COMPARATIVE ASSESSMENT OF EFFECT OF ABATTOIRS ON GROUNDWATER QUALITY: CASE STUDIES OF MOKWA AND JEBBA.

BY

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FEBRUARY, 2010.

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

FEBRUARY, 2010.

DECLARATION

I hereby declare that the project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or institution information derived from personal communications published and unpublished work were duly referenced in the text.

Abdullahi, Lukman

18 – 02 – 2010

Date:

CERTIFICATION

This project entitled "Comparative Assessment of Effect of Abattoirs on Underground Water Quality: Case Studies of Mokwa and Jebba" by Abdullahi, Lukman, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to Almighty Allah for keeping me throughout my period in the university and also my father, Alhaji Aliyu, Abdullahi who has helped me to fulfil my life ambition and represent the measure of my happiness.

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I am most grateful to Almighty Allah for giving me the grace and seeing me through the completion of this project and the B.Eng. programmed. I also want to thank my supervisor, Mr. John .J. Musa for his guidance, directive and good supervision during this project work and I also appreciate all the lecturers of Agricultural and Bioresources Engineering Department and other lecturers in School of Engineering who might have impacted knowledge to me in one way or the other, May Allah blesses you. I also thank my father, Alh. Aliyu, Abdullahi for his guidance and financial support to see me through the Programmed. I appreciate to my brothers, Br. Bashiru Abdullahi and Br. Abdulhamid Abdullahi that made higher education a challenge to me. And I also want to use this avenue to appreciate to my course mates and my friends in F.U.T Minna. May Allah bless you all.

ABSTRACT

The problem of getting quality drinking water is increasing as untreated effluents are discharged into surface and percolate into underground water. The comparative assessments of Effect of Abattoirs on groundwater quality were investigated. the well assessment of ground water parameters analyses for present and abandoned abattoirs are, Electrical Conductivity (us/cm) 1350,1200,120, 450 and 450 (us/cm) Total Dissolved Solids (mg/l), 7560,8200,110, 225, and 225, Temperature (^{o}c), 27,26.5,27.2, 29.4 and 29.5, suspended solids (mg/l), 5500,6150,0, 3.0 and 0, turbidity (FUT), 2.5,3.0,0, 1.0 and 0, Colour (pt.co), 6,5.2,0, 0 and 0, p^H, 8.8,8.6,7.2, 6.9, and 7.1, Iron Content (mg/l) 3.5,2.6,0.3,0.15,0.23 and 0.3, sulphate (mg/l), 115,128,9.0,20 and 20, Nitrate as nitrogen (mg/l) 12.5,10.5,7.6,6.9 and 7.1, Nitrate (mg/l), 79,86.33.44, 29.48 and 33.0, Total Hardness (mg/l),102,100, 62, 40 and 48, Hardness as $caco_3$,55,56, 24.8, 16 and 19.2, Hardness as $mgco_3$,47,48, 37.2, 24 and 28.8, Total Alkalinity (mg/l),55,48, 12.4, 8.0 and 6.4 and Phosphate as Phosphorus,25,30, 0.06, 0.01 and 0.025 were analyzed and world Health Organization Standard were used as standard for comparison of these studies.

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CHAPTER ONE

1.0 INTRODUCTION

1.2 Background of the Study

Environmental problem have increased in geometric proportion over the last decades with improper management practices being largely responsible for the gross pollution of the aquatic environment with concomitants increase in water borne diseases especially typhoid, diarrhea and Dysentery. Abattoirs are general knew all over the world to pollute the environment either directly or indirectly from their various process (Adelegan, 2002). In Nigeria, many abattoirs disposed their effluent directly into surrounding streams and rivers without any form of treatment and slaughtered meat is washed by the same water (Adelegan, 2002) such in the situation is several private and government abattoir in developing countries. Recent studies on abattoir are reported by Kultumen. 2003 and Amisu *et al*, 2003, that some of the consequence of man made pollution is transmission of disease by water born pathogens, entrophication of natural water bodies' accumulation of toxic or recalcitrant chemicals in the soil, destabilization of ecological balance and negative effects on human health.

The continuous drive to increase meal production for the protein needs of the ever increasing world population has some pollution problems attached. In many countries pollution arise from activities in meat production as a result of failure in adhering to good management practice and good hygiene practice. Consideration is hardly good to safety practices during animal transport to the abattoirs, during dressing of hooves and content of alimentary tract during evisceration. The negative impact on the environment includes microbes in the soil surface and ground water (Laukava *et al*, 2002, Amisu *et al*, 2003).

Abattoir waste products get washed directly to the ground within the neighborhood land nd many affect the whole biological community which includes various animal and contaminant ccumulation in the food chain. Previously some authors have reported different contaminates in oil and aquatic environment in different parts of Nigeria (Adelegan, 2003, Akpan, 2004, Lateef, 2004).

1.3 Location of Project Areas

Jebba abattoir located in jebba south along Ilorin road while Mokwa abattoir is located 1km along Mokwa-Kainji road away from Mokwa town of Niger state. The abattoirs consist of cleaning up room, goat skin banning areas, heaps of animals born burning area. The fiscal dump site cover an area extending to the animals skin and burning areas, within that area they also processes, blood and cow horn for the production of chicken feeds.

1.4 Scope of the Project

The scope of this project work is limited to the physiochemical analysis of Jebba and Mokwa abattoirs effluent on ground water in Jebba kwara state and in Mokwa Niger state Abattoirs. The physiochemical analyzed are; Electrical conductivity, total dissolved solid, temperature, suspended solids, colour, P^H, Iron contents, Sulphate, Nitrates as Nitrogen, Nitrate, total hardness, hardness as $MgCO_3$, hardness as $CaCO_3$, total alkalinity , sulphate and phosphate as phosphorus of water that sank into the ground water.

1.5 Objectives of the Project

1. To compare the effect of effluent from Jebba and Mokwa abattoirs on the ground water.

2. To suggest ways of controlling these abattoirs effluent effect on the ground water.

1.6 Statement of the Problem

In Nigeria, there is an increasing awareness that pollution and contamination of the environment is most undesirable in itself and therefore measure to abattoir pollution, should in judged from ecological stand point rather than merely by the improvement make to the human condition.

1.7 Justification of the Study

In all countries, some form of pollution of the ground water is coursed by sport slaughterhouses which are inevitable. While the killing of animals' results in significant meat supplies, a good source of protein and useful -by-products such as leather, skin and bones, meat processing activities sometimes result in environmental pollution. Areas of interest in this regard include the possibility of wastes from abattoirs interacting with underground water supplies.

The concern for increase in the level of pollutants in ground water is justified since a large proportion of rural and recently urban dwellers in Nigeria obtain domestic water, and some drinking water from shallow wells (Adegan, 2002).

CHAPTER TWO

.0.0 LITERATURE REVIEW

The major known sources of water pollution are municipal, industrial and agricultural vastes. The most polluting of them are sewage and industrial effluents mostly contain heavy metals, acids, hydrocarbons and atmospheric deposition (Adedire, 2008).

Agricultural run-off is another major water pollutant as it contains nitrogen compounds and phosphorous from fertilizers, pesticides, salts poultry wastes and wash down from abattoirs species and other surrounding environment. Contaminants are usually of varied composition ranging from simple organic substances to complex inorganic compounds with varying degrees of toxicity. Pollution of surface water, the natural habitat for aquatic animals could have consequential impact on men either directly or indirectly since less than 1% of the worlds freshwater, about 0.007% of all water on earth is readily accessible for direct human use (Liv et al., 2002). Pollution of surface water body in any form is a critical issue in water resource management. However, water quality situation therefore becomes very critical in these countries and of great environmental problem.

2.1 Quality of the Abattoirs Effluent

Commercial and industrial effluent will generally differ from domestic effluent in the proportion of organic materials and inorganic salts present in the influent. This may take form of a high organic content or a high proportion of salts. The high organic content may be easily biodegradable (such as textile industry influent).

The organic and inorganic strength of abattoirs waste will depends on the water usage. ;ince a low water consumption will result in a strong waste. It also depends on the degree of ground water infiltration into the effluent network.

2.2 Blood

Blood constitutes are of the major source of biochemical oxygen demand (BOD) in the slaughter house and met a mean generated beef was shown below with a mean BOD of 156,000mg/h (Fong, 2005).

2.3 Paunch

Discharge of paunch counters into water stream also results in a substantial increase in solids and organic loadings.

The inch content for cattle is estimated at 18.1 to 27.2kg with an average of 24kg/animal and consists of partial digested hay grass and corn. The weight of a matured cow varies with size, ranging from 400kg for thin, 550kg for moderate to 750kg for the extremely fat (Wilham, 2005) gave more detailed statistics on both life and dead weight of a cow in his study. A cow weighing 400kg would have its carcass weight reduced to about 200kg after slaughter.

Furthermore, it's losses about one third in fat and bone after passing through the butcher. Hence a 400kg live weight animal will give about 140kg of edible meat which represents only 35% of its live weight. The remaining 65% are either solid or liquid wastes corroborating the above findings, Lateef (2004) showed in their study that a slaughtered cow produced 13.6kg of blood with the bovine blood density ranging between 0.01 and $0.15gcc^{-1}$. Moreover, the volume of ater required for meat rendering or processing ranged between 1.5 and 10.0m^3t^{-1} of product for ogs, 2.5 and 40m^3t^{-1} of product for cattle and 6 to 30m^3t^{-1} of product for poultry.

:.4 Proteins

Protein is principal constituents of the animal organism. Though, they occur to a contain extent in plants. All raw materials present vary from small percentage in watering fruit such as tomatoes and in fatty tissues of meat. Proteins are unstable being subjected to many forms of decompositions some are soluble. They have high molecular weight of proteins compounds are very high varying from 20,000 to 20 million grains. The major constituent of proteins includes carbon which is common to all organic substances as well as hydrogen and oxygen. In addition, they also contain fairly high and constant proportion of nitrogen, 16% in many cases sulphur, phosphorus and iron are also constituent's. Urea and proteins are the cheap nitrogen sources in wastes, when proteins are present in large quantities extremely by either decomposition (WHO/UNICEF, 2005,).

2.5 Fats, Oils and Grease

Fats and oils are the third major components of food stuff. The term "grease" as commonly used includes the fats, oil waves and other related constituents found in waste water, grease contents is determine by extraction of the waste sample with hexane/grease. Fats and oils are compounds of esters, alcohol or glycerol (glycerin) with fatty acids. The glycenidess of fatty acid quite similar, chemically, being composed of carbon, hydrogen, oxygen in varying proportion. The grease contents of the waste water can cause many problems in the waste. Wastes from slaughter houses typically contain fat, grease, hair, feathers, blood and process water which is characterized with gh organic level. (Coker *et al*, 2001,). It can interfere with biological life in the surface water and ꞌeate unsightly floating matter and film.

.6 Characteristic of Effluent

Effluent characteristics studies are considered to determine the physical, biological and :hemical characteristics and the concentration of constituents. The effluents are the best means of reducing the pollution concentrations.

2.7 Pathogenic Organisms

Micro organisms found in waste water include bacterial, viruses and protozoa which have been excreted by animals when discharge into surface water. They make the water unfit for drinking (i.e. non-potable) if the concentration of pathogens is sufficiently high the water may also be unsafe for swimming and fishing (Amisu *et al*, 2003).

2.8 Physical Characteristics of Total Solids

The most important physical characteristic of waste water is its total solid content which is composed of floating matter; settle able matter, colloidal matter and matter in solution. Other important physical characteristics includes particle size distribution, turbidity colour, transmittance, temperature, conductivity and density specific gravity and spew weight, odor sometimes considered.

2.8.1 Colour and Appearance

Historically, the term "condition" was used along with composition and concentration to describe waste water condition which refers to the age of the water with a light brownish gray olour. However, as the travel time in the collection system increases, and more anaerobic onditions develops the colour of the wastewater changes sequentially from gray to dark gray, and ltimately to black. When the color of the wastewater is black, it is described as septic. Some ndustrial wastewater may also add a colour to the domestic waste. In most cases, the grey, dark dray and black colour of the wastewater is due to the formation of metallic sulphides, which is produced under anaerobic conditions and reacts with the metals in the wastewater.

2.8.2 Temperature

The temperature of wastewater "effluent" is commonly higher than that of the local water supply because of the addition of warm water from households and industrial activities. As the specific heat of water is much greater than that of air, the observed effluent temperatures are higher than the local air temperatures during most of the year and are lower only during the hottest summer months, depending on the geographical location.

Temperature of water is a very important parameter because of its effect on chemical reactions and rates, aquatic life, and the suitability of the water for beneficial uses. Increase in temperature; for example, can causes a changes tin the species of fish that can exist in the receiving water body. Industrial establishments that use surface water for cooling purposes are particularly concerned with the temperature of the intake water.

In addition oxygen is less soluble in warm water than in cold water. The increases in the rate of biochemical reactions that accompanies an increase in temperature, combined with the decrease in the quality of the oxygen present in surface waters, can often cause serious depletions in dissolved oxygen concentrations in the summer months.

.8.3 Conductivity

The electrical conductivity (EC) of water is a measure of the ability of a solution to conduct ın electrical current. Since the electrical current is transported by the solution, the conductivity .ncreases at the concentration of ions increases. In effect, the measured of electrical conductivity (EC) value is used as a surrogate measure of total dissolved solid (TDS) concentration. At present, electrical conductivity of the water is one of the important parameters used to determine the suitability of the water for irrigation. The salinity of treated effluent water to be used for irrigation is estimated by measuring its electrical conductivity (waste water engineering, standard method 1998).

2.8.4 pH Value

The hydrogen –ion concentration is an important quality parameter of both natural waters and effluents waters. The usually means of expressing the hydrogen-ion concentration is as pH which is defined as the negative logarithm of the hydrogen-ion concentration.

$$P^{H} = -\log_{10} [H^{+}]$$

The concentration of range suitable for the existence of most animals is quite narrow and critical. The P^H of aqueous systems typically is measured with a P^H meter.

2.8.5 Odours

Odors in domestic wastewater usually are caused by gasses produced by the decomposition of organic matter or by substances added to the wastewater. Fresh wastewater has a distinctive, some what disagreeable odor, which is less objectionable than the odors of the wastewater which is undergone anaerobic (devoid of oxygen) decomposition. The most characteristic odor of stale : septic wastewater is that of hydrogen sulphides, (H_2S) which is produced by anaerobic micro-rganisms that reduce sulphides. Industrial wastewater may contain either odorous compounds or ompounds.

2.9.0 Chemical Characteristics

2.9.1 Oil and grease

These produces a slightly oily condition and when discharges into a body of receiving water which interfere with the biological life present within the surface water, grease if untreated can also cause problems to sewer and treatment plants (Boland *et al*, 2002).

2.10 Nutrients

Nitrogen and phosphorus two nutrients of primary concern are considered to pollutant because they are too much of a good thing problems arise when nutrients levels become excessive and the food webs is glossary distributed, which causes some organisms to proliferate at the large growth of algae, which in turn becomes oxygen demanding material when they die and settle to the bottom. (Akpan, 2004). Some of the major sources of nutrients are phosphorus based detergents, fertilizers and food processing waste.

2.11 Ground Water Pollution

Groundwater pollution is a major problem in most developing nations. The source and nature of contamination however vary from one nation to another. Aside very few percentage of the population in these nations has access to good and safe water for the domestic purposes.

The groundwater pollution can either be of point source or non-point source. Point sources f pollution occur when pollutants are emitted directly to the water body from the industrial ewage or municipal waste water pipes. Non-points pollution delivers such pollution from urban un-off. (Ogunseitan, 2002).

2.12 Domestics Waste Sources

A serious source of contamination can be sub surface disposal of domestic waste water through septic tanks. If the soil is permeable, shallow water wells are potential sources of mobile pollutants like detergents, chloride and nitrate irons.

Burial of solid wastes can results in degradation of subsurface water through the generation of leachate caused by water percolating through. Refuse fill leachate is highly mineralized water containing such constituents as sodium chloride, nitrate, trace metals and a variety or organic compounds.

2.13 Industrial and Commercial Sources

The major of all hazardous wastes from manufacturing are disposed off on the land mainly this method is usually the cheapest waste management option. Amisu et al, (2003), viewed that those in aptitudes often lead to contaminations from hides, hooves and content of alimentary tract during evisceration and negatively impact on the environment including microbes in the soil and surface and ground water.

.14 Agricultural Sources

Dissolved salts are transported to ground water by the portion of rainfall or irrigation water hat filters through the surface soils of agricultural land.

Fertilizers and pesticides can also migrate into the ground water under cultivated land, except in the case of clayey soils that exhibit infiltrations while some pesticides are persistent many are readily degraded in the soil environment and did not pose a threat.

Furthermore these chemicals are applied only in limited quantities, reducing the probability of serious ground water contamination. The most troublesome health-related contaminant from agriculture is the nitrate iron, which is readily carried by water percolating down through unsaturated soil to the saturated zone.

2.15.0 Parameters in the Effluent

2.15.1 Alkalinity

Alkalinity is wastewater results from the presence of the hydroxides (OH), carbonates (CO^{-}) and bicarbonates (HCO^{3-}) of elements such as calcium, magnesium, sodium, potassium and ammonia of these, calcium and magnesium bicarbonate are most common. Borates, Silicates, Phosphates, and similar compounds can also contribute to the alkalinity. The alkalinity in wastewater helps to resist changes in pH caused by the addition of acids. Wastewater is normally alkaline, receiving its alkalinity from the water supply, the ground water, and the materials added during domestic use. The concentration of alkalinity in wastewater is important where chemical and biological treatment is to be used.

.5.2 Chlorides

Chlorides are a constituent of concern in wastewater as it can impact the final reuse oplications of treated waste water. Chlorides in natural water result from the leaching of chloride-ontaining rocks and soil with which the water comes in contact and in coastal areas from altwater intrusion. In addition, agricultural, industrial and domestic wastewaters discharged to surface waters are a source of chlorides.

Human excreta for example, contain about 6g of chlorides per person per day. In areas where the hardness of water is high, home regeneration type water softened will also add large quantities of chlorides (NISP, 2003)

2.15.3 Sulphide

Its common pressure in waste water comes partly from the decomposition of organic matter some times form industrial waste but, mostly from abattoir effluent such as anaerobic macro organisms reducing sulphides to sulphides hydrogen. Sulphides escape into the air from sulphides waste water which constituent colour nuisance (Meadows 2000).

2.15.4 Ammonia

This is non persistent and a non competitive toxic compound which arises as a rule from aerobic or anaerobic decomposition of nitrogenous organic compound.

Ammonia and ammonium compounds occur is relatively small are quantity which are toxic to fish and other aquatic lives (Akpan, 2003).

2.15.5 Nitrogen

Nitrogen and phosphorus are essential to the growth of microorganisms, plants and animals and are known as nutrients or bio stimulations. Trace qualities of other elements, such as iron, are also needed for biological growth, but nitrogen and phosphorus are, in most cases the major nutrients of importance. Since nitrogen is an essential building block in the synthesis of protein nitrogen data will be required to evaluate the tractability of waste water by biological Processes.

2.15.6 Phosphorus

Phosphorus is also essential to the growth of algae and other biological organism. Because of noxious algae blooms that occur in surface waters. There is presently much of it in domestic and industrial waste discharges and natural runoff of Municipals waste waters.

The usual forms of phosphorus that are found is aqueous solutions include the orthophosphate, polyphosphate and organic phosphate. The orthophosphates, for example, PO_4^{3-}; and H_3PO^{4-} are available for biological metabolism without further breakdown.

2.15.7 Sulphur

The sulphides ion occurs naturally in most waste supplies and is present in wastewater as well. Sulphur is required in the synthesis of proteins and is released in their degradation. Sulphides are reduced biologically under anaerobic conditions to sulfide which, in turn, can combine with hydrogen to form hydrogen sulphate (H_2S).

2.15.8 Gases

Gases commonly fund in untreated waste water include nitrogen (N_2), Oxygen (O_2,), Carbon dioxide (CO_2), Hydrogen sulphide (H_2S), Ammonia (NH_3) and Methane (CH_4). The first three are common gases of the atmosphere are found in all waters exposed to air. The latter three are derived from the decomposition of the organic matter present in waste waster and are of concern with respect to worker health and safety.

Trace quantities of many metal such as Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Ag), Nickel (Ni), and Zinc (Zn) are important constituents of most wasters many of these metals are also classified as priority pollutants. However, most of these metals are necessary for growth of biological life, and absence of sufficient quantities of them could limit growth of algae for example.

2.15.9 Potassium

Potassium is relatively abundant in the earths crust, but the potassium content in the natural water is usually small potassium is essential to animal nutrition but a very high concentration of it may be regarded as extreme limit. It causes foaming as doe's sodium in water and is not important in industrial water.

2.15.10 Magnesium

Natural water obtains their magnesium content chiefly from dolomite or dolomite limestone. It is present in water in the form of carbonate and sulphate both of which are soluble. Presence of magnesium in high concentration in water is objectionable unable because it is cathartic and diuretic to the human system.

2.15.11 Lead

Lead is a micro element in most natural water and it is found naturally in human body. It is a cumulate poison to humans and other animals as well. Ingestion (or drinking) of water containing small amount of it may give rise to symptoms of leas poisoning generally known as plumbic.

2.15.12 Iron

Iron is one of the most abundant metals in the earth crust. Some of the common humid compresses causing color in water may be due to the bone, and the blood of the animal from the slaughter houses (Okecha, 2000).

Presence of iron in water is object unable because it imparts a bitter as regent taste to water it also strain laundered goods and foods.

2.15.13 Copper

Most copper minerals are relatively insoluble and only very low concentrations can be expected from natural sources most especially in the stream water. It imparts a disagreeable metallic waste thereby rendering the water unpalatable it is therefore not desired in drinking and industrial waters.

2.15.14 Zinc

Zinc is abundant in rocks and ores, but is only a minor constituent in natural water because the free metal and its oxides are only sparingly soluble. It is present in water in the form of chlorides and sulphates both of which are highly soluble.

CHAPTER THREE

3.0 METHODOLOGY

To obtain a true indication of the nature of water or waste, it is first necessary to ensure that the sample is actually representative of the source. Having satisfied this requiremeSnt in the appropriate analysis must be carried out using standard procedures so that results obtained by physical and chemical analysis can be directly compared.

3.1 Collection of Samples

The Jebba abattoir samples were collected in the morning and evening marked as letter A and B by 6:30am and 6:30pm. While the sample of Mokwa abattoir were collected from the borehole in abattoir in the morning by 6:30am and in the evening by 6:30 pm while the other sample were collected in the town well "Mokwa" by 6:30 am of the following day.

The topography of the area was mainly used in the collection of the sample to be analyzed; since it is expected that the rate of pollution increases down the slope. The first sample taken from Mokwa abattoir by 6:30am at the borehole of abattoir was marked D while the second sample taken at 6:30pm at the same abattoir borehole was marked E while the final sample was taken in the town wells as by 6:30 am of the following day was marked as C which signified 12hrs intervals of this work. Table 3.1 shows that time and location of collection of these samples.

Table 3.1: Timing for the collection of water samples

Samples	Location	Time
A	Well water of Jebba Abattoir	6:30am
B	Well water of Jebba Abattoir	6:30pm
C	Well water in Mokwa town	6:30am
D	Mokwa Abattoir Borehole water	6:30pm
E	Mokwa Abattoir borehole water	6:30am

The samples were collected in the clean plastic containers bottles.

3.2 SAMPLE ANALYSIS

The samples analyses were carried out in Niger state water board laboratory and the apparatus used includes the following:-

1. Evaporating dish
2. Drying oven
3. P^H meter model
4. Measuring cylinder
5. Pipettes
6. Test tube

7. Wash bottles

8. Volumetric flask

9. Filter papers

10. Beakers

11. Funnels

12. Reflux apparatus

13. Conductivity meter model

14. Burettes

15. Hot plate

16. Thermometer

For the hardness test the following reagents were used:-

1. EDTA

2 Buffer solutions

While for alkalinity the following were the reagents used:-

1. Methyl orange indicator solution

2. Phenolphthalein

3. Sulphuric acid

3.3 Electrical Conductivity (Us/Cm)

Electrical conductivity (Ec), also called specific conductance is a measure of the ability of water to convey an electrical current and it is related to the concentration of ionized substances in water. Conductivity can be used as an approximate measure of the total concentration of inorganic substance in water. Irons that have a major influence on the conductivity of water are H^{+}'Na^{+},K^{+},Mg^{2+},Ca^{2+},Cl^{-},SO_4^{2-} and HCO^{3-} test are as follows:-

1. Samples
2. Bunches funnel
3. filter paper
4. Conductivity meter

3.3.1 Procedure

The conductivity meter with its electrode immerged in distilled water was switched on and left for 10 minutes to standardize. The electrode was rinsed two times with the sample. The pointer and the selected knob were adjusted to the appropriate range and readings on the scale were taking.

The samples were heated through evaporated dish in oven at 180^{0}c for 1hr. cooled in desiccators and weighed. Then the accurate volume of well mixed sample was measures and passed through glass fibre filter paper under slight suction. The transfer filtrated was pre-weighed through evaporating dish and evaporate to dryness in a hot water bath for the diction of conductivity.

3.4 Determination of Total Dissolved Solids (TDS)

The weight of empty evaporating dish and weight of dish were measured and samples were heated to dryness in the hot plate. The dish was cooled in a desiccators and constant weighed. The cycle of drying was repeated until accountant weight was obtained and recorded.

3.5 Determination of Suspended Solids (mg/l)

The filter was washed in filter holder under suction with successive small volumes of laboratory water. The filter paper was removed and placed in the aluminum dish and dry in oven at 105^0c for 1hr cool in desiccators and weighed. The procedure was repeated until the drift is less than 0.5mg.This filter were placed and dumped with laboratory water and the accurate volume of well-mixed water sample (100-500ml) and filter under slight suction then the filter was removed and dried in the oven of 105^0c for 1 hr and recorded.

3.6 Determination of pH

The pH meter was used according to the manufactures instructors and specifications. The electrode was rinsed and left in distilled water for two minutes to remove possibility or the presence of other agents. The pH meter was standardized using the buffer solution of 4, 7 and 9.2. The electrode was rinsed several times with the samples.

The pH of the samples and their value was noted. See in Table 4.1 results.

3.7 Temperature Determination

The temperature of the samples was noted by inserting a Thermometer with each sample and their result were noted.

3.8 Determination of Alkalinity

100ml of each sample was transferred to a flask and two drops of phenolphthalein indicator were added the resultant pink colour solution was titrated with 0.1 HCI or $S0^2{}_4$ until the colour change to colourless.

3.9 Determination of Colour

The colours of the samples were observed by filling one clean test tube with distilled water and another with sample and comparison was made between the two solutions and the colour was noted. For the result, see in table 4.1.

3.10 Determination of Total Hardness

The soap solution was putted into the burette, than $25cm^3$of sample was measured through pipette and pored into round bottomed flask than titrated for one minute and note weather it make lather or not. And results were noted. It can also be tested as follow: The ethylene dioxide tetra acetic acid (EDTA) solution, the pipette for 20ml aliquots of the primary standard $CaCo_3$ (0.04m) solution into 250ml conical flasks. Titrate each with the 0.004m of EDTA solution in the following manner. The 15ml is added to the EDTA solution from the burette then; 10ml of the buffer solution is added to 5 drops of the ferrochrome black indicator solution and recorded.

3.11 Determination of Nitrate

10ml of distilled water and the samples were measured in two different tubes to each sample 0.5ml bromine was added followed by the addition of 20ml of concentrated $H_2 SO_4$.

The colour of the samples solution appears to be lighter which was over come by titrating it with $AlNO_3$ until the same colour match was obtained and the result were noted.

3.12 Determination of Iron

The sample was shaking thoroughly through sample bottle and pipette of 50.0ml (aq) into conical flask. Then the 2ml of concentrated HCl was added to 1ml hydroxylamine solution and some glass beads. The sample was boiled until the volume reduced to about 20ml and the results were recorded through absorbance.

3.13 Determination of Phosphorus

The calibration standard was prepared and volume of phosphate solution corresponding to between 5kg and 60kg to a series of 50ml to each flask. Then, the 8ml of the reaction mixture into a 50ml flask and making up to the mark with water and result were noted.

3.14 Determination of Sulphate

20ml of Iodine solution was transferred into a conical flask, 20ml of HCl was added and 200ml of the samples was discharged under solution surface in the flask. The solution was than titrated with 0.025 of M Na_2SO_3 using indicator. The concentration was obtained when the trace of blue colour disappeared. The sulphide concentration was noted.

CHAPTER FOUR

4.0 RESULT S AND DISCUSSIONS

4.1 Results

The results of the underground water are presented in Table 4.1.

4.1 **Results**

The result of the underground water are presented in table 4.1

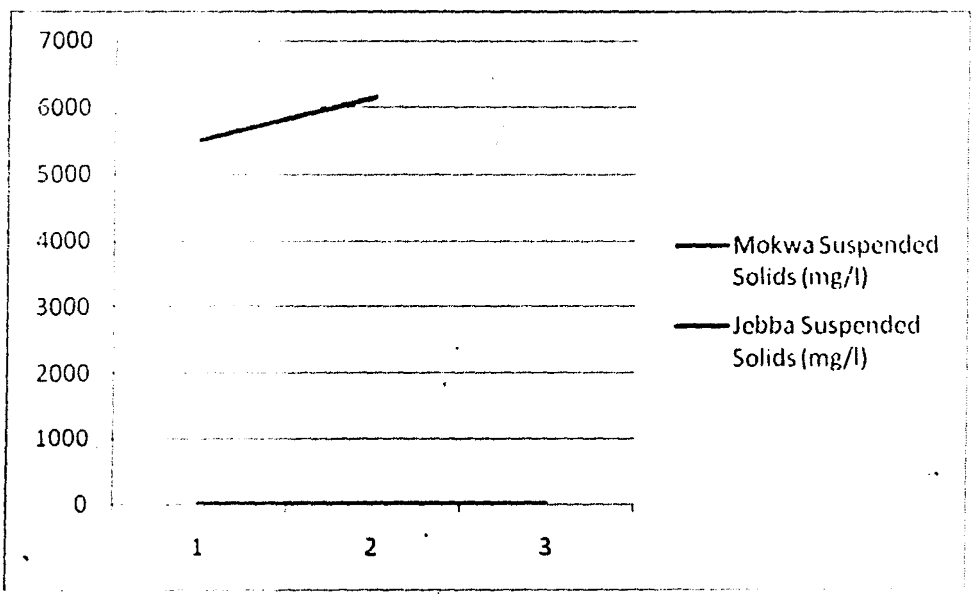
S/NO	PARAMETERS	Jebba Abattoir well water "A"	Jebba Abattoir well water "B"	Mokwa town well "C"	Mokwa Abattoir bore water "D"	Mokwa Abattoir bore water "E"	WHO limits
	Electrical conductivity (us/cm)	1350	1200	220	450	450	1000
2	Total dissolved solids (mg/l)	7560	8200	110	225	225	500
3	Temperature (^oC)	27	26.5	27.2	29.4	29.5	N/S
4	Suspended solid (mg/l)	5500	6150	0	3.0	0	25
5	Turbidity	2.5	3.0	0.0	2.0	0	5.0
6	Colour (pt.C_o)	6	5.2	0	0	0	15
7	p^H	8.8	8.6	7.2	6.9	7.1	6.5- 8.5
8	Iron Content (mg/l)	3.5	2.6	0.30	0.15	0.23	0.30
9	Sulphate (mg/l)	115	128	9.0	20	20	250
10	Nitrate as Nitrogen (N_2)	12.5	10.5	7.60	6.9	7.1	10

	(mg/l)						
11	Nitrate (Mg/l)	79	86	33.44	29.48	33.0s	50
12	Total hardness (mg/l)	102	100	62	40	48	100
13	Hardness as (Ca) $CaCO_3$	55	56	24.8	16	19.2	N/S
14	Hardness As (mg) $MgCO_3$ (mg/l)	47	44	37.2	24	28.8	N/S
15	Total Alkalinity (mg/l)	55	48	12.4	8.0	6.4	100
16	Phosphate as phosphorus	25	30	0.06	0.01	0.025	N/S

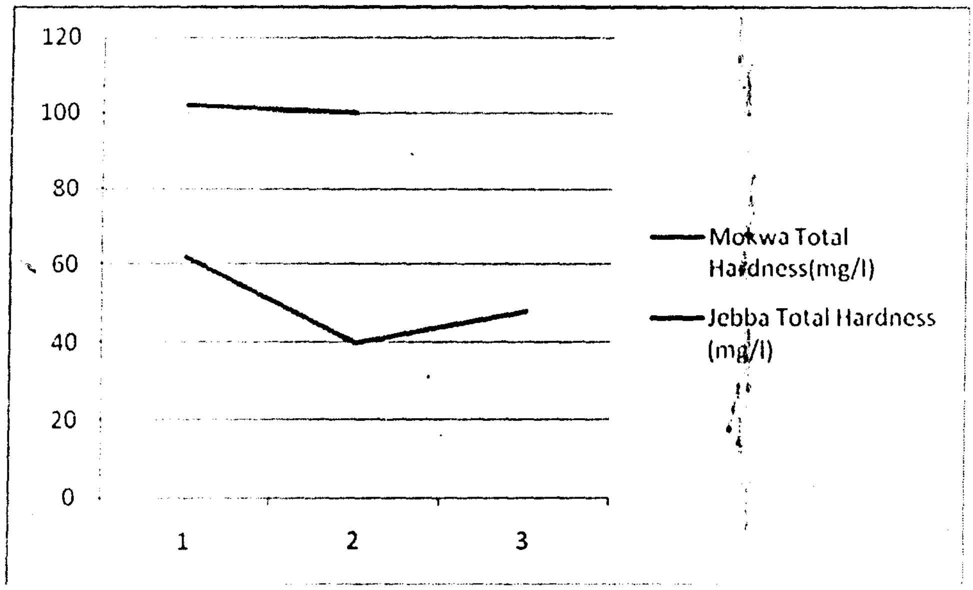
Where N/S means not stated

4.1.1 Pollutant Concentration of Effluents Comparative graphs

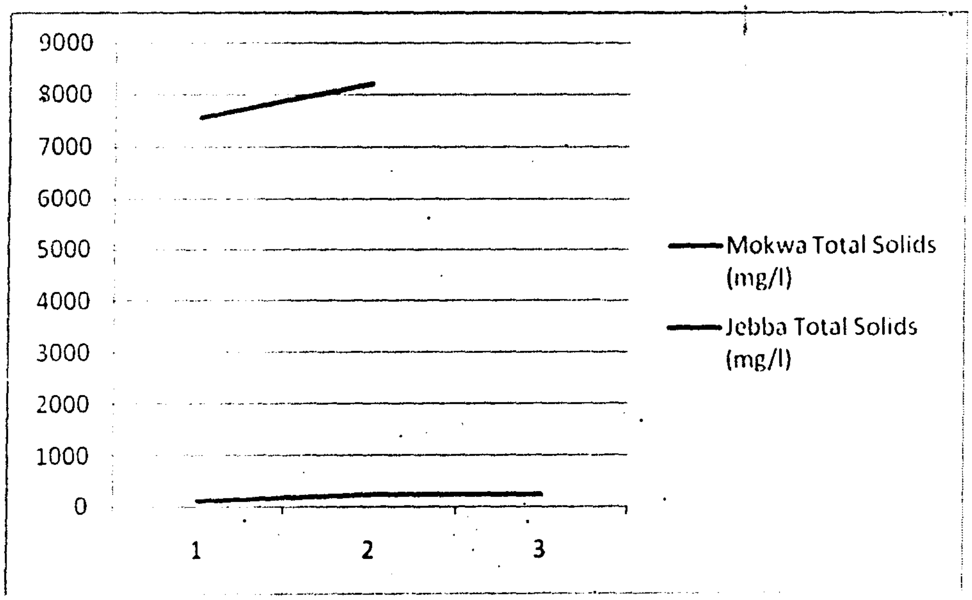
4.1.2 Jebba and Mokwa Suspended Solids Comparative Graph.



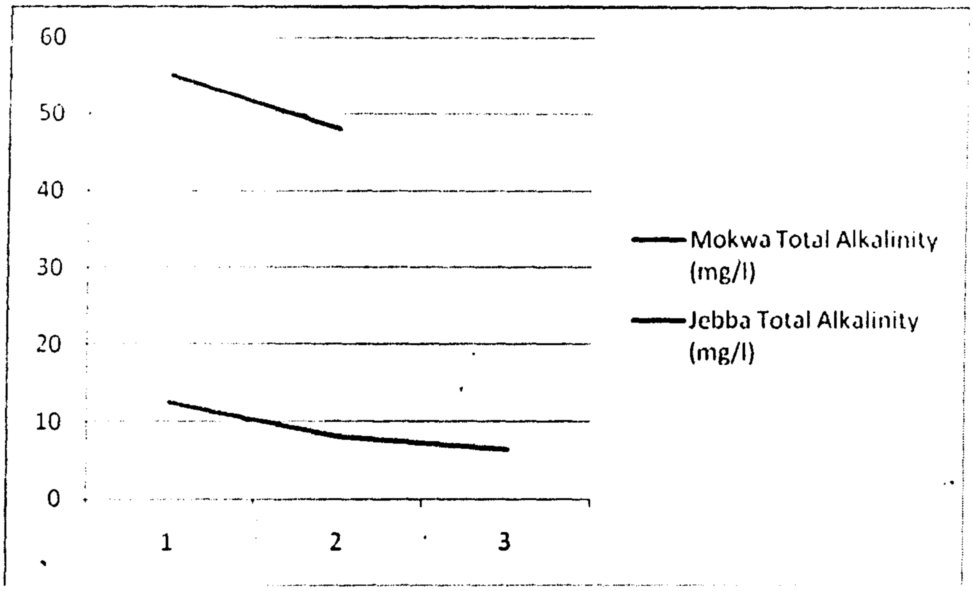
4.1.3 Jebba and Mokwa Total Hardness Comparative Graph.



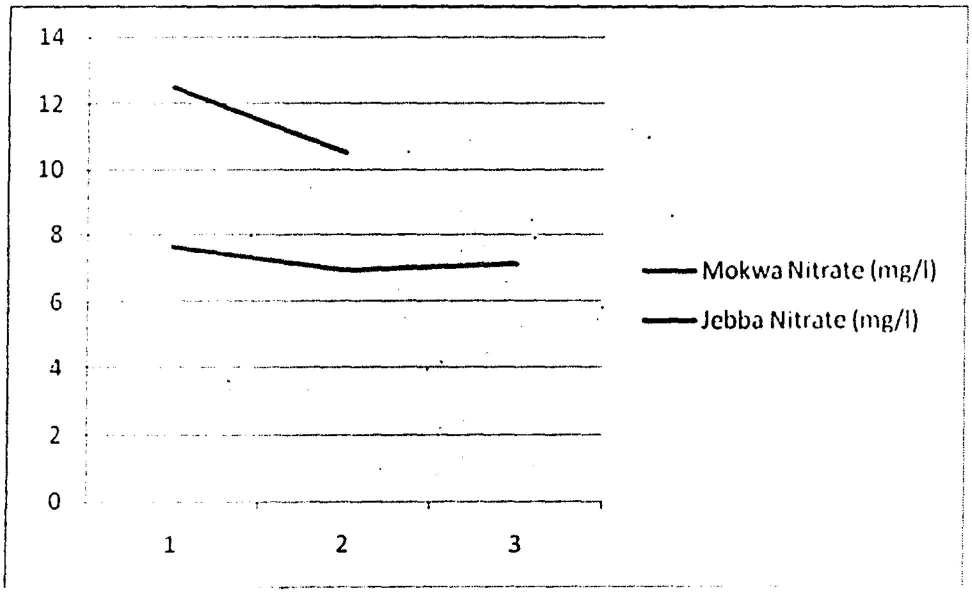
4.1.4 Jebba and Mokwa Total Solids Comparative Graph.



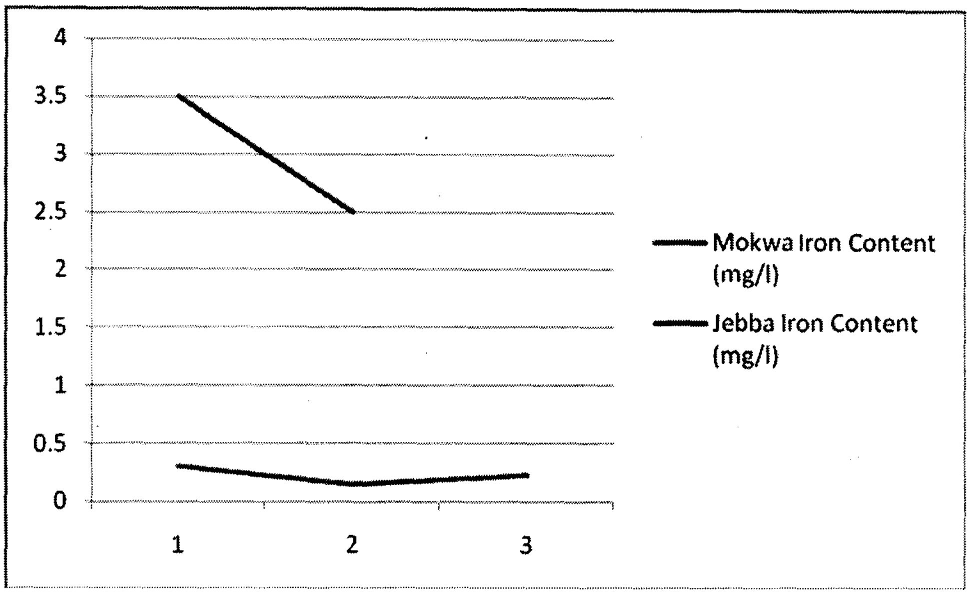
4.1.5 Jebba and Mokwa Total Alkalinity Comparative Graph.



4.1.6 Jebba and Mokwa Nitrate Comparative Graph.



4.1.7 Jebba and Mokwa Iron content Comparative Graph.



4.2.0 Discussions of Parameters

From the results above its clear that Jebba present used abattoir effluents generated have effect to the ground water and also from the results mokwa abattoir, it is undoubtedly clear that abattoir effluent generated affect ground water resources in Mokwa and Jebba. Generally, analysis of ground water resources in Jebba and Mokwa shows a marked difference in quality depending on the location of the source. From the results obtained from Mokwa abattoir ground water is clear, tasteless and odourless. It also contain low amount of solisds owing to filtration through the rocks but sometimes alkaline in reaction are highly mineralized for the same reason.

4.2.1 Discussion of Mokwa Abattoir Parameters

The Electrical conductivity (Us/cm) were 220, 450 and 450 for both Town well "C" Abattoir borehole water "D" and Abattoir Borehole "E" which are lower than the world health organization (W.H.O) limit, this can be caused from the filtration through the soil particles.

Total dissolved solids (mg/l) of the samples were 110, 225 and 228 for both the three samples collected which is lower than standards less than 500mg/l.Therefore total dissolved solid is generally satisfactory for domestic use and many industrial purposes. The total dissolved solids of the samples were compatible for domestic use. (S.I. Omofonmwa and J.O. Eseigbe).

Temperatures in the lab. (^{o}C) were 27.2, 29.4 and 29.5 for both the samples analysis which the limits as not stated on world health organization (W.H.O) limits because it depends on the environmental condition at the time of the collections and testing of the samples.

Suspended solids (mg/l) were 0, 3.0 and O for the all samples analyses which lower than 25mg/l of world health organization (W.H.O) limit standards, the lower the values of these analysis that were analyses of suspended solids of ground water is due to screening process that is taken place through the soil particle which can be use for domestic purposes.

Turbidity (FTU) were 0, 1.0 and 0 for the three samples analyses made which make water comparable with the standards (W.H.O) limit 5.0 and it can be recommended for drinking and industrial works.

Colours (pt. co) were 0, 0 and 0 for all three samples analyzed and they are lower than world health organization standard which is 15. Therefore by this W.H.O standard it clear that the ground water is good for domestic activities.

P^{H} (^{o}C) were 7.2, 6.9 and 7.1 for the three (3) samples collected and analyzed which are within the limits standard of world health organization (W.H.O) 6.5 – 8.5 and it is recommended for drinking and other domestic uses and also for agricultural purposes.

Iron contents (mg/l) were 0.39, 0.15 and 0.23 for all the three samples collected and analyzed. The obtainable values for town well water is 0.39 which is not compatible for drinking but it can be used for other domestic activities while, values obtained for abattoir borehole water "D" and borehole water "E" are compatible for drinking because the values are lower than the world health standard limits 0.3mg/l. the iron content present in water stains plumbing fixtures, stains cloths during laundering, incrusts well screen and clogs pipes (Deutsch 2003).

Sulphate (mg/l) were 9.0, 20 and 20 which are lower that the comparative standard 250mg/l, while Nitrate as Nitrogen (mg/l) were 7.6, 6.7 and 7.5 which are also lower than the comparative standard 10mg/l and based on previous research by S.I Omofonmwan and J.O Eseigbe they are good for domestic purposes.

Nitrate (mg/l) were 33.44, 29.48 and 33.0 which also lower than the standard (W.H.O) due to deepness, screening and filtration processes that taken place by the soil particles and it can be recommended for both industrial and domestic uses and Agricultural practices.

Total hardness (mg/l) were 62, 40 and 48 which are lower than the world health organization standard (W.H.O) and from this research it can be recommended for domestic, industrial and agricultural purposes because of lower ness of the values obtained compared to the W.H.O standard 100mg/l.

Hardness (Ca) as $CaCO_3$ were 24.8, 16 and 19.2 which the standard limits was not specified by world health organization. While hardness (mg) as $MgCO_3$ were 87.2, 24 and 28.8 which limits was also not stated by W.H.O and may be recommend for uses.

Total Alkalinity (mg/l) were 12.4, 8.0 and 6.4 which is lower than the world health organization standards 100mg/l. the lowerness of the results is due to deepness of the town well and Borehole of the abandoned abattoirs and it can be concluded that the ground water is still good for domestic activities, agricultural and industrial uses.

Phosphates as phosphorus were 0.06, 0.01 and 0.025 which the limits is not stated by world health organization (W.H.O).

4.2.2 Results Discussions of Jebba s Abattoir Parameters

The electrical (Us/cm) for present use abattoir were 1350 and 1200 which is higher that the World Health Organization limit, therefore the Jebba abattoir consist of inorganic materials and its not recommended for both Irrigation and domestic uses.

Total dissolve solids (mg/l) for Jebba abattoir were 7560 and 8200 which is higher than the comparative standard which mean that, the Jebba abattoir consist of inorganic element that effluence the electrical conductivity therefore, the water is not good for drinking but it can be use for washing and other activities. Temperatures of Jebba abattoir were 27 and 26.5 which the limit standard was stated by World Health Organization. While the suspended solids of the abattoir (presently in used) were 5500 and 6150 which not compactable with the standard of World Health Organization (WHO) limits and, therefore the water is not good for consumption but it can be use for other purposes. Turbidity of Jebba abattoir were, 2.5, 3.0, which are more less than the standard limit by World Health Organization therefore, it simply stated that water can be use for domestic activities. Nitrate (mg/l) of Jebba abattoir were; 79 and 86 which is higher than the World Health Organization standard limit (W.H.O) and its not good for drinking purposes but can still be use for other activities. Total hardness(mg/l) of jebba abattoir were, 102 and 100 which signify the present of dissolved rock like $CaCO_3$ and $MgCO_3$ in the water therefore, is not good for consumption because of highness of the values. Total Alkalinity (mg/l) where, 55, 48 phosphate as phosphorus were, 25and 30.0. These are also not good for comsumption.

Colour (pt co) of the Jebba abattoir were 6 and 5.2 which higher than the Mokwa abattoir which have 0,0 and 0 respectively from this result it can be deducted that the water from both abattoir are good for domestic purposes because of lowerness of these reading compare to the W.H.O limit. PH of Jebba abattoirs were 8.8 and 8.5 higher that the Mokwa and therefore the water is said to be not good for drinking but it can be use for other purposes because of highness compare to W.H.O limit. Iron content of the Jebba abattoir was 3.5 and 2.6 which is higher than the World Health Organization limit and also the abandoned abattoir. Therefore the Jebba abattoir in used water is not good for drinking but can be use for other purposes. Sulphates for Jebba abattoir were; 115 and 128, which are lower than the standard and is good for domestic activities.

4.3.0 Abattoir Effluent Characteristics

The waste products present within the premises of the abattoir consist of

(a) Solid waste made up of pouch contents horns bones and fiscal components.

(b) Slurry of suspended solids, fats, blood scraps of tissue and soluble materials

All these are deposited within and outside the immediate environment of the abattoirs hence, possessing some serious environmental hazards to the people of Mokwa and Jebba communities.

Table 4.1 Results, the Jebba abattoir parameters does not fall within a limit except few ones, but all of the water parameters of Mokwa abattoir fall within the world health organization limits (W.H.O) which can be use for drinking and other purposes.

4.4.0 Result Utilization Schemes

Based on the chemical analysis and observations made by the author, it could be understand that the principal error made in soling construction and operation of most of the slaughter houses was the failure to make an accurate assessment of potential pollutant dangers. Though most product from the abattoir are considered to be waste products to the society but when put into actual use, such products can be a source of income to the people around there. Such by-products include bones, pouch materials and fiscal component which can be modernized and used as fertilizer.

To avoid contamination of the environment with waste, the abattoir and slaughter scraps, which have been developed by urban growth, would have to be relocated (Alonge 2001).

CHAPTER FIVE

5.0 CONCLUSION

The aims of this analytical studies is to ascertain if the quality of these battoirs are the same or different. From the results of analysis the parameters of Jebba abattoir are above the limit of word health organization (W.H.O). Therefore, the water is not compactable for drinking. While Mokwa abattoir parameters full within the limit of international standard for water quality and does not affects underground water. The results of Mokwa abattoir "Abandoned Abattoir" obtained were therefore mostly unharmful while few are hazardous to the health. Thus allowing its usage by the people living within the vicinity of abattoir.

5.1 Limitation

Some parameters such as P^H, Temperature and conductivity were supposed to be determined immediately the samples were collected, but were not determined because the non-availability of potable measuring instrument. They were given the less determine in the laboratory while often problem that confront the delay of the analysis are the shortage of chemicals in the laboratory which made the time for analysis longer.

5.2 Suggestions and Recommendations

The Jebba and Mokwa abattoirs studies contained higher and lower concentration of most of the parameters tested for. Therefore; pathogens in water are agents that cause diseases in ground water quality systems. To an extent, these agents like suspended solids, total dissolved solids, bacterial, nitrate, iron hardness, sulphate and phosphate vary from borehole to the town well as seen in table 4.1. However, their presence in ground water on Jebba abattoir has serious effects which are not advisable for drinking. While abandoned Mokwa abattoir do not cause significant health hazards despite the presence of these pathogens in water. As showed in Jebba and Mokwa comparative graphs. These variation graphs decreasing down with time, (hr) do to the abandoned character of Mokwa abattoir (two years abandoned).

Comparable of present and abandoned abattoir effluent handling, controlling and monitoring techniques in Jebba and Mokwa abattoirs most be geared towards achieving quality environmental condition for man to live in. This will go a long way to protecting natural resources such as water that are degraded by these effluents. From this framework, it's possible to articulate a position on thorough environmental management procedures to protect ground water resources in Mokwa and jebba. The following recommendations are therefore suggested.

- Effluent should be recycled instead of discharging them without treatment into the surrounding environment unless if otherwise, by the time abattoir restart their work, proper waste collection and management system should be authority that in ministry of environmental awareness through enlightenment campaigns, exploration of ground water should be deep, analysis of ground water should be encouraged at both government and put in place by the relevant ministries.

- The federal Government should enact a law s which would prevent the abattoir area from being more congested as to minimize the environmental pollution due to effluent discharge.

- More surveys of this nature should be commissioned in order to fully assess measures necessary to prevent ground water pollution.

- Waste disposal authorities should exercise caution in the close of slaughtering house and dumpsites to ensure that the disposal of solid waste did not pose danger to public health non cause serious detriment to the amenities of the locality on a regular basis in order to detect departure of pollutants from natural background condition.

- The solid waste from the Jebba and Mokwa abattoirs should be recycled and restoration of damaged resources or environment. People within the environment should be forced to use waste bins and other facilities provided by waste managers for disposing of their waste.

Since it's difficult to evaluate resident from the already established area health education especially as it concerns simple water treatment processes might be necessary.

REFERENCES

Adelegan J. A (2002). Environmental policy and slaughter house waste in proceedings of the 28th WEDC conference Kolkata (Calcuta) India. Pp 3-6.

Adesemoye A.O, Adedire C.O (2005). Use of cereals as basal medium for the formulation of alternative culture media for fungi world J. Microbial Biotechnology. 21: 329-336.

Adewoye S.O, Lateef A. (2004). Assessment of the microbiological quality of claries gariepinus exposed to an industrial effluent in Nigeria. The environmentalist 24: 249 – 254.

Adeyemo O.K (2003). Consequences of pollution and degradation of Nigeria aquatic environment of fisheries resources the environmentalist 23: 297 – 306.

Akpan A.W (2004). The water quality of some tropical fresh water bodies in Uyo (Nigeria) receiving municipal effluents, slaughter house washings and agricultural land draining. The environmentalist 24: 49 – 55.

Amisu K. O, Coker A.O Onsliv, Isokpehi R.D (2003). Arcobacter butzlieri strains from poultry abattoir effluent in Nigeria – East Africa medical J. 80: 218 – 221.

Boulter J.L., Trevor J.T., Boland G.J (2002). Microbial studies of compost bacterial identification and their potential for turf grass pathogen suppression. World J. Microbial. Biotechnology 18: 661 – 671.

Deutsch M. 2003. Natural controls involved in shallow Aquifer contamination. Ground water 3. U.s Environmental protection Agency, pp 37 – 40.

Engineer Adaoye ABE 544, Course material Title waste treatments, 2009.

Fonseca LFL 2000, Concentration of hardness, Alkalinity and Nitrate in water used for cleaning milk equipment in Brazilian Diary farms. Isah Miasmic. The Netherlands, pp 100 – 103.

Hughes J.L, 2004. Evaluation of ground water degradation Result from water disposal to Alluvium near Barton, California. U. S Geological survey professional paper 878.

Ingles G.D Cohen A.C (2002). Influence of anti – microbial agents on the spoilage of meat based – entromophate diet. J. Economic Entronol.

Lapygina E.V, Lysak L.V, Zuyaginastsev D.G (2002). Tolerance of soil bacterial complexes of salt shock. Microbial. 71: 143 – 147.

Laukova A, Marekova M, Vasilkova Z, Papajova I, Juries P (2002). Selected microbial consortium of raw and digested slurry and its susceptibility t entrains world J. Microbial Biotechnology. 18: 11 – 15.

Madigan M.T, Marhinko J.M, Parker J. (2003). Brock biology of micro organism International education Prentice Hall intern Ltd, London, pp 1020 – 1040.

Masse D.I.s, Massel (2002). Characterization of effluents from six hog slaughterhouses in Easter Canada and Evaluation of their impact effluent Treatment systems can. Agric. Eng. 42: 139 – 146.

Ministry of land and survey 2005. Report magazine 5. Benin city, Nigeria.

Nigeria industrial standard NIS 554: s2007.

Nigeria Standard for drinking water quality Approved by: SON governing council (2007).

Nigeria institute of safety professionals 2003. Contractor Employee HSE Training Manuel, level 3, ECNEL Ltd Port Harcourt, Nigeria.

Ogunseitan O.A (2002). Caffeine – Induced Enzyme activity in pseudomonas putida. ATCC 70097 world J. Microbial 12: 596 – 601.

Okecha S.A 2000, Pollution and conservation of Nigeria Environment, T' Afrique international Associates, Oweri, Nigeria 22, Onianwa pc (2001). Roadside Topsoil concentrations of lead and other Heavy metals in Ibadan, Nigeria: for soil sediment contain. 10 (6): 577 – 591.

Practical Environmental Analysis Miroslov Radojevic department of Chemistry, University of Brunei Darussalam page 32-65.

Shi Z, Ln Ke S, Fang HHp (2005) Applications of two – phase anaerobic degradation in industrial effluent treatment, int. J. Environ. Pollute. 23(1): 65 – 80.

Waste water engineering treatment and Reuse fourth Edition international Edition 2004.

Wilham J.L, Doris TC 2005. Biological parameters for water quality criteria. Bioscience 18(8):4772-481.

World Health Organization WHO (2007). Guidelines for drinking water Quality international Reference point for standard setting and drinking water

XU H, Liu, show K, Tay J (2002). Anaerobic graduation technology. Free wastewater treatment. World J. microbial. Biotechnology. 18:99 – 11.

APPENDIX

3.4 Determination of total dissolved solids

Calculation

$$\text{Mg total solid K} = \frac{(A\text{-}B)\times 1000}{\text{Ml sample}}$$

Where

A = Weight of dish + residues (mg)

B = Weight of empty dish (mg)

3.5 Determination of suspended solids

Calculation

$$\text{Suspended solids in ppm} = \frac{1000\times \text{mg silver}}{\text{Ml of the sample}}$$

3.8 Determination of alkalinity

Calculation

$$\text{Ml 0.1m} = \frac{\text{HCl} \times 50.00\times F}{\text{Ml sample}}$$

Where N = Normality of the acid

F = HCl factor = 1

3.12 Determination of iron

Calculation

$$Fe\ mg/l = \frac{Absorbance\,x\ \ 6.86}{Ml}$$

3.13 Determination of Sulphate

Calculation

$$Mg\ 1L(s) = \frac{A \times B - (C \times D) \times 16{,}000}{Ml\ sample}$$

Where: A = ml Iodine Solution

B = Normality of the Iodine solution

C = ml of Na So_3 solution

D = Normality of $Na_2\ SO_3$ solution

And the results were noted.

List of Tables

Table 4.1.2 Comparative of Mokwa and Jebba Abattoirs suspended solids

Mokwa Abattoir suspended solids (mg/l)	Jebba Abattoir suspended solids (mg/l)
0.0	5500
3.0	6150
0.0	_

Table 4.1.3 Comparative of Jebba and Mokwa Abattoirs Total Hardness.

Mokwa Abattoir Total Hardness (mg/l)	Jebba Total Hardness (mg/l)
62	102
40	100
48	_

Table 4.1.4 comparative of Mokwa and Jebba Abattoirs Total solids.

Mokwa Abattoir Total Solids (mg/l)	Jebba abattoir Total Solids (mg/l)
110	7560
225	6150
225	_

Table 4.1.5 Comparative of Mokwa and Jebba Abattoirs Total Alkalinity.

Mokwa Abattoir Total Alkalinity (mg/l)	Jebba Abattoir Total Alkalinity (mg/l)
12.4	55
8.0	48
6.4	–

Table 4.1.6 Comparative of Mokwa and Jebba Abattoirs Nitrate.

Mokwa Abattoir Nitrate (mg/l)	Jebba Abattoir Nitrate (mg/l)
7.6	12.5
6.9	10.5
7.1	–

Table 4.1.7 Comparative of Jebba and Mokwa Abattoirs Iron Content.

Mokwa Abattoir Iron Content (mg/l)	Jebba Abattoir Iron Content (mg/l)
0.30	3.5
0.15	2.5
0.23	–