EVALUATION OF POLLUTANT DISCHARGE FROM SLAUGHTERHOUSES ON RECEIVING WATER BODIES

ABSTRACT

Aim: The aim of this study is treatment and appraisal of the consequence of slaughterhouse wastewater discharge into surface water of selected slaughterhouse environment.

Study Design: Three (3) main stream/surface water discharged slaughterhouses was analyzed. Water samples were collected at the Middle Course (MC) of the receiving water body. Sampling was be carried out between the hours of 10.00 am and 11.00 am when the discharge of effluent into the rivers/streams always occur.

Methodology: Wastewater samples were collected from the different slaughterhouses in order to determine the quality of the effluent before it was discharged into nearby stream/river. The MC samples will be collected from about 40 m from the point of entry of the slaughterhouse waste. Waste samples were collected from each sampling site with a clean polyethylene bottles. The containers was washed with diluted HCl and then rinsed with the wastewater from the slaughterhouse so as to neutralize or reduce the effect of external contaminants. The samples were appropriately labeled and transported to the laboratory, stored in the refrigerator at 4ºC prior to being analyzed for the physical, chemical and biological parameters present.

Results: The parameters assessed include, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), Phosphate, pH, Magnesium, Zinc, Iron, Manganese, Cadmium and Lead. High level of BOD, COD, and TS was revealed on receiving streams with minimum values of 1001mg/l, 1120mg/l, and 990mg/l.

Conclusion: The physico-chemical parameters showed the negative impact of the abattoir effluent on the stream thus rendering the water of worthless value to humans. Furthermore, the abattoir urgently needs an effluent treatment facility to be installed to reduce the health hazard its effluent poses on the abattoir users and users of the streams receiving the effluent.

Keywords: Slaughterhouse, biochemical oxygen demand, (BOD), Physico-chemical Parameters, Abattoir Effluent.

1. INTRODUCTION

The common processes that take place at slaughterhouses are stunning, bleeding, hide removal or treatment, evisceration, carcass dressing and washing [1]. Many slaughterhouses also have a boning process in which finished carcasses are cut into retail portions. Most slaughterhouses also have casings and offal processing departments, which produce value-added products from casings (intestinal tract) and edible offal. The basic process for slaughtering and processing of cattle along with wastewater generation includes plant services and ancillary activities as well as the basic meat processing steps, associated wastes and processes, by-products recovered or reclaimed [2].

Environmental problems have increased in geometric proportion over the last three decades with improper management practices being largely responsible for the gross pollution of the aquatic environment with parallel increase in water borne diseases especially typhoid, diarrhea and dysentery. Slaughterhouses are generally known all over the world to pollute the environment either directly or indirectly from their various processes [3]. Slaughterhouse wastewater is very harmful to the environment. Mohammed and Musa (2012) [4] observed that effluent discharge from slaughterhouses have caused the de-oxygenation of rivers.

According to Leung (2015) [5], illumination and ventilation of slaughterhouses, where reasonably practicable, should be considered during construction so that meat inspection can be carried out effectively. Every slaughterhouse shall be provided with well distributed artificial light of an overall intensity of not less than 20 foot candles. Throughout the slaughter hall and work rooms, provided that at places where inspection is carried out, the overall intensity of artificial light shall not be less than 50 foot candles. Every slaughterhouse shall be provided with suitable and sufficient means of ventilation to the external air except in the case of humidity or temperature-controlled chambers.

Charles and Kennedy (2013) [6], while commenting on slaughterhouse building equipment, stated that personnel and operating procedures should assure the continued wholesomeness and freedom from adulterations of carcasses and meat. Floor, walls and ceilings should be constructed with materials and in a manner that allows sanitary operation and thorough cleaning. The supply of hot and cold water and cleaning materials should be available for slaughtering, cleaning and personal hygiene. Water of at least 180oC should be available to sanitize and clean equipment, knives and utensils that may have had contact with diseased carcasses before being used again. Wastewater drainage with proper trapping and sewage disposal, should be adequate to maintain the slaughterhouse in a sanitary condition. Ventilation should be sufficient to assure that the areas are free of noxious odours. Access to flies, rodents and other vermin should be prevented. Lightening should be maintained at intensity adequate for cleaning and inspection. Personnel should wear clean garments and follow all hygiene and sanitation procedures.

Mohammed and Musa (2012) [4], stated that slaughterhouse in the developing countries of the world may pose public health threats due to unsanitary practices and unwholesome discharges of their wastes and wastewater into the environment. Slaughterhouse wastes are part of the animal that are not used for food productions and may include internal organs, blood bones, ligaments, tendons, urine, feces and carcasses. Discharge of wastes and wastewater into water surfaces is a common way of contaminating drinking water as such discharges can contain a significant level of bacterial pathogens. Studies on slaughterhouse wastewater and the receiving water had shown that slaughterhouse serves as sources of water pollution as it was reported to contain high levels of coliform bacteria that have been found to be far beyond the recommended and permissible limit for discharge into water bodies.

In virtually all the process industries and residential areas, solid and liquid wastes are generated. Slaughterhouse wastes can produce large quantities of malodorous gases when the entrained organic materials are decomposing and are allowed to settle, thereby rendering the vicinity offensive with pungent smell. It also poses a danger to human health because it contains numerous pathogenic organisms removed from the human intestinal tract or certain industrial waste. Slaughterhouse waste contains assorted nutrients that is suitable to the aquatic life but may also be toxic. Because of these reasons, immediate removal of slaughterhouse waste from the generation point, treatment and disposal is necessary.

The continuous drive to increase meat production for the protein needs of the ever increasing world population has some pollution problems attached. Pollution arises from activities in meat production as a result of failure in adhering to Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) [7]. Consideration is hardly given to safety practices during animal transport to the slaughterhouse, slaughter and dressing. Slaughterhouse 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, slaughterhouses are littered with non-meat products and wastes that need to be recycled into useful by-products for further agricultural and other industrial uses [1].This constitutes public health risks and nuisance in most slaughterhouses spread across Nigerian markets, producing air, soil, and water pollution as well as infestation of flies and other disease vectors. For hygienic reasons, slaughterhouses use large amount of water in processing operations; this produces large amount of wastewater. The major environmental problem associated with this slaughterhouse wastewater is the large amount of suspended solids and liquid waste basically discharged into water bodies [8].

The Port Harcourt slaughterhouses serve the entire town, and their locations beside the stream or fallow land mass have facilitated easy disposal of the wastes into streams channels or soil profile respectively even without any proper treatment. The work thus seeks to verify whether or not there are significant differences in the concentration of heavy metals on slaughter wastes discharged streams/shallow waters and recommended standards.

METHODOLOGY

2.1 STUDY AREA

Appropriate study sites were selected based on the accessibility of the location and the bench mark of long term level of pollution from slaughterhouse wastes in at least a minimum of six (6) years after a general review of various slaughterhouses was conducted within the study area. A total of three (3) stream/surface water discharge slaughterhouses were analyzed. Study area will be focused on Obio Akpor and Ikwere Local Government Areas of Rivers State, with estimated population of 649,600 and 265,400 respectively all in Port Harcourt, Nigeria (Kalu et al, 2010) [9] as shown in Figure 1.

The lists of selected slaughterhouses to be evaluated are as listed below;

1. Elelenwo Slaughterhouse
2. Mgbuoshimili Slaughterhouse
3. Alakahia Slaughterhouse

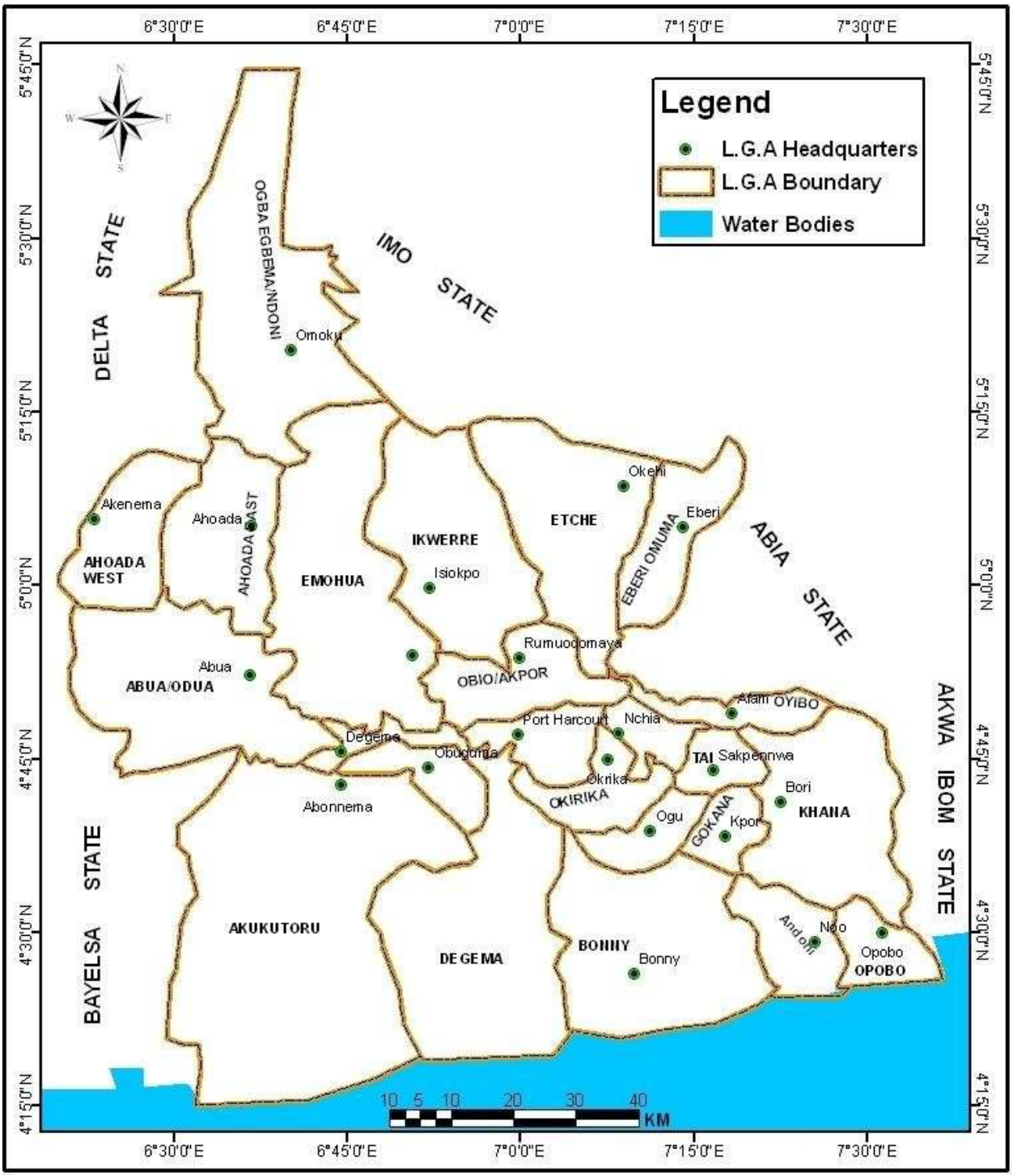

Figure 1: Map of Rivers State Showing the Local Government Area

2.2 SAMPLE AND SAMPLING TECHNIQUES

Wastewater samples will be collected from the different slaughterhouses in order to determine the quality of the effluent before being discharged into the river/land. Water samples will be collected at the Middle Course (MC) of the receiving water body. Sampling will be carried out between the hours of 10.00 am and 11.00 am when the discharge of effluent into the rivers/streams always occur. The MC samples will be collected from about 40 m from the point of entry of the slaughterhouse waste. Waste samples will be collected from each sampling site with a clean polyethylene bottles. The containers will be washed with diluted HCl and then rinsed with the wastewater from the slaughterhouse so as to neutralize or reduce the effect of external contaminants. The samples will be appropriately labeled and transported to the laboratory, stored in the refrigerator at 4ºC prior to being analyzed for the physical, chemical and biological parameters present.

2.3 NATURE AND SOURCES OF DATA

Data will be strictly for laboratory analysis of the various water parameters to be considered. The wastewater, river/stream water were analysed for physico-chemical parameters that include: pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total alkalinity (TA), total hardness (TH), Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO^{3-}, SO_4^{2-}, Cl-, Cu^{2+}, Fe^{2+} and Mn^{2+} ions. Various experimental and instrumental techniques were employed to analyse the different chemical components. Summaries of these methods are presented in section 3.6 below, while a complete description of the methods can be found in Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA, 1998) [10].

2.4 METHODS OF DATA COLLECTION AND INSTRUMENTATION

Collected wastewater samples will be analyzed according to Standard Methods for Examination of Water and Wastewater [10]. The following parameters will be analyzed for the purpose of this study.

1. pH
2. Temperature
3. Conductivity
4. Biochemical oxygen demand (BOD)
5. Chemical oxygen demand (COD)
6. Total solids (TS)
7. Phosphates
8. Nitrates
9. Fecal Coliform
10. Sulphate
11. Fluoride
12. Zinc
13. Lead
14. Manganese

15. Cadmium
16. Carbonate

2.4.1 pH MEASUREMENT

The pH is a measurement of the hydrogen ion (H+) concentration in the samples. The measurement was done with the Mettler Delta 340 pH meter. The pH meter was first calibrated using standard buffer solutions of pH 4.01 and 7.0. The electrode was rinsed with distilled water and dipped into the test sample. The pH value displaced on the screen, which remains unchanged for 5 minutes, was recorded as the pH value of the test sample.

2.4.2 TEMPERATURE

Temperature measurements were made with a mercury-filled Celsius thermometer. The samples were collected and the temperature measured by immersing the thermometer in the samples. Sufficient time was allowed for the thermometer to reach a constant reading. The thermometer readings were recorded in degree Celsius for each of the samples.

2.4.3 ELECTRICAL CONDUCTIVITY

Electrical conductivity measurement was done with the Setraa DDA-11A conductivity meter. The conductivity meter was first calibrated using standard 0.01M potassium chloride solution. The electrode was rinsed with distilled water and dipped into the test sample. The conductivity value displaced on the screen, which remains unchanged for 5 minutes, was recorded as the electrical conductivity value of the test sample.

2.4.4 BIOCHEMICAL OXYGEN DEMAND (BOD_5)

Air tight 300m1 capacity BOD bottles were filled to over-flowing with the sample. The initial dissolved oxygen in the sample was determined. Dilution water was then prepared by measuring out 22.5g/L MgSO4.7H2O; 27.8g/L CaCl2.2H2O; 0.25g/L FeCl3.6H2O; Phosphate buffer: 8.5g KH2PO4; 21.75g of K2HPO4; 33.40g Na2HPO4.7H2O; 1.7g NaCl, at pH 7.2 and into a measuring flask and the volume made up to 1.0L with distilled water. The contents of the flask were mixed by swirling and covered. The dilution water was first saturated with dissolved oxygen by shaking in a partially filled bottle before using it to dilute the samples. Two BOD bottles were then filled with the diluted samples and another 2 bottles with the dilution water to serve as blank. The bottles were stoppered carefully to avoid the entrapment of air. One experimental and one blank BOD bottles were used for the initial DO determination. The remaining 2 BOD bottles were water-sealed by filling the flared neck of the bottles with distilled water from a wash bottle. The cover-cap supplied with the BOD bottles was used to retain the water. The bottles were incubated at $20^{o}C$ for 5 days. At the end of this period the final DO was determined. The BOD_5 in mg/L of the samples was calculated using the relationship.

$$BOD_5(\frac{mg}{l}) = \frac{D_1 - D_2}{P}$$

Where:

D_1 = Dissolved Oxygen (mg/L) of samples 15 minutes after preparation

D_2= Dissolved Oxygen (mg/L) of samples 5 days after incubation at 200^{o}C

P = Decimal Volumetric Fraction of samples used.

2.4.5 CHEMICAL OXYGEN DEMAND (COD)

The chemical oxygen demand was determined using the Rapid oxidation method. The chemical oxygen demand is a measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. The samples were collected in clean glass bottles and 25ml of the sample was introduced into a clean flask and 1.0ml of 20% sulphuric acid added to acidify it. Increasing volumes of potassium permanganate were added and examined at intervals for the pink colour of the permanganate to develop. As it tended to disappear, more permanganate was added to maintain a definite excess.

This was incubated for 4 hours. At the same time, a blank solution was prepared by adding the same reagents as used in the test samples and also incubated. The reaction was terminated at the end of 4 hours by addition of 5.0m1 of 10% potassium iodide solution (10% w/v aqueous solution) and titrated with 0.0125N sodium thiosulphate (3.l0g $Na_2S_2O_3$ and 1.0g Na_2CO_3 in 1.0L of distilled water) using starch as indicator until the blue colour disappeared. The titration was repeated on the blank and volume of the thiosulphate was also recorded. The COD in mg/L of the sample was calculated thus:

$$COD\ \left(\frac{mg}{l}\right) = \left(\frac{(A - B) \times N \times 1000}{V}\right)$$

Where:

A = ml litre of $Na_2S_2O_3$ used for blank

B = ml litre of $Na_2S_2O_3$ used for sample

N = normality of titrant

V = volume of sample used for test

1000 = conversion to litre.

2.4.6 TOTAL SOLIDS (TS)

The gravimetric method according to standard method was used. 250ml capacity beaker was thoroughly washed, rinsed with distilled water, dried in the oven at 105ºC for 1 hour and then cooled in the desiccator. The beaker was weighed and 50ml of test sample was introduced into the beaker. The sample was heated to dryness and the beaker containing the residue was cooled in the desiccator and reweighed.

The TS in mg/l of the sample was calculated thus:

$$TS\left(\frac{mg}{l}\right) = \left(\frac{(B - A) \times 1000}{V}\right)$$

Where:

A= weight of empty beaker (mg)

B= weight of beaker + residue (mg)

V=volume of sample used (ml)

1000= conversion to litre.

2.4.7 Phosphate Determination

The ascorbic acid method was used in this determination. 5.0ml of sample was pipetted into a clean dry test tube and a drop of phenolphthalein indicator was added. No red color developed. Then 1ml of combined reagents (50ml of 5N H_2SO_4; and 5ml of potassium antimonyl tartrate solution) was added and the solution was thoroughly mixed. It was allowed to stand for 10 minutes and the absorbance was measured at 470nm using spectrophotometer and blank as reference solution. The amount of phosphate in mg/L in the sample was calculated from the relation:

$$PO_4^3(\frac{mg}{l}) = \frac{A \times 1000}{ml\ of\ sample}$$

Where:

A = mg PO_4^3 from curve

1000 = Conversion to litre

2.4.8 Nitrate Determination

The Brucine method was used to determine nitrate in the samples. One millilitre of sample was introduced into a clean test-tube and 0.5m1 of 25% brucine reagent (2.5g of brucine or brucine sulphate in 100ml of glacial acetic acid). One millilitre of dilute nitrate standard solution (0.2 □g NO3-N per millilitre) was added and then 2ml of concentrated sulphuric acid was added rapidly and shaken well. This solution was mixed for 30 seconds and allowed to stand for 5 minutes. A light yellow colour was developed. The solution was mixed again and 2ml of distilled water was added and mixing continued for another 30 seconds. Then a curvette was filled with the solution and the absorbance was read at 470nm. The amount of nitrate in the sample was calculated:

$$NO_{3-}(\frac{mg}{l}) = \frac{C \times 100}{ml\ of\ sample}$$

Where:

C = mg nitrate in sample from curve

2.4.9 Turbidity Determination

About 200ml of the sample was placed in a beaker and allowed to settle at room temperature (23 to 27°C). It was mixed thoroughly to disperse the solids and allowed to settle until air bubbles disappeared.

The sample was then poured into the turbidimeter tube. The turbidity value was read directly from the instrument scale and recorded to the nearest whole number in Nephlometric Turbidity Units (NTU).

2.4.10 Electrical Conductivity Measurement

About 200ml of the sample was placed in a beaker and allowed to settle at room temperature (23° to 27°C), while the cell of the conductivity meter was washed thoroughly with the sample water before the measurement was taken. The cell was then dipped into the beaker containing the sample, and electrical conductivity was measured in accordance with the instructions and reported as micro Siemens.

2.4.11 Zinc – Spectrophotometric Method

Amounts of Zinc in the samples were determined by HACH DR2 spectrophotometer using zinc powder pillows at wavelength of 560nm. The results were expressed in mg/l.

2.4.12 Iron – Spectrophotometric Method

Amounts of iron (II) in the samples were determined by HACH DR2 spectrophotometer using ferrous powder pillow at wavelength of 508nm. The results were expressed in mg/l.

2.4.13 Manganese – Spectrophotometric Method

Amounts of manganese in the samples were determined by HACH DR2 spectrophotometer using manganous powder pillows at wavelength of 526nm. The results were expressed in mg/l.
Other parameters including Lead and Cadmium were also analysed by spectrophotometric method.

2.4.14 Total bacteria

Total bacteria will be estimated using the standard spread-plate dilution method. Samples of the soil and wastewater contaminated with the abattoir wastes were serially diluted in ten folds. Total viable heterotrophic aerobic counts were determined using pour plate technique. Then the molten nutrient agar, TCBS, MacConkey and Sabouraud dextrose agar at 45ºC were poured into the Petri dishes containing 1mL of the appropriate dilution for the isolation of the total heterotrophic bacteria and fungi*,* Vibrio cholerae and coliforms respectively. They were swirled to mix and colony counts were taken after incubating the plates at room temperature for 48h and preserved by sub culturing into nutrient agar slants which were used for biochemical tests.

2.5 Statistical Analysis

Means were subjected to Two-sample t-test and z-test for multiple comparisons of the nutrient build-up of slaughter houses deposited wastes at various depths of the soil. This was done with the statistical

package of XLSTAT. Significance level was set at p values <0.05. The results were expressed as Mean ± SD.

3. RESULTS AND DISCUSSION

3.1 RIVERS/ STREAM DISCHARGED SLAUGHTERHOUSE ANALYSIS

Data set for analysed streams and boreholes within and around selected slaughterhouses are as presented in Table 1.

Table 1: Results of data set of parameters analysed for streams/rivers within selected slaughterhouses.

		Receiving Streams			WHO Standard
Parameters	**Raw Effluent**	**xxx (RS1)**	**yyy (RS2)**	**zzz (RS3)**	
pH	7.58	7.23	7.18	7.3	6.5-8.5
Temperature (ºC)	26.23	23	25.2	24.5	
Turbidity (NTU)	631	219	259	301	0.1
Total solid (mg/l)	5748	1090	990	1032	1000
Conductivity (µS/cm)	179.45	186	156	174	1200
COD (mg/l)	18230	1120	1525	2612	NG
Oil/grease	258	12	15	17.43	NG
BOD_5 (mg/l)	11101	1001	1112	1378	20
Nitrate (mg/l)	701	346	332	378	50
Iron (mg/l)	39	14	19	16.4	0.3
Phosphorous (mg/l)	62.4	12.6	11.32	10.32	1
Sulphate (mg/l)	1100	656	712	706	450
Fluoride (mg/l)	24.7	13.6	15.43	14.52	2
Total coliform (cfu/100l)	1860000	5523	6212	5322	0

ND: Not Detected; NG: No Guideline, Elelenwo Slaughterhouse River XXX (RS1); Mgbuoshimili Slaughterhouse River YYY (RS2);Alakahia Slaughterhouse Stream ZZZ (RS3)

3.1.1 Elelenwo Slaughterhouse River XXX (RS1) Result Presentation

A percentage rating chart for the parameters measured at Elelenwo slaughterhouse is as presented below in Figure (2).

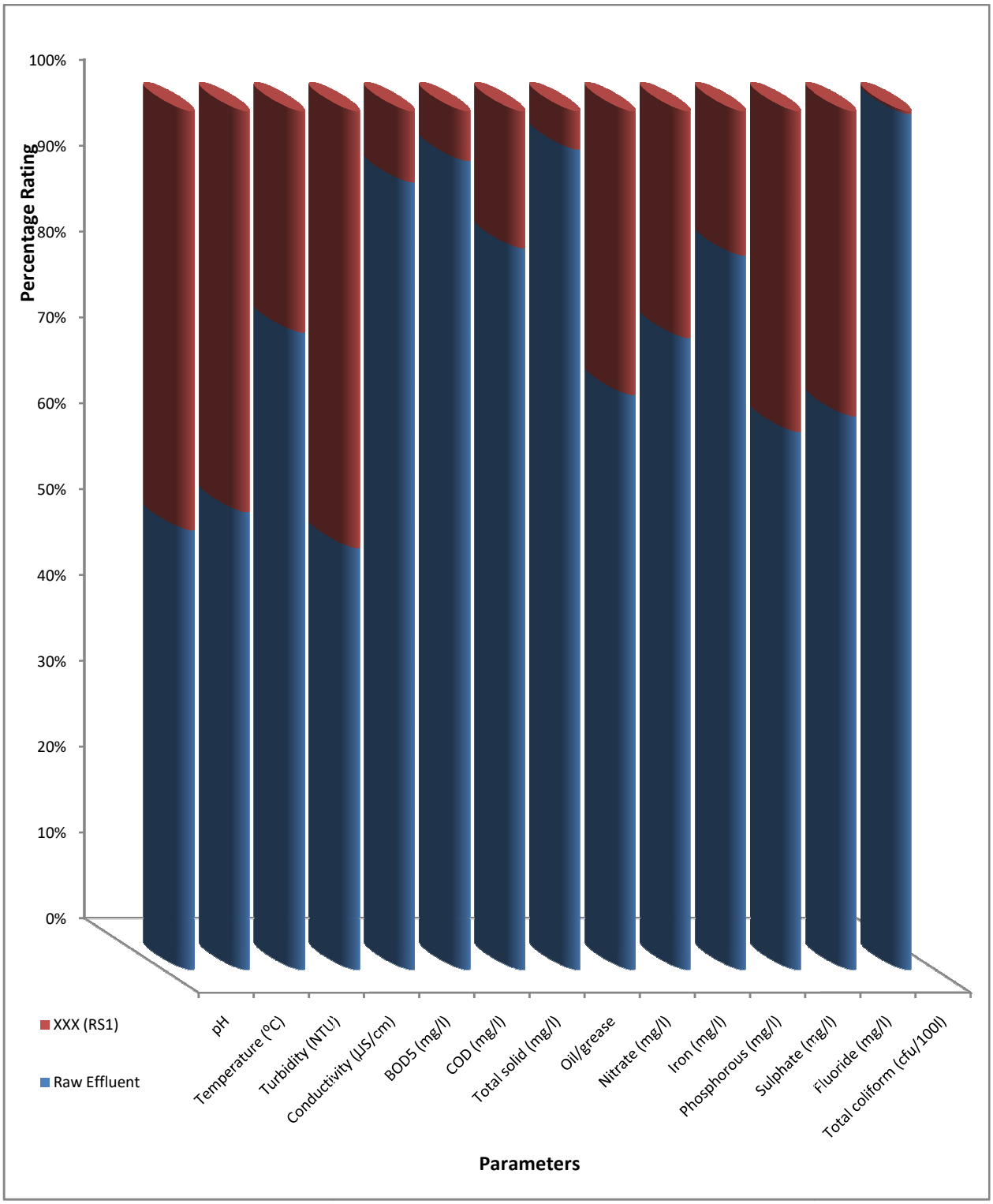

Figure 2: Percentage Rating Chart for Elelenwo Slaughterhouse Parameters

3.1.2 Mgbuoshimili Slaughterhouse RiverYYY (RS2) Result Presentation

A percentage rating chart for the parameters measured at Mgboshimili Slaughterhouse is as presented below in Figure (3). A careful review of the abattoir wastewater discharged into the river site (YYY (RS2)) shows a high level of BOD_5 and COD load in the receiving stream. This also contributed to the increased values of total solids, hence, the increased rate of turbidity of the receiving river. A BOD_5 and COD load of 1112mg/l and 1525mg/l as compared to the WHO Standard of 20 mg/l is also very alarming [11]. There is also a need for urgent treatment measure to be taken, to protect the life of organisms living within this river. Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were all high above the WHO recommended standard in the trend as Sulphate>Nitrate>Iron>Fluoride>Phosphorous. However an assessment of a hand dug well for Mgboshimili Slaughterhouse (YYY (HDW2)) within the slaughterhouse environment showed a BOD_5 and COD decrease below the WHO recommended standard with measured sample values of 6.9mg/l and 17.25mg/l respectively. . Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were also of lower values but all still above the WHO recommended standard except for Sulphate with a measured value of 192mg/l as compared to the 450mg/l recommended standard. Also similar assessment of borehole around the Mgboshimili Slaughterhouse (YYY (BH2)) showed a further decrease in BOD_5 and COD below the WHO recommended standard with measured sample values of 4.01mg/l and 5.7mg/l respectively. Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were also of lower values with Phosphorous, Iron and Fluoride above the WHO recommended standard with measured value of 3.01mg/l , 0.53mg/l and 3.2mg/l as compared to the recommended standards of 1mg/l, 0.3mg/l and 2mg/l respectively.

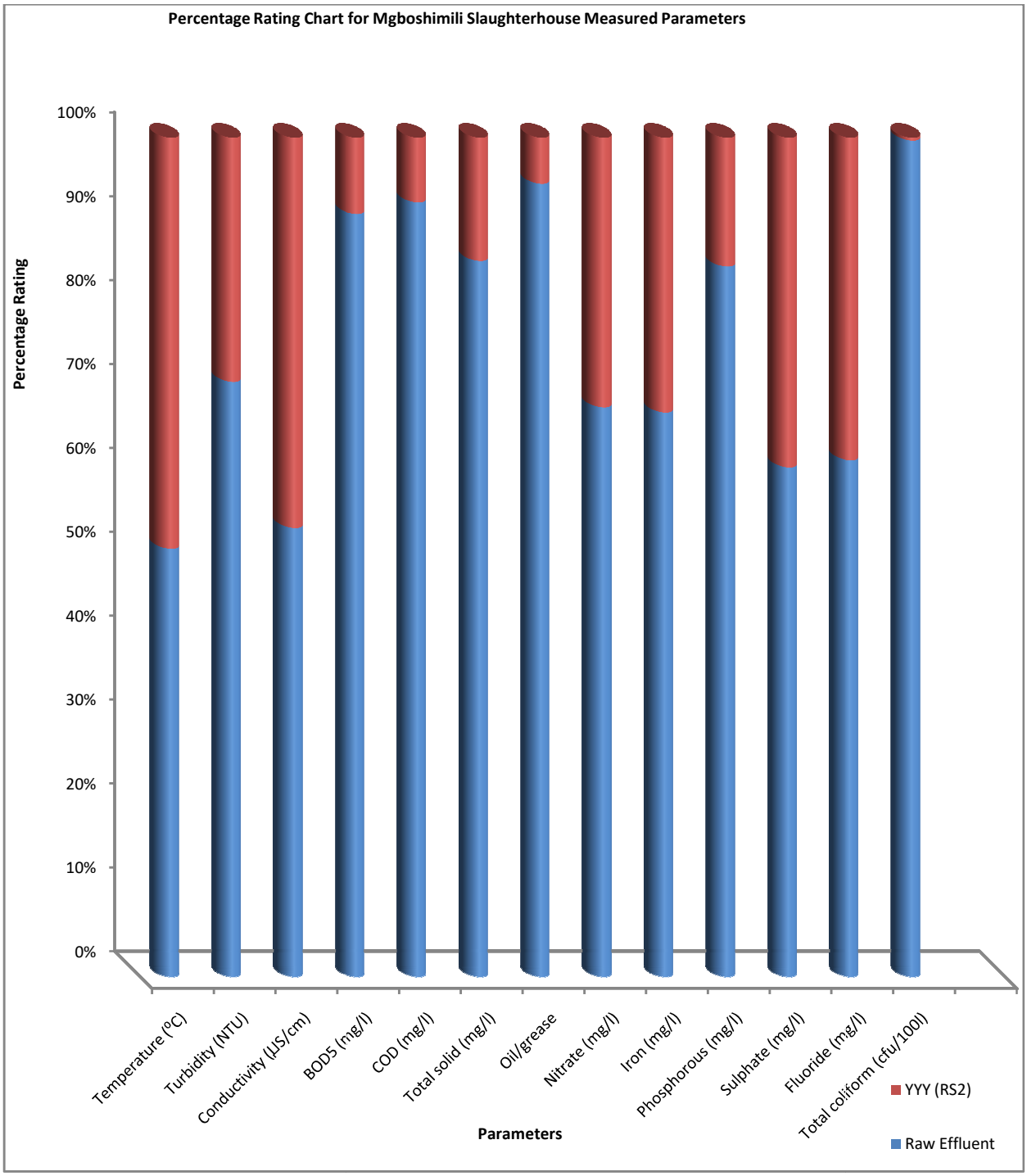

Figure 3: Percentage Rating Chart for Mgboshimili Slaughter house Measured Parameters.

3.1.3 Alakahia Slaughterhouse Stream ZZZ (RS3) Result Presentation

A percentage rating chart for the parameters measured at Alakahia Slaughterhouse is as presented below in Figure (4). Also a review of the abattoir wastewater discharged into the Stream site (ZZZ (RS3))

shows a high level of BOD_5 and COD load in the receiving stream. This also contributed to the increased values of total solids, hence, the increased rate of turbidity of the receiving river. A BOD_5 and COD load of 1378mg/l and 2612mg/l as compared to the WHO Standard of 20 mg/l is also critically alarming corresponding to the same high loads in soil profile analysis as presented in the works of Ogbebor et al, 2021 [12]. There is also a need for urgent treatment measure to be taken, to protect the life of organisms living within this river. Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were also high above the WHO recommended standard in the trend as Sulphate>Nitrate>Iron>Fluoride>Phosphorous. However an assessment of a hand dug well around Alakahia Slaughterhouse (ZZZ (HDW3)) showed a BOD_5 and COD decrease below the WHO recommended standard with measured sample values of 8.4mg/l and 11.45mg/l respectively. Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were also of lower values but all still above the WHO recommended standard except for Sulphate with a measured value of 218mg/l as compared to the 450mg/l recommended standard. Also similar assessment of borehole around the Alakahia Slaughterhouse (ZZZ (BH3)) showed a further decrease in BOD_5 and COD below the WHO recommended standard with measured sample values of 3.76mg/l and 4.9mg/l respectively. Other physico-chemical parameters such as Nitrate, Iron, Phosphorus, Sulphate and Fluoride were also of lower values with Phosphorous, Iron and Fluoride above the WHO recommended standard with measured value of 2.42mg/l, 0.89mg/l and 3.82mg/l as compared to the recommended standards of 1mg/l, 0.3mg/l and 2mg/l respectively.

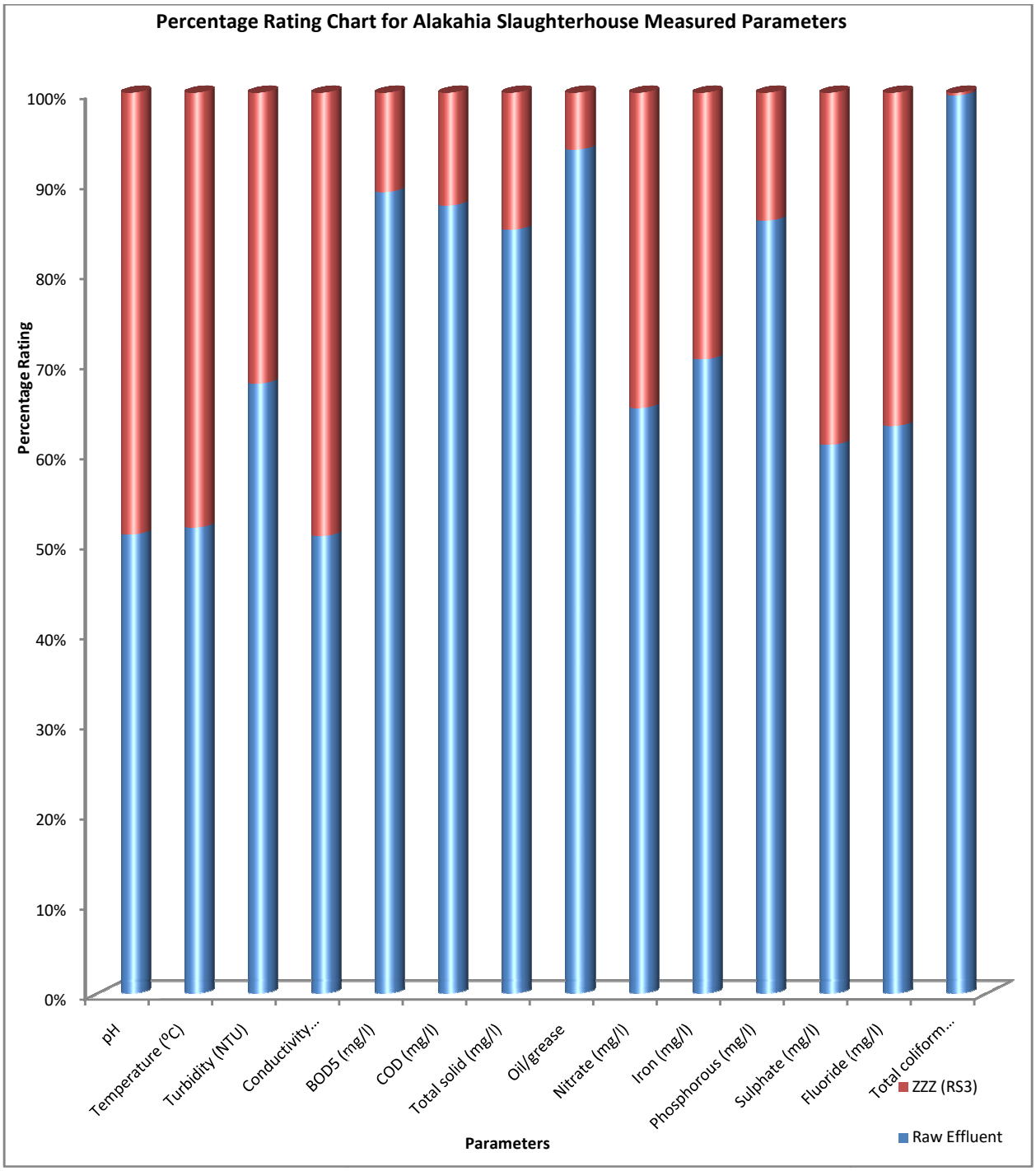

Figure 4: Percentage Rating Chart for Alakahia Slaughterhouse Measured Parameters

Table 2: Results of data set of parameters analysed for wells and boreholes within selected slaughterhouses.

		Hand Dug wells			Bore holes			WHO Standard
Parameters	**Raw Effluent**	**xxx (HDW1)**	**yyy (HDW2)**	**zzz (HDW3)**	**xxx (BH1)**	**yyy (BH2)**	**zzz (BH3)**	
pH	7.58	6.8	6.93	7.11	6.84	7.13	6.72	6.5-8.5
Temperature (ºC)	26.23	23.4	24	23.5	22.5	23	24	
Turbidity (NTU)	631	0.92	0.83	1.2	0.09	0.07	0.02	0.1
Total solid (mg/l)	5748	104	110	148	67	49	56	1000
Conductivity (µS/cm)	179.45	93	74	69	142	196	155	1200
COD (mg/l)	18230	13.4	17.25	11.45	6.3	5.7	4.9	NG
Oil/grease	258	0.32	ND	ND	ND	ND	ND	NG
BOD_5 (mg/l)	11101	7.9	6.9	8.4	3.6	4.01	3.76	20
Nitrate (mg/l)	701	85	73	92	26.2	16	15.7	50
Iron (mg/l)	39	10.5	7.2	6.6	0.7	0.53	0.89	0.3
Phosphorous (mg/l)	62.4	6.4	8.2	7.44	2.63	3.01	2.42	1
Sulphate (mg/l)	1100	256	192	218	157	116	168.3	450
Fluoride (mg/l)	24.7	10.12	3.24	4.34	1.63	3.2	3.82	2
Total coliform (cfu/100l)	1860000	63	34	56	3	0	0	0

3.2 Result analysis for t-test and z-test

The present study showed that continuous discharge of slaughter house on land increases the level of nutrient and contaminant build-up in the soil. Z-test analysis was carried out to determine the significance of slaughter house waste discharge on open lands. 5% level of significance was used for a two tailed test comparing “significant” and “insignificant” parameters. The null and alternative hypothesis was taken for the mean values of sampled depths for each slaughter house considered. At a 0.05 level of confidence, the decision is that if z and t observed is greater than ± 1.96 (see table 4for critical value of z), the results are significant at the 0.05 level and H0 is rejected, otherwise, H0 is accepted. The results obtained from the z-test and t-test carried out using mean values of the sampled depths and summary of the analysis is shown in Table 4. The results obtained indicate that the level of nutrient build-up are significant in the slaughter houses as all the values obtained are higher than the critical value of z at 5% level of significance which is ±1.96 and as such, the null hypothesis, H0 is rejected.

4. CONCLUSION

From the result obtained therefore, it is revealed that effluent generated from the slaughterhouse is highly polluted and have a detrimental effect on the stream water in which it is being disposed into without any form of treatment.

It should be noted that due to urbanization there would always be increase in population which would in turn increase consumption of meat, therefore, good information on the slaughterhouse waste will go a long way to estimate possible problems and proffer suggestion on how to curb the menace created by abattoir wastes.

The physico-chemical parameters showed the negative impact of the abattoir effluent on the stream thus rendering the water of worthless value to humans. Furthermore, the abattoir urgently needs an effluent treatment facility to be installed to reduce the health hazard its effluent poses on the abattoir users and users of the streams receiving the effluent. Swift intervention by the government and other stakeholders by putting in place effluent treatment facilities to treat wastes from abattoirs in Port Harcourt as well as adoption of cleaner technologies will go a long way to curb the environmental health risks posed by these hazardous effluents from abattoirs. Hence, we recommend the use of a Sequencing Batch Reactor (SBR) and composting for the immediate treatment of recovered wastewater and solid wastes from abattoirs before disposal to receiving water bodies and lands respectively. The SBR and composting treatment process are flexible and economical as these treatment functions are carried out in a time sequence rather than in the conventional space sequence of continuous-flow systems.

REFERENCES

1. Ediene V. F; Iren O. B and Idiong M.M. (2016): Effects of slaughterhouse effluent on the physicochemical properties of surrounding soils in Calabar Metropolis. Int J Adv Res;4:37-41.
2. Ubwa, S.T., Atoo, G. H., Offem, J. O., Abah, J. and Asemave, K. (2013); Effect of activities at the Gboko slaughterhouse on some physical properties and heavy metals levels of surrounding soil. Int J Chemist. 5:49-57.
3. Osu C. I and Okereke V. C. (2015); Heavy metal accumulation from slaughterhouse wastes on soils and some edible vegetables in selected areas in Umuahia metropolis. Int J Curr Microbial Appl Sci;4:1127-1132.
4. Mohammed S. and Musa J. J. (2012). Impact of Slaughterhouse Effluent on River Landzu, Bida, Nigeria. J. Chem. Biol. Phys. Sci. 2(1), 132-136.
5. Leung, P. O. (2015). Distribution and Seasonality of Microbial indicators of pollution In Subin an Urban River in Kumasi, Ghana MSC Thesis Kwame Nkrumah University of Science and technology. Kumasi Ghana.
6. Charles and Kennedy (2013). Management Of hazardous waste in Croatia Waste management 28, 1049-1056.
7. Akinnibosun F. I and Ayejuyoni T. P. (2015): Assessment of microbial population and physico-chemical properties of slaughterhouse effluent-contaminated soils in Benin City, Nigeria. Journal of Tropical Agricult Food Environ Exten;14:1-6.
8. Abubakar G. A. and Tukur A. (2014): Impact of slaughterhouse effluent on soil chemical properties in Yola, Adamawa State, Nigeria. Int J Sustain Agricult Res;1:100-107.
9. Kalu, P; Eke, U and Ehiodo, C.C. (2010). Contemporary studies of local government administration in Nigeria. Aba: Cheedul global prints Ltd.
10. APHA, (1998). Standard Methods for the Examination of Water and Wastewater. 20th Edn., American Public Health Association, Washington DC.
11. Ogbebor D.; Ugbebor N. J; Momoh O. L. Y. and Ndekwu B. O. (2021): “Land Pollution Assessment from Slaughterhouses Waste Discharge in Port Harcourt”. Journal of Engineering Research and Reports 21(6): 10-28, 2582-2926 (19 pages).
12. Ogbebor D, Ugbebor NJ, Momoh OLY, Ndekwu BO. Modelling of soil profile pollutant yield on slaughterhouse wastes deposited land. J Eng Res Rep. 2021;21(8):16-29, 2582-926.