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Determination of the Physico-Chemical Characteristics of Effluent Discharged From Karu Abattoir

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ABST RACT

This study was carried out so as to determine the physico-chemical characteristics of the effluent discharged from the karu abattoir indiscriminately. Effluent samples were collected in 1.5 litre plastic bottles and 250ml of glass bottles for the period of six months (wet and dry season). Samples were taken to the laboratory for analysis and the parameters analyzed were pH, temperature, electrical conductivity, TDS, turbidity, TSS, BOD_5, dissolved oxygen, nitrate, phosphate, chloride, iron, lead, zinc, manganese and Oil and grease. Results obtained showed that parameters such as electrical conductivity, TDS, TSS, BOD_5, dissolved oxygen, nitrate, phosphate and oil & grease did not meet the recommended standards given by FEPA (1991) for discharge into surface water. Also the paired sample student t-test analysis revealed that there was no significant difference between the means of both seasons samples analyzed i.e. wet and dry season samples ($t_{calculated}<t_{critical}$). Hence, the effluent generated and discharged from the abattoir could have a detrimental effect on the surface water quality in which it is being disposed into without any form of treatment. Hence, proper collection, channelization, and pre-treatment of effluents discharged from abattoirs should be looked into by authorities' in-charge of the meat processing industries.

Keywords: *Abattoir Effluents, Physico-Chemical Characteristics, Pollution, Water Quality, Abuja*

1. INTRODUCTION

In Nigeria, the development and growth of livestock production has been on the increase and has guaranteed steady supply of food animals meant for slaughter and processing for human consumption as such is being considered a major food for the world's population; however it has been a pollutant contributor to country sites and cities, when the slaughter wastes are not properly managed and discharged into waterways. Such practices could introduce enteric pathogens and excess nutrients into surface water [13]. The pollution potential of meat processing plants has been estimated at over 1 million population equivalent in the Netherlands and 3million in France [21]. An abattoir also known as a slaughter house is a special facility designed and licensed for receiving, holding, slaughtering and inspecting meat animals and meat products before release to the public [4] and has been known all over the world as a pollution contributor to the environment either directly or indirectly [2].

The operations carried out at abattoirs produce solid, liquid and gaseous wastes and these wastes come from stockyards, abattoirs etc.; of which contains fats, blood, gut content, heavy metal antibodies and other substances [7]. Solid wastes from abattoirs is made up of paunch content, bones, horns, faecal components , undigested ingesta slurry of suspended solids while liquid wastes is composed of dissolved solids, blood, water and urine [20]. Due to scarcity of water, abattoirs are generally located near flowing rivers or streams in most developing countries [14], as such effluent from wash operations are indiscriminately discharged into such streams and rivers without any form of treatment which leads to the impairment of water quality. In Nigeria, most rivers bodies across the nation are grossly contaminated by discharge of industrial effluents, agricultural wastes among others [22] as the control of untreated effluent into the environment is still a major problem irrespective of the establishment of the Federal Environmental Agency since 1998 [3].

Abattoir effluent contains high levels of organic matter due to the presence of manure, blood and fat. It was reported that the nature and composition of abattoir effluents are; High organic content, Sufficient organic biological nutrients, Adequate alkalinity, relatively high temperature [20 to 30 ^{0}C] and Free toxic material [12]. A study showed that effluent discharged from Abattoirs had caused the de-oxygenation of water bodies [17]. Abattoir effluents reaching streams contribute significant levels of nitrogen, phosphorous, Biochemical Oxygen Demand (BOD), total solids as well as other nutrients that result in the stream pollution [16]. These nutrients which are in excess, causes the water body in which they are discharged into to be choked with organic substances which reduces stream water physical and chemical qualities, more so pathogens from cattle waste could be transmitted to humans recreating in such streams. The excess nutrient which chokes the water bodies has led to the death of fishes and other organisms present in such water. a study by Raymond reported that animal waste can affect water, land or air qualities if proper practices of management are not adhered to[19].

There is high possibility these effluents discharged are not suitable to be discharged into surface water bodies. This study therefore seeks to determine specific physico-chemical characteristics of Karu abattoir effluent during the wet and dry season and it also evaluates if there exists seasonal variability on the parameters tested.

Study Area

This study was carried out at the Karu abattoir in Abuja one of the satellite towns under the Abuja Municipal Area Council (AMAC) of the Federal Capital Territory, Nigeria. It has an area of about 275km2 and is located about 7km north east of the Federal Capital City (FCC), off the Abuja–Keffi express way. The study area lies between latitudes 8o 59' 38.6"N and 9o 01' 39.6"N and longitudes 7o 33' 17.19"E and 7o 34' 49.61"E as shown in Figure 1 below. Karu is also bordered to the north by Nyanya, to the south by Jikwoyi, to the west by Kugbo and to the east by Mararaba (Nasarawa State). Slaughtering and cleaning operations taking place at the abattoir has led to the generation of effluents which are highly polluting when released indiscriminately into the environment. The effluent is channelled directly into the near-by Tauga stream which is adjacent the abattoir without any form of pre-treatment. Hence, could impair the water quality of the stream thereby rendering it unfit for use by downstream users.

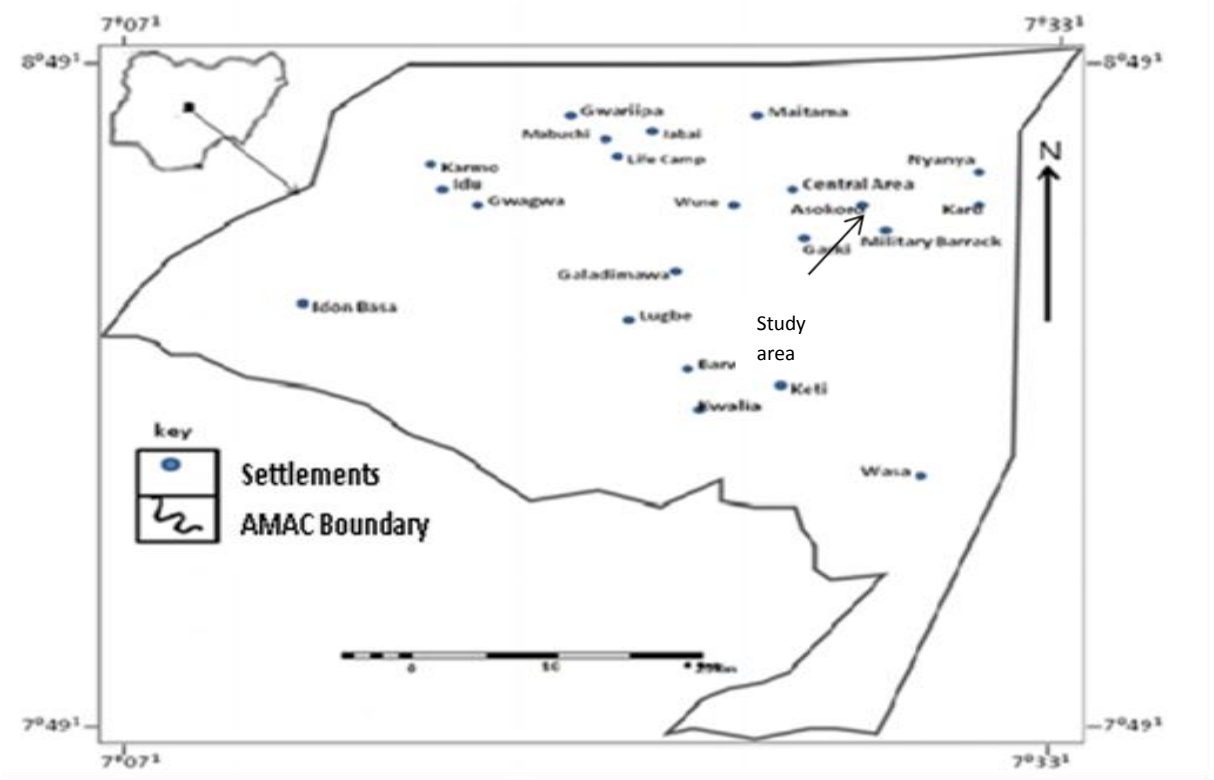

Figure 1: Map of AMAC showing the study area, Abuja, FCT
Source: A.G.I.S. (2011); Makwe & Chup, (2012)

2. MATERIALS AND METHODS

Some materials and equipment's used in carrying out the field operation for data collections are as follows;

i. Ice chest box for preservation of samples collected
ii. 1.5 litre plastic bottles
iii. 250ml Glass bottles
iv. Nitric Acid
v. Glass Thermometer (0-100^{0}C)
vi. pH meter(Hanna electronic meter; H18915ATE)
vii. Dissolved oxygen Probe and
viii. Electrical conductivity meter.

2.1. Study Design & Sample collection

Samples were collected for a period of six months during the rainy and dry season; July – September 2014 (wet season) and November 2014 to January 2015. Effluents samples before discharge into the nearby stream were collected at the end of the drainage discharge channel from the abattoir in 1.5 litre plastic bottles and 250ml glass bottles. Samples were collected once in each month giving a total of six 1.5litre plastics bottles effluent samples and six samples of 250ml of effluent samples collected over the six months period. For the purpose of determining the presence of Oil & Grease in the sample, the use of glass bottles are recommended for the sample collection. The plastic bottles were first rinsed with dilute nitric acid followed by distilled water and then air dried after which they were rinsed two times with the sample to be collected. The glass bottles were not rinsed with the sample

water collected. Samples were collected at around 7.30am as this was when slaughtering and washing operation was at its peak. The samples were then labelled with the date and time of collection. After which, it was taken to the laboratory for water quality analysis.

2.2. Laboratory Analysis

Standard laboratory reagents and apparatus were used to analyse the effluent samples into physical and chemical parameters. The physico-chemical characteristics of the effluents determined in the lab were investigated using standard methods given by APHA, (1995). Parameters tested insitu were pH, Temperature, Electrical conductivity, and Dissolved Oxygen (DO) whereas those determined in the laboratory were as follows; TDS, Turbidity, TSS, $BOD_{5,}$ Nitrate, Phosphate, Chloride, Iron, Lead, Zinc, Manganese and Oil & Grease.

2.3. Data Analysis

The results obtained were analysed using tables; Student paired t-test and compared with FEPA (1991) interim guidelines and standards for industrial effluent. Analysis of results was carried out using SPSS V17 software package.

3. RESULTS AND DISCUSSION

The results for the mean values of the physico-chemical parameters tested for both wet and dry seasons samples are shown in table 1 below.

Table 1: Physico-Chemical Characteristics of Wet and Dry Season Effluent Samples

S/No.	Parameters	Wet season Mean	Dry season Mean	FEPA (1991) Limits
1	pH	6.88	6.75	6 to 9
2	Tempt. (oC)	26.60	29.17	<40
3	Conductivity (uS/cm)	3352.00	4007.70	1000
4	TDS (mg/l)	2114.27	2507.93	2000
5	Turbidity (NTU)	70.47	63.20	NG
6	TSS (mg/l)	2690.67	2133.33	30
7	BOD5 (mg/l)	2466.67	2602.33	50
8	Dissolved Oxygen DO (mg/l)	1.81	1.69	7.5
9	Nitrate (mg/l)	216.33	252.00	20
10	Phosphate (mg/l)	6.86	6.43	5
11	Chloride (mg/l)	86.10	86.47	600
12	Iron (mg/l)	3.77	4.07	20
13	Lead (mg/l)	0.33	0.41	<1
14	Zinc (mg/l)	0.52	0.64	<1
15	Manganese (mg/l)	0.36	0.41	5
16	Oil and Grease (mg/l)	142.77	146.50	10

Note: mg/l= milligram/litre, 0C= degree Celsius, uS/cm= micro siemes / centimetre

The pH is a measure of acidity or alkalinity of water. The pH mean of the abattoir effluent for the wet season was 6.88 and whereas during the dry season mean value of pH was 6.75. When compared with FEPA (1991) standard limit of 6 to 9 for discharge of wastewater from all industries, the pH of the effluent fell with the standard recommended. The temperature mean values of the effluent during the wet season were 26.6^{0}C and 29.17 ^{0}C during the dry season. The highest temperature mean (29.17^{0}C) coincided with the dry season as heat from the sunlight is higher during the dry season which increase ambient air temperature and subsequently could lead to increase of the effluent temperature [9] and also the hot water used in the cleaning operation could also be a reason for the high temperature in the month. The abattoir effluent temperature fell within FEPA recommended limit of <40^{0}C. Electrical conductivity mean for the abattoir effluent varied between 3352uS/cm during the wet season and 4007.7 uS/cm during the dry season. The electrical conductivity value was far higher than FEPA (1991) tolerance limit 1000uS/cm. The high conductivity value could be attributed to salts present in the animal wastes and gut contents washed off and salts used to preserve the hides of the slaughter animals.

The Total Dissolved Solids (TDS) mean values for the abattoir effluent varied from 2114.27mg/l in the wet season and 2507.93mg/l during the dry season. The values were above FEPA (1991) limit of 2000mg/l. The impact of dissolved solids in water is it produces aesthetically displeasing odour, tastes and colour. Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended materials in water [18]. Turbidity mean values varied between 70.47 NTU during the wet season to 63.20 NTU during the dry season. Turbidity of the abattoir effluent could be as a result of suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter and other microscopic organisms present in the effluent.

Total Suspended Solids (TSS) in water may consist of inorganic or organic particles [18]. The TSS means during the wet and dry season varied between 2690.83mg/l and 2133.33 mg/l respectively which were far above FEPA (1991) recommended values of 30mg/l. This could be due to the fact that lesser water was used for washing animal carcass and also due to lack of sedimentation facility in the abattoir to separate solid wastes from liquid waste before the effluent is discharged. Biochemical Oxygen Demand (BOD_5) is a measure of the amount of biologically and/or chemically degradable organic material that is present in the water. A high BOD result shows low levels of dissolved oxygen in water, hence such would be said to be grossly polluted. The mean value for both wet and dry season of the effluent was gotten to be 2466.67mg/l during the wet season and 2602.33mg/l during the dry season. The BOD_5 values were far above the limit set by FEPA as 50mg/l and not suitable for direct discharge into water bodies.

Dissolved Oxygen (DO) the mean values for both wet and dry season was 1.81mg/l and 1.69mg/l respectively and was far below FEPA (1991) tolerance limit of 7.5mg/l. Lower DO values are often associated with increases in TSS, TDS, and BOD [15].Nitrates mean values for both wet and dry season was gotten as 216.33mg/l and 252mg/l respectively. These values were far above the stipulated limit given by FEPA of 20mg/l. The reason for the high nitrate value could be accorded to the high volume of animal waste (blood, gut content, furs etc.) in the effluent. Phosphates mean values of the abattoir effluent for both the wet and dry season were 6.86mg/l and 6.43mg/l respectively and were above FEPA limit of 5mg/l for discharge into surface water. The reason for such high values could be that much detergent was used to wash the roasted carcass before being discharged. Chloride mean values for the abattoir effluent for both wet and dry season were gotten as 86.1mg/l and 86.47mg/l respectively and were observed to be within the limit given by FEPA as 600mg/l. Chloride sources could be soluble salts (NaCl and KCl) from blood discharged into the effluent; salt used in skin processing [10]. Chloride also increases the electrical conductivity of water.

Iron, lead, manganese and zinc are classified as heavy metals. The iron values were acceptable as it did not exceed FEPA limit of 20mg/l. The mean iron values for wet and dry season were 3.77mg/l and 4.07mg/l respectively. Lead values fell within FEPA limit of <1mg/l as mean lead values for the wet and dry season were 0.33mg/l and 0.41mg/l respectively. Zinc values fell FEPA limit of <1mg/l. The mean zinc values for wet and dry season were 0.52mg/l and 0.64mg/l respectively and Manganese values did not exceed FEPA limit of 5mg/l as the mean manganese values for wet and dry season were 0.36mg/l and 0.41mg/l respectively. Oil & Grease mean values were above FEPA limit of 10mg/l as the mean values for wet and dry season were 142.77mg/l and 146.50mg/l respectively. High values gotten could be attributed to blood released during slaughter operations as it is found to have high concentration of oils [8].

Paired sample student t-test was carried out to determine if there was seasonal variability between the two study seasons parameters tested and results computed in table 2 revealed there was no statistical significant difference seasonally between the wet and dry season mean values in the sixteen physico-chemical parameters tested on the effluents discharged from the abattoir ($t_{calculated}<t_{critical}$) and most of the parameter such as conductivity, dissolved oxygen, TDS, TSS, BOD_5, nitrate, lead, phosphate and oil & grease had their values not meeting the recommended standards by FEPA (1991) for discharge into surface waters and according to [6], indiscriminate disposal of untreated abattoir effluent could lead to increases salinity of the soil, groundwater pollution and disease outbreak.

Table 2: Paired Sample T-Test for Difference in Concentration between the Wet and Dry Season Abattoir Effluent Characteristics

S/No	Parameters	Pair	Mean±Std. Error	N	df	$t_{calulated}$	$t_{Critical}$	Remarks
1	pH	Wet Season Dry season	6.88±0.28 6.75±0.03	3 3	2	0.73	4.30	NS
2	Tempt. (oC)	Wet Season Dry season	26.6±0.21 29.17±0.44	3 3	2	0.05	4.30	NS
3	Conductivity (uS/cm)	Wet Season Dry season	3352±2.51 4007.7±5.68	3 3	2	0.00	4.30	NS
4	Turbidity (NTU)	Wet Season Dry season	70.47±9.99 63.20±6.30	3 3	2	0.25	4.30	NS
5	TDS (mg/l)	Wet Season Dry season	2114.27±63.98 2507.93±203.83	3 3	2	0.67	4.30	NS
6	TSS (mg/l)	Wet Season Dry season	2690.83±17.69 2133.33±296.11	3 3	2	0.19	4.30	NS
7	BOD_5 (mg/l)	Wet Season Dry season	2466.67±101.38 2602.33±51.2	3 3	2	0.46	4.30	NS
8	DO (mg/l)	Wet Season Dry season	1.81±0.30 1.69±0.42	3 3	2	0.88	4.30	NS
9	Nitrate (mg/l)	Wet Season Dry season	216.33±4.67 252±29.28	3 3	2	0.37	4.30	NS
10	Phosphate (mg/l)	Wet Season Dry season	6.86±0.44 6.43±0.23	3 3	2	0.58	4.30	NS
11	Chloride (mg/l)	Wet Season Dry season	86.1±5.96 86.47±3.17	3 3	2	0.97	4.30	NS
12	Iron (mg/l)	Wet Season Dry season	3.77±0.43 4.07±0.12	3 3	2	0.63	4.30	NS
13	Lead (mg/l)	Wet Season Dry season	0.33±0.01 0.41±0.01	3 3	2	0.02	4.30	NS
14	Zinc (mg/l)	Wet Season Dry season	0.52±0.01 0.64±0.02	3 3	2	0.05	4.30	NS
15	Manganese (mg/l)	Wet Season Dry season	0.36±0.02 0.41±0.03	3 3	2	0.44	4.30	NS
16	Oil and Grease (mg/l)	Wet Season Dry season	142.77±3.62 146.50±4.56	3 3	2	0.67	4.30	NS

Note: NS=not significant, df = degree of freedom, N= number of observations

4. CONCLUSIONAND RECOMMENDATION

The results showed that most of the parameters had their values not meeting stipulated standard by FEPA (1991) for discharge into surface waters; such parameters were electrical conductivity, TDS, TSS, BOD5, DO, Nitrate, phosphate, and Oil& grease. Also the paired sample student t-test analysis revealed there was no significant seasonal variation between the wet and dry season means of all the parameters tested for the effluent discharge. From the result obtained therefore, it is revealed that effluent generated from the abattoir is highly polluted and could have a detrimental effect on the stream water in which it is being disposed into without any form of treatment.

Therefore from the findings revealed from this study, it is recommended that effluents discharged from abattoirs should be properly channelized, collected and pre-treated to a non-toxic state before discharge into surface waters so as to prevent pollution problems to surface water and that the application of cleaner meat production cycle be adopted and monitored by the FCTA and other environmental regulatory bodies in Nigeria which are attached to the meat processing industries.

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