American Journal of Engineering Research (AJER) 2016
American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-5, Issue-3, pp-64-69
www.ajer.org
Research Paper Open Access

Assessment of Physicochemical Parameters and Heavy Metals inGombe Abattoir Wastewater

Nasiru A[1], Osakwe C.E[1], Lawal I.M[2] andChinade A.U.[2]
[1](*Department of Civil Engineering, ModibboAdama University of Technology Yola, Adamawa state, Nigeria)*
[2](*Department of Civil Engineering, Abubakar Tafawa Balewa University, Bauchi, Bauchi state, Nigeria)*

ABSTRACT : *The physical parameters pH and Temperature of Gombe abattoir wastewater sample of 6.5 and 27.6^{o}C respectively were within the WHO/USEPA discharge limits while turbidity, TSS, Conductivity and TDS with mean values of 1100NTU, 5600mg/L, 59mS/c and 38.5g/L respectively were also above the WHO/USEPA limits. For chemical parameters, concentration level of Nitrates (1034mg/L), Nitrogen (234mg/L), Ammonia (285mg/L), Ammonium (301mg/L), phosphate (163mg/L), phosphorus (53mg/L), and phosphorus-pentoxide (122mg/L) in thewastewater sample were above WHO/USEPA limits, only sulfate (44mg/L) that is below the WHO/USEPA limit of 250mg/L. The COD and BOD_5 values of 3539mg/L and 635mg/L respectively were also above the WHO/USEPA limits, Dissolved oxygen (DO) mean values of 2.3mg/L was below requirement of WHO/USEPA limits for the discharged of wastewater into river. The concentration of heavy metals in Gombe Abattoir wastewater sample determines are Copper (0.01ppm), Manganese (0.30ppm), Magnesium (9.60ppm), iron (0.20ppm), Chromium (0.01ppm), Cadmium (0.00ppm), Nickel (0.06ppm), and Lead (0.01ppm) were within the WHO/USEPA recommended standard limits, except the concentration of Zinc (0.26ppm) that was above the WHO/USEPA recommended limits of 0.10ppm, abattoir wastewater requires pretreatment before discharging into environment and more research should be conducted to reduce the abattoir wastewater concentration and its effect on the immediate environment.*

Keywords *–Abattoir, heavy metals, limits, pretreatment, wastewater*

I. INTRODUCTION

An abattoir is a special facility designed and licensed for receiving, holding, slaughtering and inspecting animal's meat and meat products before release to the public [1]. Abattoir waste generated as the result of abattoir operations is one of the greatest general environmental threat, this is because they actually pollute all phases of the environment namely land, water and air. Wastes emanating from slaughtered animals are basically in solid and liquid states. However, the gases and the odor emitted from putrefying wastes become very offensive to the nostrils, and can sometimes be source of localized air pollution.Almost each day, in all the urban and rural towns in Nigeria, animals are slaughtered and waste are generated in each day of the week, the meat and other extracts from the animals are made available to the public for consumption and the abattoir wastes originate from killing; hide removal or de-hairing, paunch handling, rendering, trimming, processing and clean-up operations in the abattoir.Fresh Abattoir wastewater is mainly composed of diluted blood, fat and suspended solids.

Generally, fresh abattoir effluent has been shown to contain solids, minerals, metals, and micro-organisms and to exert oxygen demand. On the other hand, aged and decomposing abattoir effluent is often malodorous [2].In a study conducted by [3] on five abattoirs in Ibadan, it shown that pH levels were within acceptable range, all other standards were found to be in excess of 2000mg/L, suspended solids were between 590 to 1050 times the acceptable limits and phosphate levels ranged from 115-175 mg/L. Nitrate levels were not as extreme but all the sites were within six times the general discharge standard of 20mg/L.Comparatively, in a study conducted on some abattoirs by [4] in Quebec, Canada, the COD and TS was found to be between 2333-8620mg/L; SS was between 736-2099mg/L, Nitrogen and Phosphorus were 6.0 and 2.3g/L of COD. The COD of fresh blood that is universally put at 375,000mg/L was compared to the COD of manure put at 15,000-30,000 mg/L.It was established that abattoir effluents increase Nitrogen, phosphorus, solid and BOD levels of the receiving water body, potentially leading to eutrophication. Pathogens from cattle waste can also be transmitted to humans who are in contact with the water body [5].

Wrongful and unlawful discharge of blood and animal faeces into streams and rivers may cause oxygen-depletion as well as nutrient-over enrichment of the receiving system which could cause increased rate of toxin accumulation [6]. Humans may also be affected through outbreak of water borne diseases and some researchers point out that abattoir activities are responsible for the pollution of surface and underground waters as well as air quality which directly or indirectly affect the health of residents living within the vicinity of abattoirs ([7]; [8]; [9]). In addition, primary producers in affected water bodies may be destroyed by such pollutants, which may directly affect the aquatic ecosystem, with serious consequences on diet [10].

Gombe abattoir is situated in Gombe town, behind kasuwarkatako along AYU/TRIACTA quarry sites, BCJ area of Gombe local Government in Gombe state, Nigeria. With a total catchments area of about 52 km^2 (20 square mile), it lays between latitude 100 17'23N and longitudes 11010'2E at an altitude of about 508m (1669 feet) above sea level. Animals (cows, goats, sheep, and camels) are slaughtered daily throughout the year. The wastewater generated flows directly into a stream behind the abattoir without treatments. Most of the activities of this Abattoir remain unregulated, due to this the present study therefore aimed at assessing the Abattoir wastewater samples from Gombe abattoir for physical and chemical parameters and the presence of Cu, Zn, Mn, Mg, Fe, Cr, Cd, Ni, and Pb in the abattoir wastewater. Data obtained could be important in providing basics for future wastewater management practices in the Abattoir and its impact to the immediate environment.

II. METHODS AND MATERIALS

2.1SAMPLE AREA AND COLLECTION

The abattoir wastewater sample was collected from the abattoir drainages in Gombe metropolis main abattoir building. Numbers of animals (cows, goats, sheep, and camels) are slaughter in this abattoir. Abattoir wastewater sample was collected using grab/composite sampling where the sample was collected directed at the main drainage channels within the main abattoir building, the wastewater was collected in a 20 liters plastic container previously cleaned by washing with non-ionic detergent, rinsed with tap water and finally rinsed with deionized water prior to usage. During sampling, the sample container was rinsed with sample wastewater three times and then filled to the brim by grabbing about four liters at each different five points within the drainage channel and was later mixed thoroughly to obtained a composite sample of that wastewater. The sample was labeled and transported to the sanitary laboratory, Abubakar Tafawa Balewa University, Bauchi within 2hours at about 4^OC (kept in a cooler covered with ice water) prior to analysis under safe conditions in accordance with [11], on Sampling for water Quality.

The time in which the sample was collected from the abattoir wastewater was around 6:00am to 8:30am when the slaughtering activity is at its peak and when the effect of sun could not alter the chemistry of the wastewater. Samples were collected from the month of June to November 2015.



Plate 1: Abattoir Operations at Gombe Abattoir
Plate 2: Conducting Parameters Analysis of Abattoir Wastewater UsingDR/890 Colorimeter
Plate 3: Conducting Titration for COD Determination of Abattoir Wastewater

2.2 DETERMINATION OF PHYSICAL AND CHEMICAL PARAMETERS

pH and Temperature were determined using Labtech Digital pH meter and compare with another pH meter MODEL PHB-4 pH meter serial no. 600910099001 for accuracy; while the levels of total dissolved solid (TDS) and electrical conductivity of abattoir wastewater were determined using a 430 pH/conductivity meter

JENWAY, serial No. 20051, (part No. 430-201, made in PRC). Dissolved oxygen was determine in this research by using dissolved oxygen meter HANNA HI 9146 serial no. 08689921 by Hanna® Instrument
For the determination of total suspended solid (TSS), 100ml of the wastewater samples were filtered through a pre weighed filtered paper. The filtered papers used was whatman®110mmØ by whatman international LTD Maidstone, England with serial no. *+H71810011101-*, the filter paper was then dried at 103-105^{O}C. TSS was determined by using the following formula [12]:

$$TSS\ \left(\frac{mg}{l}\right) = \left(\frac{(final\ \ weig\,ht - initial\ \ weig\,ht)}{amount\ \ of\ sample\ \ taken}\right) * 1000 \qquad (2.1)$$

Nitrate, total nitrogen, ammonium and ammonia were determined using cadmium reduction method 8039 ([13] and [14]), by using powder pillows Nitraver®5Nitrate reagent CAT NO. 2106169, Sulfate was determined by using Sulfa Ver methods 8051 ([13] and [14]). USEPA accepted for reporting wastewater analysis by using powder pillows sulfaver®4sulfate reagent CAT NO. 21067-69, Phosphate,phosphorus and phosphorus-pentoxide were determined by using orthophosphate phosVer 3 (Ascorbic Acid) Method 8048 (Powder Pillows) ([13] and [14])). USEPA accepted for reporting wastewater analysis by using powder pillows phosver®3phosphate reagent CAT NO. 2106069 and Turbidity was estimated using absorptometric method 8237 ([13] and [14]). USEPA accepted for reporting wastewater analysis, the Nitrate, Sulfate, Phosphate and Turbidity were all determined using various methods with a DR/890 colorimeter of serial no. 130290694066, produced by Hach company world headquarters, Loveland, USA.

Titrimetric method is used in the determination chemical oxygen demand (COD) and Biochemical oxygen demand (BOD_5) was determined by using the United States environmental protection agency (USEPA) standard method: The test was done in accordance with [15].

2.3 DETERMINATION OF HEAVY METALS IN ABATTOIR WASTEWATER SAMPLES

Determination of Cu, Zn, Mn, Mg, Fe, Cr, Cd, Ni, and Pb were made directly on each final solution using MODEL 210VGP Atomic Absorption Spectrophotometer (AAS).
The samples (100ml) were transferred into a beaker and 1.6ml concentrated (HNO_3) nitric acid was added. The beaker wall and watch glass were washed with distilled water and the samples were filtered using whatman®110mmØ by whatman international LTD Maidstone, England with serial no. +H71810011101-* to remove some insoluble materials that could clog the atomizer. A blank sample was digested to allow a blank correction to be made. This was done by transferring 100ml of deionized water into a beaker and digested with 1ml of concentrated (HNO_3) nitric acid.

III. RESULTS AND DISCUSSIONS

3.1 THE ABATTOIR PHYSICOCHEMICAL PARAMETERS

The pH of the Gombe abattoir wastewater sample from Table 1, pH values ranging from 6.5-7.0 obtained at 27.6^{o}C. pH is the measure of acidity and alkalinity of water. However, the mean pH level of 6.5 iswithin the WHO/USEPA tolerance limits for the discharged of wastewater from all industries into a river. [16], [17].
The mean conductivity level in the abattoir wastewater sample was found to be 59mS/cm from Table 1; therefore the electrical conductivity of the Gombe abattoir wastewater sample is above WHO tolerance limits of 1mS/cm. Similarly, the mean turbidity value was 1100 NTU which was higher than the WHO/USEPA guideline of 5 NTU for the discharged of wastewater into river or stream.
The mean concentration of TDS in the abattoir wastewater sample was found to be 38.5g/L and was above WHO/USEPA limits of 2000mg/L (2g/L) and the mean TSS of 5600mg/L is however above the WHO/USEPA limits of 20mg/L.
The level of Nitrates in Gombe abattoir wastewater sample was observed to be 1034mg/L which is above 45mg/L discharge limits of WHO/USEPA, while that of Nitrogen, Ammonia and Ammonium were 234mg/L, 285mg/L and 301mg/L respectivelywhichare also above the WHO/USEPA limits of 100mg/L, 5mg/L and 35mg/L respectively for the discharged of wastewater into river.
The mean concentration of phosphate in the abattoir wastewater obtained is 163mg/L which is above the WHO/USEPA limits of 5mg/L. The phosphorus P, and phosphorus-pentoxide P205 of the abattoir wastewaters are 53mg/L and 122mg/L respectively for the discharged of wastewater into river, the levels of nitrate observed in this study in addition to phosphate levels can cause eutrophication and may pose a problem if discharged into river or stream.

The mean sulfate level of 44mg/Lisbelow the WHO/USEPA limits of 250mg/L. Dissolved oxygen (DO) values obtained from the abattoir wastewater ranged between 1.2-3.8 mg/L. DO is a measure of the degree of pollution or waste loadings by organic matters, the standard for sustaining aquatic life is stipulated at 5mg/L a concentration below this value adversely affects aquatic biological life in the water, while concentration below

2mg/L may lead to death for most Aquatic life [18]. The mean DO value of 2.3mg/L was below the WHO and USEPA permissible limit of 4mg/L and 5mg/L respectively for the discharged of wastewater from industries into river.

From the results findings of this research, the abattoir wastewater COD mean values obtained was 3539mg/L and is higher than WHO/USEPA recommended standard limits of 1000mg/L for the discharged of wastewater into surface water respectively. More so, for BOD_5, thus the mean BOD_5 of the abattoir wastewater sample was averagely 638mg/L and is higher than WHO/USEPA recommended standard limits of 20mg/L for the discharged of wastewater into surface water respectively.

Table 1: Physicochemical Parameters of Gombe Abattoir Wastewater compared to WHO/USEPA Limit

Parameter	Mean Value	WHO-USEPA limits	Remark
pH	6.5	6.5 - 9.5	Met Standard
Temperature (^oC)	27.6	< 40	Met Standard
Conductivity (mS/cm)	59	1	Above Limits
TDS (g/L)	38.5	2	Above Limits
TSS (mg/L)	5600	20	Above Limits
Turbidity (NTU)	1100	5	Above Limits
N (mg/L)	234	100	Above Limits
NO_3 (mg/L)	1034	45	Above Limits
NH_3 (mg/L)	285	5	Above Limits
NH_4 (mg/L)	301	35	Above Limits
P (mg/L)	53	NA	-
P_2O_5 (mg/L)	122	NA	-
PO_4 (mg/L)	163	5	Above Limits
SO_4^{2-} (mg/L)	44	250	Met Standard
COD (mg/L)	3539	1000	Above Limits
BOD_5 (mg/L)	638	20	Above Limits
DO (mg/L)	2.3	4	

3.2 DETERMINATION OF HEAVY METALS IN ABATTOIR WASTEWATER

The heavy metals presences in Gombe abattoir wastewater determines are Copper (Cu), Zinc (Zn), Manganese (Mn), Magnesium (Mg), iron (Fe), Chromium (Cr), Cadmium (Cd), Nickel (Ni), and Lead (Pb) and the heavy metal value for each metal is presented in fig. 1.

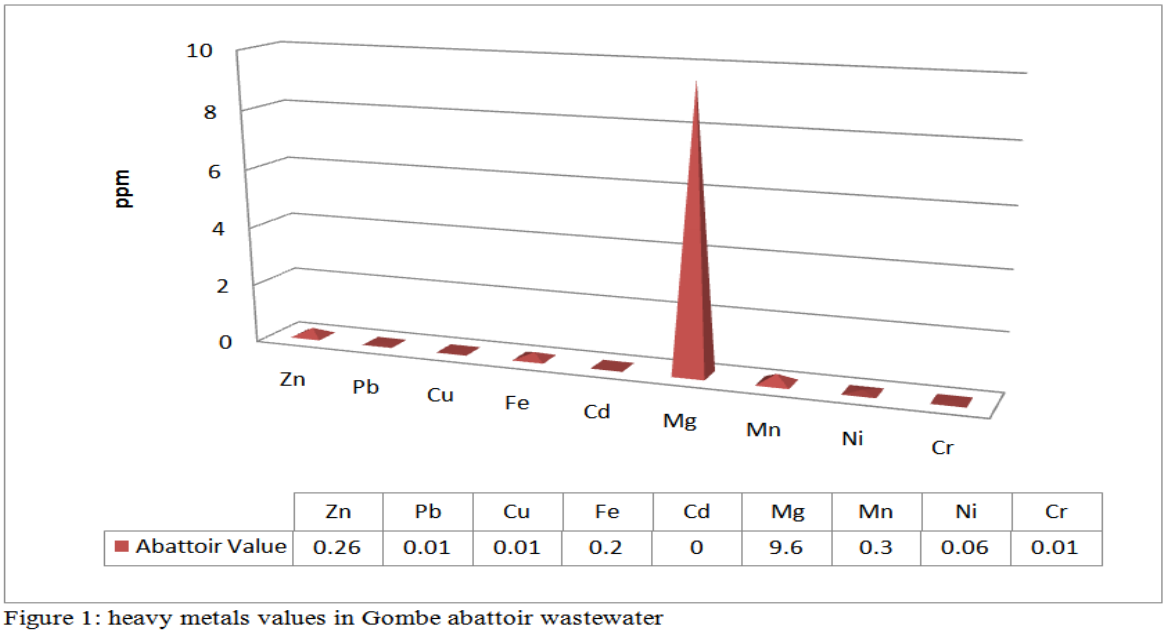

Figure 1: heavy metals values in Gombe abattoir wastewater

In the area of environmental pollution, there are few subjects that, during the latest years, have developed as rapidly as the study and research on toxic metals [19]. According to the World Health Organization (WHO), the metals of most immediate concern are Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, Hg and Pb. It is apparent that the presence of a toxic metal may not represent a hazard if a threshold contents is below which there are no observable effects. It should be understood that some heavy metals, including Al, Cu, Cd, Fe, Pb, Mn and Ni are essential/beneficial or harmful in trace quantities [20].

Table 2: Heavy Metals in Abattoir wastewater compared to standard

Heavy metals	Abattoir Value	WHO-USEPA limits	REMARK
Zn	0.26	0.10	Above standard
Pb	0.01	0.10	Met Standard
Cu	0.01	0.05	Met Standard
Fe	0.20	0.30	Met Standard
Cd	0.00	0.003	Met Standard
Mg	9.60	N.A	Met Standard
Mn	0.30	0.40	Met Standard
Ni	0.06	0.10	Met Standard
Cr	0.01	0.10	Met Standard

The concentration of heavy metals in Abattoir wastewater sample is as presented in Table 2 which averagely shows that the levels of Pb, Cu, Cd, Mg, Mn, Ni and Cr were within the WHO/USEPA recommended standard limits. The concentrated level of Zn was found to be highly concentrated in the abattoir wastewater above the WHO/USEPA recommended standard limits of 0.1mg/L

IV. CONCLUSIONS

The physical parameters pH and Temperature of Gombe abattoir wastewater sample were within the WHO/USEPA tolerance discharge limits while turbidity, TSS, Conductivity and TDS were above the WHO/USEPA tolerance limits. For chemical parameters, concentration level of Nitrates (NO_3), Nitrogen (N), Ammonia (NH_3), Ammonium (NH_4), phosphate (PO_4), phosphorus (P), and phosphorus-pentoxide (P_20_5) in the abattoir wastewater sample were above the WHO/USEPA tolerance limits for the discharged of wastewater into a river, only the concentrations of sulfate content that met the WHO/USEPA limits. The COD and BOD_5 values are also above the WHO/USEPA limits, Dissolved oxygen (DO) values obtained from the abattoir wastewater with mean value of 2.3mg/L which was below WHO/USEPA limits for the discharged of wastewater from industries into river, therefore it can be concluded that most of the physicochemical parameters of Gombe abattoir wastewater had not met the tolerance discharge limits and hence it requires pretreatment before discharging into the environment as it might cause eutrophication; deflection of oxygen in the stream and hence affect the aquatic ecosystem. The concentration of heavy metals in Gombe Abattoir wastewater sample determines are Copper (Cu), Zinc (Zn), Manganese (Mn), Magnesium (Mg), iron (Fe), Chromium (Cr), Cadmium (Cd), Nickel (Ni), and Lead (Pb) were within the WHO/USEPA recommended standard limits, except the concentration level of Zn that was found to have the higher concentration in the abattoir wastewater of 0.26 above the WHO/USEPA recommended standard limits of 0.10.

Therefore, this research will provide basics knowledge in field of abattoir waste management by providing basic data of the physicochemical parameters and heavy metals presence in abattoir wastewater and hence more research should be conducted on how to reduce the abattoir wastewater concentration and its effect on the immediate environment.

REFERENCES

[1] D.O. Alonge, *Meat and Milk Hygiene in the Tropics* (Farmose Press, Ibadan, Nigeria, 2005)
[2] S.L. Ezeoha, *Pollution and Biogas Production Potentials of Abattoir Wastes*, Masters's diss., University of Nigeria, Nsukka, Nigeria, 2000
[3] A.Y. Sangodoyin, and O.M. Agbawe, Environmental Study on Surface and Groundwater Pollutants from Abattoir Effluents, *Bio resource Technology, 41(2),* 1992, 193-200.
[4] G.S. Mittal, Characteristic of the Effluent Wastewater from Abattoirs for Land Application. *Journal of Food Reviews International, Taylor and Francis group. 20(3),* 2004, 229-256.
[5] FEPA, *Strategic Options for the Redressing of Industrial Pollution*, Volume 2, Nigeria 1995.

[6] M.I. Nwachukwu., S.B. Akinde., O.S. Udujih, and I.O. Nwachukwu, Effect of Abattoir Wastes on the Population of Proteolytic and Lipolytic Bacteria in a Recipient Water Body (Otamiri River), *Global Resources Journal of Science, 1*, 2011, 40-42.
[7] C.L. Raymond, *Pollution Control for Agriculture* (Academic Press Inc, New York, 1977).
[8] R.C. Patra., D. Swarup., R. Naresh., P. Kumar., D. Nandi., P. Shekhar., S. Roy, and S.L. Ali, Tail Hair as an Indicator of Environmental Exposure of Cows to Lead and Cadmium in Different Industrial Areas. *Ecotoxicology Environmental Safety, 66*, 2007, 127-131.
[9] S.A. Odoemelan. and O. Ajunwa, Heavy Metal Status and Physicochemical Properties of Agricultural Soil Amended by Short term Application of Animal Manure, *Journal of Chemical Society. Niger, 20*, 2008, 60-63.
[10] E.O.A. Aina, and N.O. Adedipe, *Water Quality Monitoring and Environmental Status in Nigeria* (FEPA Monograph, Lagos, 1991) 12-59.
[11] Canadian Government, Ministry of Supply and Services, *Sampling for water Quality*, Environment Canada, 1983
[12] R. Anon, *Standard Methods of Water and Wastewater Examination*, (American Public Health Association, Washington, DC. 18, 1992, 2-172)
[13] American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, (American Public Health Association, America Water Works Association and Water Pollution Control Federation, Washington, DC. 14, 1976, 68-165)
[14] DWAF. *Analytical Methods Manual. TR 151*, (Department of Water Affairs and Forestry, Pretoria, South Africa, 1992)
[15] G.C. Delzer, and S.W. McKenzie, *Five-Day Biochemical Oxygen Demand*. (3rd Edition, USGS Twri Book 9–A7, 2003)
[16] World Bank. *Nigeria, Strategic Options for Redressing Industrial Pollution* (Industry and Energy Operations Division, West Africa Department of World Bank, 11, 1994)
[17] USEPA Volunteer Lake Monitoring A Methods Manual. EPA 440/4-91-002. (Office of Water, U.S Environmental Protection Agency: Washington, DC, 1999)
[18] D. Chapman, *Water Quality Assessment*. (A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring. E&FN Spon: London, UK, 2, 1997).
[19] A.K. Bhattacharya, and C. Venkobachar, Removal of Cadmium (II) by Low Cost Adsorbents, *Journal of Environmental Engineering, 110(1)*, 1984, 110-192.
[20] P.W. Kirk, and J.N. Laster, Significance and Behaviors of Heavy Metals in Wastewater Treatment Processes, *Journal of Science and Total Environment, 40*, 1984 1-44.