THE EFFECTS OF ABATTOIR WASTE ON WATER QUALITY IN GWAGWALADA-ABUJA, NIGERIA.

MAGAJI, J.Y. and CHUP, C.D.

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Abstract

This paper examined the impact of abattoir wastes on water quality around an abattoir site in Gwagwalada. The work was premised on the fact that untreated wastes from the abattoir are discharged directly into open drainage which flows into a nearby stream. Leachates from dumped and decomposed wastes have also been observed to percolate into soil, and also flow into the stream. Water samples were collected from four points along the stream and subjected to laboratory analysis for heavy metal contents (Lead (Pb), Iron (Fe), Cupper (Cu), Cadmium (Cd), Aluminium (Al) Cyanide (Cn), Boron (B), and Nickel (Ni)., as well as some physical and chemical properties [such as pH, Dissolved Oxygen, salinity, conductivity, and Total Dissolved Solids (TDS)]. The student t –test, and the Analysis of Variance were utilized to determine variations in concentrations of the analysed properties. It was discovered that most of the analysed properties of the water such as:- pH (5.75), Filterable Solid (0.06), DO (5.15), TDS (153.75), Cd. (0.11)Cu(0.25)B (0.14) are still below the nationally and internationally accepted limits. Despite that, continuous discharge of these wastes into the stream however, may in no distant time, pose a threat to human health. The paper thus concludes by recommending that a mechanism be put in place for the treatment of these abattoir wastes before they are then properly disposed.

Key words: *Abattoir; Wastes; Water quality, Pollution.*

Introduction

Livestock production is considered a potential food for the world's needy people. It however, becomes a major pollutant of the country site and cities, when the slaughter wastes are not properly managed, and especially, discharged into waterways, as such practices can introduce enteric pathogens and excess nutrients into surface water (Alonge, 1991; Meadows, 1995).

The wastes from abattoir operations which are often separated into solid, liquid and fats could be highly organic. The solid part of the wastes consist of condensed meat, undigested ingest, bones, hairs, and aborted foetuses. The liquid aspect on the other hand consists of dissolved solids, blood, guts contents, urine, and water, while fat waste consists of fat and oil. The pollution of water resources often results in the destruction of primary producers, which in turn leads to an immediate diminishing impact on fish yields, with the resultant consequence of decrease in diet (Aina and Adedipe (1991).

The slaughtering of animals for community consumption is inevitable in most nations of the world and dated back to antiquity. Public abattoir had been traced to the 15th and 16th centuries, in Rome and France, where slaughter houses were among the public facilities provided by the State. In Italy, a law of 1890 required that public abattoirs be provided in all communities of more than six thousand inhabitants. Similar reports in Norway, Sweden, Denmark, Netherlands and Romania in the late 18th century (Jode, *et al.*, 1906). In Nigeria, nearly every town and neighbourhood is provided with a slaughter house or slaughter slab. Edwards *et al.* (1979) observed that abattoirs may be situated in urban, rural and nominated industrial sites, and that each has advantages and disadvantages. Sridhar (1988) also reported that, a cow brought for slaughtering produces 328.4kg of waste in form of dung, bone, blood, horn and hoof. Robert (2005) submitted that the disposal of waste products is a problem that has always dominated the slaughter sector, and on the average, 45 per

Department of Geography and Environmental Management
University of Abuja, Nigeria.
**Corresponding author:* johnmagaji@yahoo.com

cent of each live beef animal, 53 per cent of each sheep, and 34 per cent of each pig consist of non-meat substances. The characteristics of slaughter house wastes and effluents vary from day to day depending on the number, types of stock being processed, and the processing method (Tove, 1985).

Clean water resources used for drinking, sustaining aquatic and terrestrial ecology, industry and aesthetic values, along with breathable air, rank as the most fundamental and important need of all viable communities. These water resources should remain within specific quality limits, and therefore require stringent and conservative protection measures. Raymond (1977 reported that animal wastes can affect water, land or air qualities if proper practices of management are not adhered to. The same wastes however, can be valuable for crops but can also cause water quality impairment. It also contains organic solids, trace heavy metals, salts, bacteria, viruses, other microorganisms and sediment. The waste from animals can also be washed into streams if not protected and reduces oxygen in water, thereby endangering aquatic life. Raymond (1977) also reported that improper animal waste disposal can lead to animal diseases being transmitted to humans through contact with animal faeces. Cooper *et al.* (1979) reported that abattoir effluents reaching streams contribute significant levels of nitrogen, phosphorous and biochemical oxygen demand, as well as other nutrients, resulting in stream pollution. Sangodoyin *et al.* (1992) also reported that the ground water quality in vicinity of the abattoir were adversely affected by seepage of abattoir effluent as well as water quality of receiving stream that was located away from the abattoir.

The Federal Capital Territory has generally witnessed large scale infrastructural and population changes in the last two decades. The population dynamics have by far exceeded those of infrastructure, and other social amenities (Chup and Mundi, 2000, Magaji and Dung-Gwom, 2007; Makwe, 2005). The cumulative impact of this scenario has been an overstretching of most basic amenities. The Gwagwalada abattoir serves the entire town, and its location beside the stream has facilitated easy disposal of the wastes into the stream channel, even without any proper treatment. This paper therefore attempts to examine the implication of the continuous discharge of these abattoir wastes into the stream water, on water quality. This is seen to be justified by the fact that the downstream residents of this locality very much depend on this same stream water for some domestic activities. The paper therefore attempts to evaluate the water quality at some locations in the stream channel, with the aim of establishing the extent to which untreated abattoir wastes would have impacted on the stream water quality. The work thus seeks to verify whether or not there are significant differences in the concentration of heavy metals within the abattoir area, and those away from it. The paper further sought to establish whether there exists a significant difference between the heavy metals concentration in the analysed water, when compared to local and international standards.

Study Area

Gwagwalada is located about 55 km south west of the Capital City, along the Lokoja – Kaduna road. It is the administrative headquarters of Gwagwalada Area Council. The town, which was the second largest settlement within the FCT, as at the time of the creation of the Territory in 1976, is situated between Lat. 8° 55' and 8° 60' North, and Long. 7° 05' and 7° 11' East. The Gwagwalada Abattoir is located at new Kutunku ward of the town, beside one of the tributary streams of river Usuma, which drains through the town. Gwagwalada town, with an aerial extent of about 118km², has an elevation of between 142.2m and 213.3m asl in the southern and northern parts of the town respectively. The town has recorded mean annual temperatures that range from 30° c to 37° c, and total annual rainfall of about 1650mm. Relative humidity range from about 25% to 50% in the dry and rainy seasons respectively.

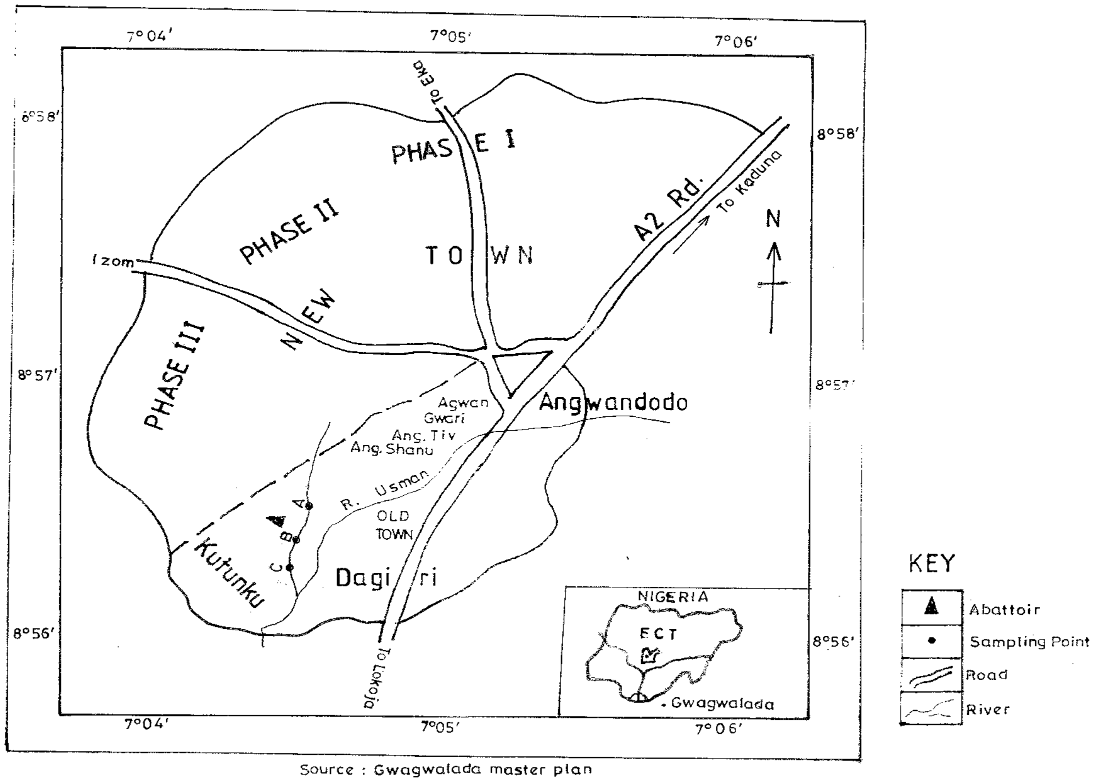

Figure 1 The Gwagwalada town.

The Gwagwalada abattoir is located in a high density residential area (Kutunku) of the town, and it consists of three sections. These are the slaughtering section, the processing and the dumping sections. Its location the heart of the town has indeed been worrisome, as the wastes could easily serve as pollutants to the immediate environment.

Materials and Method

Sampling and Laboratory Analysis

Water samples were collected from four points along the stream that drains the abattoir for laboratory analysis. The first point was about 100m upstream before the abattoir, which served as the control sample point. The second point was at the entrance of the abattoir effluent into the stream, the remaining two points were at points down the river. All the points were at intervals of 100m, and sampling was conducted at about 11:30am.This time was specially chosen in order to allow the effluent from the abattoir reach the stream.

Some parameters, such as Temperature, pH, Dissolved Oxygen, salinity, conductivity, and Total Dissolved Solids (TDS), were taken *in-situ.* A mercury inglass thermometer was used in measuring temperature, Portable Electronic Conductivity meter (model Mel-V) and A portable digital DO probes model Parker (1987) were used in measuring the conductivity and quantity of oxygen in the water respectively. The following parameters were investigated in the water samples, Temperature, pH, conductivity, dissolved oxygen (DO), Total Dissolved Solids (TDS), biological oxygen demand (BOD), Chemical Oxygen Demand (COD) and salinity. Some selected heavy metals examined are Lead (Pb), Iron (Fe), Cupper (Cu), Cadmium (Cd), Aluminium (Al) Cyanide (Cn), Boron (B), Phenol (C_6H_5OH), zinc (Zn^{2+}), Ammonium (NH^{4+}) and Nickel (Ni). Bacteriological examination of the water samples was also conducted. The choice of these heavy metals is justified by the fact that, they are some of the toxic metals that readily affect human health. The laboratory analysis was conducted as prescribed by Ademority, (1996).

Statistical Analyses

The statistical tests best suited for this work are the student t-test and Analysis of Variance (ANOVA), analysed with the aid of the Statistical Package for Social Sciences (SPSS).

Results and Discussion

Results of the various analyses conducted are presented in Table 1 below.

Table 1 Descriptive analysis of the Laboratory Results.

Parameters (mg/l)	**Range**	**Mean**	**Std. Deviation**	**Coefficient of variation**	**Statistical significance**
Temperature (^{0}C)	28.50-28.80	28.65	0.13	0.45	Insignificant
pH	5.50-6.50	5.75	0.50	8.70	Insignificant
Conductivity (µS/cm)	46.70-403.00	237.73	190.42	80.01	Significant
Salinity (%)	0.00-0.20	0.13	0.10	76.92	Significant
Filterable Solid FS	0.01-0.08	0.06	0.03	50	Significant
Dissolved Oxygen (DO_2)	4.70-6.20	5.15	0.70	13.59	Insignificant
Total Dissolved Solid (TDS)	48.00-223.00	153.75	76.26	49.60	Significant
Iron Fe^{2+}	0.36-0.76	0.48	0.19	39.58	Insignificant
Cadmium Cd^{2+}	0.07-0.16	0.11	0.04	36.36	Insignificant
Copper CU^{2+}	0.18-0.38	0.25	0.09	36	Insignificant
Ammomium NH^{4+}	0.02-0.08	0.05	0.02	40	Insignificant
Boron B	0.10-0.19	0.14	0.04	28.57	Insignificant
Zinc Zn^{2+}	0.01-0.8	0.06	0.03	50	Significant
Nickel Ni^{2+}	0.22-0.61	0.37	0.17	45.95	Insignificant
Cyanide CN^-	0.02-0..06	0.04	0.02	50	Significant
Aluminium AL^{3+}	0.07-0.12	0.09	0.02	22.22	Insignificant
Phenol C_6H_5OH	0.50-0.89	0.60	0.19	31.67	Insignificant
Lead Pb^{2+}	0.47-0.79	0.56	0.16	28.57	Insignificant
BOD_5	1.31-5.09	2.87	1.85	64.46	Significant
COD	54.00-316	213.50	124.93	58.52	Significant

The results in the above table indicate that there is a consistency in the concentration of most of the analysed variables. It is also evident that variables such as FS, TDS, Fe^{2+}, Cd^{2+}, Cu^{2+} NH^{4+}, B, Zn^{2+}, Ni^{2+} , CN^- AL^{3+}, C_6H_5OH, and Pb^{2+} are slightly varied from one point to another. The concentrations of conductivity, salinity, BOD and COD, however, differ greatly from one sampling point to another.

The laboratory result was subjected to descriptive statistics as shown in Figure 3 below.

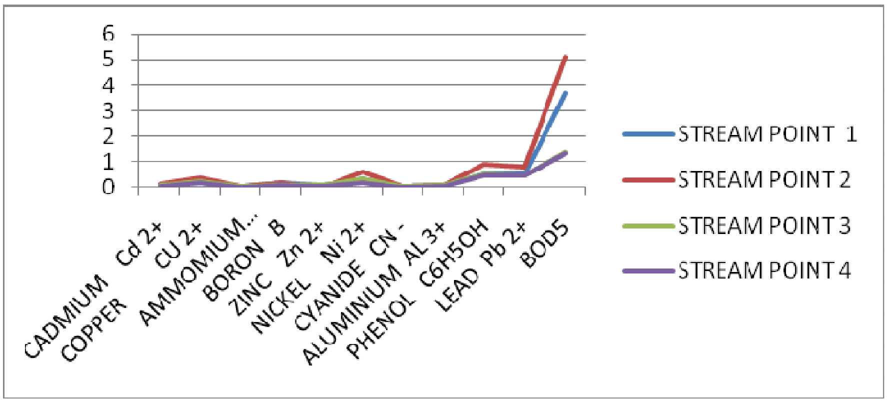

Figure 3 Values of the parameters at different sampling points.

Figure 3 shows that all the concentrations of the parameters in sample point 2 were higher than those of the remaining three sampling points. Sample point 2 is the receiving point of the effluent from the Abattoir. Point 1 is a point about a 100m away before the abattoir, though this part of the stream may also be contaminated by other human activities. Point 3 is a point 100m away from the abattoir downstream, the concentration values decrease as the water flows down. This could be accounted for by the fact that as the water flows there is a sort of natural purification in the river, and also some of the pollutants are dissolved as they enter the stream.

The result of the mean values of the water samples was compared with the FEPA recommended limits, with the view of finding the deviation from the acceptable standards. This was to determine whether the abattoir effluent has already affected the water quality of the stream, to an extent that it may be injurious to human health.

Table 2 Comparison of the Analysed samples with the FEPA acceptable limits

PARAMETERS (mg/l)	Mean values	FEPA Limit	Deviation	Remark
Temperature (0C)	28.65	<40	12.25	WL
pH	5.75	6-9	0.25-3.25	BL
Conductivity (µS/cm)	237.73	1000	-762.27	WL
Salinity (%)	0.13	0.1	0.03	AL
Filterable Solid FS	0.06	30	-29.94	BL
Dissolved Oxygen (DO_2)	5.15	7.5	-2.35	BL
Total Dissolved Solid (TDS)	153.75	1500	-1346.25	BL
Iron Fe^{2+}	0.48	0.3	0.18	AL
Cadmium Cd^{2+}	0.11	0.003	0.107	BL
COPPER CU^{2+}	0.25	1.0	-0.75	BL
Ammomium NH^{4+}	0.05	0.5	-0.45	BL
Boron B	0.14	1.0	-0.86	BL
Zinc Zn^{2+}	0.06	5	-4.94	BL
Nickel Ni^{2+}	0.37	0.02	0.35	AL
Cyanide CN^{-}	0.04	0.01	0.03	AL
Alluminium AL^{3+}	0.09	0.2	-0.11	BL
Phenol C_6H_5OH	0.60	0.001	0.599	AL
Lead Pb^{2+}	0.56	0.01	0.55	AL
BOD_5	2.87	30	-27.13	BL
COD	213.50	80	133.5	AL
Salmonella sp	Present	0	Present	AL
Shigella sp	Present	0	Present	AL
E-coli	Present	0	Present	AL
Other coliforms	Present	Present	Present	AL
Most Probable Number of Bacteria (MPN/100ml)	900	400	500	AL

WL= Within limit; BL =Below limit; AL = Acceptable limit.

Temperature and conductivity are within the FEPA range, while pH, FS, DO, TDS, Cd, Cu, NH, B, Zn, Ni, Al. and BOD are below the FEPA recommended limit. On the other hand however, salinity, Fe, Ni, CN, C_6H_5OH, Pb, *Salmonella. Shigella* and *Escherichia coli* are above the FEPA acceptable limit Apart from people defecating along the river bank, the abattoir's borehole is not functioning, so the animal slaughtered are taken to the river for washing, thus adding to the quantity of wastes. The following can be further deduced from the results in the above table.

The temperature of the samples ranged between 28.5 – 28.8^{o}c. This is in compliance with the FEPA effluent permissible limit of 40^{o}C. The pH values of the samples ranged from 5.5 – , 6.5, which places the values within the FEPA acceptable limit, and less than those of Adeyemo, *et al.* (2002), and Osibanjo and Adie (2007), which were 7.0 - 8.3, and 6.92-8.18, respectively. This implies that the pollution level of this study is relatively fair compared with their own study area.

Conductivity of the samples range between 101.2 – 467 µScm^{-1} the upstream, sample point 1 had the lowest conductivity of 101.2 while sample point 2 had the highest value. Sample points 3 and 4 have 403 and 400 µScm^{-1} respectively. This clearly shows that it is highest at the meeting point of the abattoir effluent and the stream. Though these figures are lower than FEPA limit for portable water, they are nevertheless higher than FAO recommended limit for agricultural purposes such as irrigation. (Chukwu, 2005).

The total dissolved solids (TDS) of the samples were quite low, compared to recommended limits (FEPA 1991), which is 1500 mg/l. The figures of the different sample points however show that effluent have dilution effect on TDS as there is progressive decrease from the upstream section through the point the effluents enters the stream to the 2 other points down stream. It can be further seen from the results presented above that salinity values ranged between 0.0-0.2 with an average of 0.1, which is within FEPA recommended limit of 0.1. Dissolved oxygen in the samples range between 4.7 – 6.2 mg/l, which is very much higher than the result of Chukwu*, et al* (2008); and still within FEPA limit of 7.5 mg/l. Most Game fish required at least 4-5mg/l level of DO to thrive.

The COD values ranged between 54-316mg/l. A close look at table 1 shows that sample Point 1, has 174 mg/l, while points 2, 3 and 4 have 54, 316 and 310mg/l respectively. This could probably be due to the rate of dilution of the pollutants that led to the increase at point 3, and decrease at point 4. The recommended FEPA standard is 80 mg/l. It was discovered however that at the point of entry of the abattoir effluent into the stream, COD was 54mg/l, but much higher at the other sample points. High level of COD indicates the presence of chemical oxidants in the effluent while low COD indicates otherwise. High COD could likely cause nutrient fixation in the soil resulting to reduce rate of nutrients fixation in the soil resulting to reduced rate of nutrient availability to plants. Chemical oxidants affects water treatment plants by causing rapid development of rust (Chukwu *et al.,* 2008).

Iron concentration in the collected samples range between 0.36-0.76mg/l and it is above the recommended level of 0.3mg/l by FEPA, if water is to be used for drinking purposes. This implies that if the abattoir discharges its wastewater into other water bodies used for drinking purposes downstream, it could be a contaminant and hence, hazardous to human health. In order to verify whether or not there was significant difference in the concentration of heavy metals at the different sample points, the results relating to heavy metals was subjected to the Analysis of Variance (ANOVA), and the calculated value when compared to the table value, indicate that there are actually significant differences. This further implies that there is significant difference in the concentration of some of the pollutants taken at different sampling points. Secondly, in order to verify whether the heavy metals concentration in the sampled water significantly varies with the FEPA approved limits, the data in Table 2 was subjected to the student t-test, and the result indicate that there was indeed significant variations.

Conclusion and Recommendations

The heavy metals verification as reported above indicates that indicate that there is significant difference in the concentration of the pollutants taken at different sample points. Furthermore the concentration of heavy metals in the sampled stream water was discovered to be significantly different from the National and International standards. This calls for concern, as most of the analysed values were above the recommended standards, which obviously signals danger to human health, and also, plants.

Though the water quality was generally still above recommended standards, it is however under threat if the present habit of discharging untreated abattoir wastes continues. Residents living in abattoir vicinity may in no distant time begin to experience severe consequences of pollutants from abattoir activities located in their neighbourhood.

In view of the findings of this work, and in addition to the fact that the abattoir is located in the heart of the town, and also, in view of the fact that the discharge of untreated abattoir wastes may continue unabated, the following recommendations are hereby made:

(i) Efforts should be made to commence activities towards the relocation of the abattoir to an area away from residential areas.

(ii) Immediate steps should be taken to put in place machinery that will enable treatment of the abattoir wastes before they are disposed.

(iii) Aggressive public awareness and enlightenment on possible impacts of pollution from abattoir wastes should be embarked upon by relevant agencies.

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