerant levels. Others fall within the WHO acceptable limits. The results of the study indicated that the contamination of the surface water due to the brewery effluent discharged, which could probably be hazardous to human health (Ekhaise and Anyasi, 2005).

Akaninwor, Anosike & Egwim (2007) studied the effect of Indomie industrial effluent discharge on microbial properties of new Calabar River. The study which sampled the upstream, effluent fall out points, 200, 400 and 600 m distances from the fallout point determined the pollution caused by the industrial effluent discharge using the control (upstream) as an index of comparison. The results of the analysis indicated a significant difference in the microbial parameters assessed between the control and fallout points, indicating that this sampling point was polluted as a result of the direct effluent discharge at the sampling at this sampling point. The microbial analysis indicated that the viable bacterial counts of the samples ranged from 5.4 x103 to 26 x 103 cfu (Akaninwor *et al.*, 2007). This shows that the water samples contain heavy microbial load. The biochemical identification of the isolate in the water samples showed that *Staphylococcus aureus*, *Shigella sp.*, *Proteus vulgaris*, *Escherichia coli* and *Citrobacter sp*. predominated the water samples while the fungal microscopy identified *Candida species*, *Fusarium*, *Circinotrichum* and *Cephaliophora* in the water samples. The elevated levels of microbial pollution indicators would invariably affect the taste, smell, appearance and aesthetic properties of the river water and thus pose a potential health hazard of varying degrees to various life forms that depend on the water for survival and recreational purposes.

Raheem and Morenikeji (2008) investigated the impact of abattoir effluents on surface waters of the Alamuyo stream in Ibadan. The physico-chemical analysis were carried out on samples collected from four sampling stations located along a stream that receives effluent discharge from an Abattoir in Ibadan, Nigeria using standard methods. The data revealed that the effluent discharge had high temperature (33.48±0.354oC) and a neutral pH H^+ (7.70±0.86). DO was not detected in the effluents. Comparison of the water physico-chemical status and the abattoir effluent load indicates that, there seem to be pollutional stress of the stream (Raheem and Morenikeji, 2008).

MATERIALS AND METHODS

- **Design of the Study**

The methodology adopted in this study was the investigative approach; this includes abattoir visitation, conversation with the management and workers of the abattoirs at Ntak Inyang. Moreover, experimental procedures were followed in the analysis of water properties.

- **Description of Sample Site**

The abattoir is located at Ntak Inyang community in Itu Local Government Area of Nigeria. Ntak Inyang River (See Figure 3.1) is a tributary to Cross River which empties into the Atlantic Ocean at Bight of Bonny. It is one of the major Rivers in Ikpa Basin. It contains some important and commercial fish species harvested from it and the natural resources like good quality white sand. At Ntak Inyang, diverse activities take place along the river course, on river banks and the neighbouring watershed environment include sand dredging, abattoir services, fishing, Sit-out and recreation and riparian cropping. Vegetables in dry season can be grown on drying swamps of Ikpa tributary wetlands and is in high demand with ready markets in both urban and rural areas where it serves as a staple diet. The natural vegetation riparian buffer with an area of 25000 m^2 (that is, 50 m width × 500 m length), is identified on a part of the River course.

Ntak Inyang is in the equatorial rain-forest belt and houses tropical vegetation of green foliage trees, shrubs, grasses and oil palm trees (Essien, 2012). Water sample was collected from Ntak Inyang stream. The stream is surrounded by a thick bush including oil palm trees and other economic trees. The stream is wide and is of more economic importance such that sharp sand is extracted. The water is also used for both agricultural and domestic purposes. The sample was collected at a midstream when there was no disturbance of the stream water body by any operation at 4am. Figure 3.1 shows the map of Itu locating the study area and the sampling site respectively. Ntak Inyang Abattoir is located beside the stream and along the stream bank. Ntak Inyang abattoir is used for the slaughtering of cows consumed in Itu, Uyo surburbs and other neighboring L.G.A. Prior investigations revealed that four to seven cows are slaughtered per day depending on the demand which is dependent of season and festivities. Cows are slaughtered daily from Mondays to Saturdays. Open concrete drains convey spilled blood and water from the slaughtering house and empties the content into an earthen trench at the river bank. Tiny rills are however created by natural flow from the slaughter house into the adjourning stream. This thus, conveys water, blood, tissues and organ mixture into the gently flowing stream.

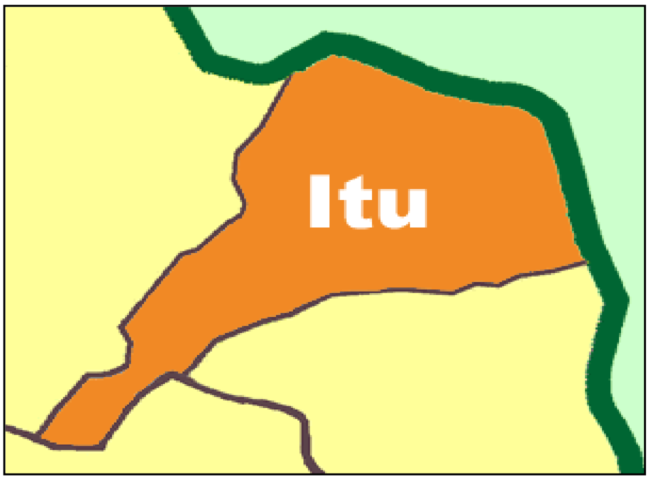

Figure 3.1: Itu Map Showing the Study Site

EXPERIMENTAL PROCEDURES

- **Waste and Stream Water Samples Collection**

Raw wastewater sample was taken from the abattoir for chemical property analysis and samples was also taken from the adjoining stream receiving these effluents. For water analysis, water samples were collected from these water sources in sterile 500mL container which were rinsed three times with the sample water prior collection. 30mL of the collected sample was filtered through a 0.45µm syringe filter and stored in a 20ml polypropylene container. It was stored under 4^oC and taken for laboratory analysis within 6 hours of collection (Chukwu *et al.*, 2011). Three stream water samples were collected (one sample from the upstream of the abattoir effluent pollution point and two samples from the downstream of the abattoir effluent pollution point at 5 and 10 metres respectively.

- **Water Samples Analysis**

The water samples were analyzed for chemical parameters using APHA (2005) methods. For chemical analysis, the water samples were divided into two and their temperature was maintained at 4^oC. The first portion which is acidified to pH less than 2 with concentrated HNO_3 was left for 4 days to equilibrate before taking it for ICP analysis. The second portion (untreated) was used for IC (Ion Chromatography) analysis. Milliq water was used to prepare the laboratory blanks and was treated in the same way with the samples. Cations of low concentrations (≤ 0.01µg/L will be analyzed with coupled plasma- mass spectrographic (ICP-MS-Japan 7500). Major cations (≥ 0.1mg/L) will be determined by coupled Plasma Optical Emission spectrography (ICP-OES-5300, DV, USA). Anions were analyzed using IC Diomex CA, USA. Total Solids were analyzed using gravimetric method.

CHEMICAL OF WATER SAMPLES

Chemical properties that were evaluated include pH, electrical conductivity, and phosphorus, Bio-chemical Oxygen Demand, Nitrogen, Calcium, Magnesium, Potassium, Sodium, Sulphate and Chlorides. These chemical parameters were selected based on their significance as macro and microelements in fertilizer.

- **Water pH:** This was determined using pH meter with glass electrode (Thomas, 1996).
- **Dissolved Oxygen (DO)**: This was measured in the leachate extract using a DO meter
- **Biochemical Oxygen Demand (BOD):** This was measured in the leachate extract using a DO meter
- **Determination of Acidity:** Phenolphthalein acidity (PA) 50ml of each water sample was measured into 250ml conical flasks. Three (3) drops of phenolphthalein indicator was added in each case and the solution titrated with CO_2 free NaOH solution (0.02) until the appearance of a faint pink colour (pH 8.3) is observed. This was indicated by the endpoint of the titration (A.O.A.C, 1984).
- **Determination of COD:** 100ml of each water sample was measured into different conical flasks. 5ml of dilute H_2SO_4 (1:3) was added and the solution quickly transferred to a steam bath for boiling. Then 15ml of $0.011MH_2C$ was added followed by dropwise addition of $KMnO_4$ (0.01m) from the burette until the solution turns pink (A.O.A.C, 2006).
- **Determination of Chloride:** 100ml of water sample was measured into beaker and three drops of $5\%K_2C_1O_4$ indicator will be added and titrated with as standard $0.02MGNO_3$ until the colour changes from yellow to brick red (Alexandrou *et al.,* 2018).
- **Determination of NItrate:** 10ml of each water sample was transferred into different 25ml standard flasks and 2ml of Burcine reagent was then added; then 10ml of cone. H_2SO_4 was also added rapidly. It was mixed for about 30 seconds and allowed to – for 5 minutes. The flasks were set in cold water for about 5minutes then made up to volume with deionized water. The absorbance was read at 470nm using visible spectrometer (Alexandrou *et al.,* 2018).
- **Determination of Phosphate:** 25ml of each water sample was measured into 50ml volumetric flasks. 10ml of varadatemelybdate reagent will be added and diluted to volume with deionized water. A reagent blank was prepared by making up 20ml of reagent to volume in a 50ml volumetric flask. The solutions

was mixed and allowed to stand for about 10minutes for colour development. The absorbance was read at 470 using visible spectrometer (Alexandrou *et al.,* 2018).

- **Determination of Sulphate:** 10ml of each water sample was measured into different 25ml volumetric flasks. 10ml of deionized water was added. 1m of gelatin-$Bacl_2$ reagent was also added in each case and mixed thoroughly, made up to volume with deionized water. It was allowed 'to stand for about 30minutes. The absorbance was read at 420nm with using visible spectrometer (Alexandrou *et al.,* 2018).
- **Determination of Ca and Mg: To determine the concentrations of Ca and Mg,** 50ml distilled water was placed into another 250ml Erlenmeyer flask, 25ml of 20% KOH was added and 10 drops of Ca and Mg solution. A few grains of calcein indictor will also be added and the mixture was shaken to obtain light standard EDTA to obtain fluorescent yellow end point (A.O.A.C, 1984). However, volume for Mg alone = A-B.

  Calculation: $$\text{Ca (mg/l)} = 40080 \frac{\text{x M x B}}{\text{ml. Sample}}$$

  $$\text{Mg (mg/l)} = 24320 \frac{\text{x M x (A-B)}}{\text{ml. Sample}}$$

Where A is the volume (ml) of EDTA for Ca and Mg titration; B is the volume (ml) of EDTA for Ca titration; and M and molarity of EDTA.

STATISTICAL ANALYSIS OF RESULTS

Descriptive and inferential statistics was used to analyse the results of the physical and chemical properties of the water and effluent samples using SPSS software 17.0.

RESULTS AND DISCUSSION

Summary of Results of Water Analysis

Water samples from Ntak Inyang Stream and the polluting abbatoir effluent collected were analysed for chemical properties at Akwa Ibom State Ministry of Science and Technology and the results are presented in Table 1.

Prof. Godliness Okokon Umoh,
Sunday Daniel Gregory Ph.D
&
Akintude, Oluwaseyi Olusina Ph.D

Table 1: Results of waste effluent and stream water samples showing chemical properties

S/N	Parameters	Unit	Waste Effluent	Stream water
1	pH		1.72	1.74
2	Iron (Fe^{3+})	mg/l	2.4	1.6
3	Salinity	%	453	343
4	Electrical Conductivity	us/cm	863	698
5	Total Dissolved Solid	mg/l	2802	1105
6	Nitrates (NO_3)	mg/l	0.9	0.5
7	Nitrites (NO_2)	mg/l	0.2	0.04
8	Phosphate (PO_4^{3+})	mg/l	2.26	0.48
9	Suspended solids	mg/l	890	592
10	Sulphate (SO_4^{2})	mg/l	80	63
11	Acidity	mg/l	1.72	1.74
12	Total Alkalinity	mg/l	1008	756
13	Chloride (Cl^-)	mg/l	8	4.1
14	Dissolved Oxygen (O_2)	mg/l	15	4.9

The result above show 14 chemical properties tested in both the waste effluent and Ntak Inyang stream including: pH, Iron (Fe^{3+}), Salinity, Electrical Conductivity, Total Dissolved Solid, Nitrates (NO_3), Nitrites (NO_2), Phosphate ($PO4^{3+}$), Suspended solids, Sulphate (SO_4^{2}), Acidity, Total Alkalinity, Chloride (Cl^-) and Dissolved Oxygen (O_2).

The results showed that all measured chemical parameters were higher in waste effluent than in stream water except nitrites and acidity. This shoes the tendency of the waste effluent to impart the chemical quality of the stream water,

Hazardous Effects of Abattoir Effluent on the Chemical Properties of Ntak Inyang stream Water

To measure the effects of abattoir effluent on the chemical properties of Ntak Inyang stream water, the measured chemical properties of the polluted water Ntak Inyang stream was compared with the Nigerian Standard for Drinking Water Quality (NSDWQ) as shown in Table 4.2 and the degree of compatibility of each parameter of the water sample with the NSDWQ was designated by remarks as "**suitable**" and "**Not suitable**"..

Generally, water quality is a term which indicates the degree of suitability of water sources depending on the context of consideration. Nigerian Standard for Drinking Water Quality (NSDWQ) (Appendix I) was used as standard in judging the quality of water source under investigation based on the parameters considered in this work.

Table 2: Comparison of result of physiochemical analysis of polluted stream water sample with NSDWQ

S/N	Parameters Compared	Unit	Stream water	NSDWQ max. permissible limits	Compatibility remarks
1	pH		1.74	6.5 - 8.5	Not Suitable
2	Iron (Fe^{3+})	mg/l	1.6	0.3	Not Suitable
3	Salinity	%	343	0.5	Not Suitable
4	Electrical Conductivity	us/cm	698	1000	Suitable
5	Total Dissolved Solid	mg/l	1105	500	Not Suitable
6	Nitrates (NO_3)	mg/l	0.5	50	Suitable
7	Nitrites (NO_2)	mg/l	0.04	0.2	Suitable
8	Phosphate (PO_4^{3+})	mg/l	0.48	3.5	Suitable
9	Suspended solids	mg/l	592	10	Not Suitable
10	Sulphate (SO_4^{2})	mg/l	63	1000	Suitable
11	Acidity	mg/l	1.74	4.5 – 8.2	Not Suitable
12	Total Alkalinity	mg/l	756	100 – 200	Not Suitable
13	Chloride (Cl^{-})	mg/l	4.1	250	Suitable
14	Dissolved Oxygen	mg/l	4.9	1.0 – 5.0	Suitable

From Table 4.2, the comparison shows that 7 out of 14 tested chemical parameters of the water sample was within the permissible limits of the NSDWQ. Thus, the average compatibility grade of the stream water recorded a value of 0.857. This shows that the stream water sample at upstream of the abattoir effluent pollution point is 85.7% compatible with the Nigerian Standard for Drinking water Quality.

Specifically, pH, Iron (Fe^{3+}), Salinity, Total Dissolved Solid, Suspended solids, Acidity, and Total Alkalinity were found to exceed the ranged allowed for drinking by NSDWQ. This shows that the water was hard coupled with high contents of iron which poses great risk to human health if consumed.

Prof. Godliness Okokon Umoh,
Sunday Daniel Gregory Ph.D
&
Akintude, Oluwaseyi Olusina Ph.D

CONCLUSION

This study analyzed the hazardous effect of abattoir effluent on the chemical properties of Ntak Inyang stream water in Itu Local Government Area of Akwa Ibom State. The quality of the water was compared to Nigerian Standard for Drinking Water Quality. Based on the study results, it is discovered that the waste water effluent contains high amount of heavy metals which has degraded the quality of the stream water. Results showed that pH, Iron (Fe^{3+}), Salinity, Total Dissolved Solid, Suspended solids, Acidity, and Total Alkalinity were found to exceed the ranged allowed for drinking by NSDWQ. This places a potential risk on human health if the water is consumed.

RECOMMENDATIONS

Based on the findings of the study, it is recommended that the abattoir management should look into the improvement of their sanitation modules and find an alternative waste management approach. Proper waste disposal systems backed up with strict legislation should be developed at the abattoir to minimize the stream water pollution.

Moreover, a riparian buffer should be created between the stream and the abattoir to help shade and partially protect the stream from the impact of non-point source pollution of the stream by the abattoir effluent. This will intercept surface runoff and substrate flow by controlling the sediments, removing nutrients, especially suspended solids, Nitrates, hardness and alkalinity and heavy metals.

REFERENCES

Achudume, A. C. (2015). The Effect of Petrochemical Effluent on the Water Quality of Ubeji Creek in Niger Delta Region. *Bull Environmental Toxicology* 83: 410 – 415.

Agbaire, P. O. and Obi, C.G. (2009). Seasonal Variations of Some Physico-Chemical Properties of River Ethiope Water in Abraka, Nigeria. *Journal of Applied Science and Environmental Management* 13(1) 55 - 57

Akaninwor, J. O. E. O. Anosike and O. Egwim (2007). Effect of Indomie industrial effluent discharge on microbial properties of new Calabar River. *Scientific Research and Essay* 2 (1): 1-5. Retrieved on 15/01/2013 from http://www.academicjournals.org/SRE

Akinro, A. O., I. B. Ologunagba and Y. Olotu (2009). Environmental implications of unhygienic operation of a city abattoir in Akure, Western Nigeria. *ARPN Journal of Engineering and Applied Sciences* 4: 311-315.

Alao, O., O. Arojojoye, O. Ogunlaja and A. Famuyiwa (2010). Impact assessment of brewery effluent on water quality in Majawe, Ibadan, Southwestern Nigeria. *Researcher* 2 (5): 21-28.

Alexandron, L., Meehan, B. J., Jones, O. A. (October 2018). "Regulated and emerging disinfection by-products in recycled waters". *The Science of the Total Environment.* 627 – 638 – 1607 – 1616. Bibcode: 2018ScTEn.637.1607A. doi10.1016/j.scitotenv.2018.04.391.

APHA (2005). Standard methods for the examination of water and wastewater. *American Public Health Association* 46.

Chukwu, O., P. A. Adeoye and I. Chidiebere (2011). Abattoir wastes generation, management and the environment: A case of Minna, North Central Nigeria. *International Journal of Biosciences* 1(6): 100-109.

Clapham, W.S. (2000): Natural Ecosystem. Macmillan Press., New York.

Diersing, N. (2009): Water Quality: Frequently Asked Questions. PDA. NOAA. http//floridakeys.noaa.gov/pdfs/wqfaq.pdf. Accessed 2009-08-24

Ekhaise, F. O and Anyasi, C. C. (2005). Influence of breweries effluent discharge on the microbiological and physicochemical quality of Ikpoba River, Nigeria. *African Journal of Biotechnology* 4 (10): 1062-1065.

Essien, O. E. (2010). Effect of anthropogenic pollution loads along Ikpa River tributary under urbanization expansion. *Journal of Applied science in Environmental Sanitation* 5(3): 273-282.

Essien, O. E. (2012). Effectiveness of hydrologically upgraded natural vegetation riparian buffer on stream water quality protection at Uyo municipality cattle market/slaughter, Nigeria. *African Journal of Agricultural Research* 7(45): 6087-6096.

Evans, M. D., Villamagna, A. M., Green, M. B. and Campbell, J. L. (August, 2018). *Origins of Stream Salinization in an upland New England Watershed.* 190(9): 523 Bibcode: 2018MnAs.190.523E doi 10.1007/s10661-081-6802-3

Eyo, R. J (2012): *Physiochemical Study of Surface Water in Nsit Atai Local Government Area, Akwa Ibom State*. B. Sc. Project, Faculty of Sciences, University of Uyo, Nigeria.

Imoobe, T. O. T. and koye P. I. O. (2011). Assessment of the impact of effluent from a soft drink processing factory on the physico-chemical parameters of Eruvbi stream Benin City, Nigeria. *Bayero Journal of Pure and Applied Sciences* 4(1): 126-134.

International Organization for Standardization, (2014). Water Quality – Evaluation of the "Ready", "Ultimate" Aerobic Biodegradability of Organic Compounds in an Aqueous Medium – Method of analysis of Dissolved Organic Carbon (Doc); *International Organization for Standardization:* Geneva, Switzerland.

Kanu, I. and Achi, O. K. (2011). Industrial effluent and their impact on water quality of receiving rivers in Nigeria. *Journal of Applied* Technology in *Environmental Sanitation*. 1 (1): 75-86.

Lentech (2014). Metals and water. Available at http://www.lenntech.com/periodic/water/sodium /metals-and-water.htm. Accessed 23/03/2015

Lin, L., Yang, H. and Xu, X. (2022). Effects of Water Pollution on Human Health and Disease Heterogeneity: A Review. *Front Environmental Science. 10.880246. doi 10.3389/fenus. 2022.880246*

Moses, A. N., N. N. Destaings, N. E. Masinde and J. B. Miima (2011). Effluent Discharge by Mumias Sugar Company in Kenya: An Empirical Investigation of the Pollution of River Nzoia. *Sacha Journal of Environmental Studies* 1(1): 1-30.

Muhirwa D., I. Nhapi, U. Wali, N. Banadda, J. Kashaigili and R. Kimwaga (2010). Characterization of wastewater from an abattoir in Rwanda and the impact on downstream water quality. *International Journal of Ecology & Development* 16: 30-46.

Ogunlaja,A. and Ogunlaja, O. O.(2007). Physicochemical analysis of water sources in Ubeji Communities and their Histological impact on organs of albino mice. *Journal of Applied Science and Environmental Management* 11(4):91-94.

Osibanjo O. and Adie, G. U. (2007). Impact of effluent from Bodija abattoir on the physico-chemical parameters of Oshunkaye stream in Ibadan city, Nigeria. *African Journal of Biotechnology* 6: 1806-1811.

Otokunefor, T. V. and Obiukwu, C. (2005). Impact of Refinery effluent on physicochemical Properties of a water body in Niger Delta. *Applied Ecology& Environmental Research*, 3(1):61-72.

Raheem, N. K. and Morenikeji, O. A. (2008). Impact of abattoir effluents on surface waters of the Alamuyo stream in Ibadan. *Journal of Applied Science and Environmental Management* 12(1) 73 – 77.

Singh, V. P. and Neelam, S. (2011). A survey report on Impact of Abattoir Activities Management on environments. *Indian Journal of Veterinarians* 6: 973-978.

Torres, B. (2007). *Making a Killing*. AK Press: p. 45.

Uzoekwe, S. A. and Oghosanine, F. A. (2011). The effect of refinery and petrochemical effluent on water quality of Ubeji Creek Warri, southern Nigeria. *Ethiopian Journal of Environmental Studies and Management* 4(2): 107-116.

WHO and UNICEF (2017). *Progress on Drinking Water; Sanitation and Hygiene:* 2017. Update and SDG Baselines Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).

Willkinson, John L., Boxall, Alistain B. A., *et al.* (February 14, 2022). *Pharmaceutical Pollution of the World's River.* 119(8) Bibcode: 2022PNAS. 11913947w doi 10.1073/Pnas 2113947119 ISSN 0027 -8424

World Health Organization (2006). Guidelines for drinking water quality: First addendum to third edition. World Health Organization, Geneva, 515.

World Health Organization (2011). *Hardness in Drinking-water*. Background document for development of WHO Guidelines for Drinking-water Quality

Xiao, J., Wang, L., Deng, L. and Jin, Z. (2019). Charis tics sources, water quality and health risk assessment of trace elements in river water and well water in the Chinese loess Plateau. *Sci Total Environ.* 620 (pt. 2).