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Effects of Wastewaters From an Abattoir on Surface Water Quality in Akure, Ondo State, Nigeria.

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Key words:
Abattoir;
Wastewater,
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A B S T R A C T

The study examined the effect of Onyearugbulem abattoir wastewaters discharge on surface water quality in Akure. Water samples were taken at three different locations along the receiving water body namely the Upper Course (UC), Middle Course (MC) and the Lower Course (LC). UC samples were collected at the point of entry of the abattoir wastes; MC samples were taken about 50m from the point of entry while LC samples were taken about 100m away from the point of entry of the abattoir waste.The samples were collected, preserved and analyzed in the laboratory using standard methods. The wastewater parameters analyzed were dissolved oxygen (DO), pH, total suspended solid (TSS), total dissolved solid (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and heavy metals.The mean concentration of 0.24 mg/l for Cr and 0.02 mg/l for Pb exceeded the WHO (1993) and FEPA (1991) standard of 0.1 mg/l Cr and 0.01 mg/l Pb for the discharge of wastewater into river, while the levels of nitrate, TSS and TDS were also higher than the WHO limits for the discharge of wastewater into river. The mean values of 1.9 mg/l, 1626.6 mg/l, 466.67 mg/l and 1666.67 mg/l for DO, COD, TSS and TDS exceeded the WHO permissible limit of ≥5mg/l for DO, N/D for COD, 500 mg/l for TSS and 500 mg/l for TDS for the discharge of wastewater from Onyearugbulem abattoir into the river. Based on the results obtained, the Abattoir Practice Regulatory body should be put in place by the Environmental Protection Agency to regularly regulate and monitor abattoir activities in the study area in order to prevent environmental pollution and health hazards caused by activities of abattoirs.

1. Introduction

An abattoir is a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption (Alonge, 1991). While abattoir wastes are waste or waste water from an abattoir which could consist of the pollutants such as animal faeces, blood, fat, animal trimmings, paunch content and urine.In Nigeria, the abattoir industry is an important component of livestock industry providing domestic meat supply to over 200 million people and employment opportunities for teaming population. However, the abattoir industries are generally less developed in developing countries like Nigeria when compared with advanced countries, where waste generation analysis and treatment are considered before constructing the abattoir (Ogbonnaya, 2008; Ogbonnaand Ideriah, 2014). Environmental problems have increased in geometric proportion over decades with improper management practices being largely responsible for the gross pollution of the aquatic environment with concomitant increase in water borne diseases especially typhoid, diarrhea and dysentery as a result of increase in abattoir practices. Abattoirs are generally known all over the world to pollute the environment either directly or indirectly from their various processes (Adelegan, 2002). Bull et al., (1982); Coker et al., (2001), Nafamda et al., (2006) classified abattoir wastes into solid, liquid and fat which are highly organic. The Solid wastes include condensed meat, undigested feed, bones, horns, hairs and aborted fetuses. The liquid waste is usually composed of dissolved solids, blood, gut contents, urine and water, while fat wastes consists of fat and oil.

The pollution of water resources often results in the destruction of primary producers and this in turn leads to diminishing consumer populations in water. The direct repercussion of this is diminishing fish yield with the resultant consequence of human diet suffering. Such conditions arise through careless discharge of dangerous slowly biodegradable and non-biodegradable wastes e.g pesticides. In terms of biological

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indication of water quality, use is made of aquatic lives (e.g., Diphniamagna), which are very sensitive to changes in pressure, pH, dissolved oxygen, toxicity and other chemical changes in water. The Organisms may become disfigured or their reproductive lives impaired or are killed (Aina et al., 1991). This case has become rampant in Nigerian abattoirs without any solutions to it. Sangodoyin and Agbawe (1992) identified improper management and supervision of abattoir activities as a major source of risk to public health in Southwestern Nigeria.

From research, it has been shown that pollution potential of meat processing and slaughter houses have been estimated at over one million population equivalents in Netherlands and recent studies on abattoirs as reported by Cadmus et al. (1999) showed that zoonotic diseases (diseases of animals transmitted to humans) are yet to be eliminated or fully controlled in more than 80% of the public abattoirs in Nigeria.

World Bank (1998) estimated that total amount of wastes produced per animal slaughtered is approximately thirty five percent its body. Verheijen et al. (1996) found that for every 1000 kg of carcass weight, a slaughtered cow produces 5.5 kg of manure (excluding rumen contents or stockyard manure) and 100 kg of paunch manure (partially digested food). Also from analysis, Scahill (2003) reported that a cow weighing 400 kg would have its carcass weight reduced to about 200 kg after slaughter. Furthermore, it losses about one-third fat and bone after passing through the butcher. Hence, a 400 kg live weight animal will give about 140 kg of edible meat which only represents 35% of its initial weight. The remaining 65% are either solid or liquid wastes. In correspondingto the findings above, Gannon et al. (2004) showed that a slaughtered cow produces 13.6 kg of blood. Raymond (1977) reported that animal wastes can affect water, land or air quality if proper practices of management are not adhered to. Report from Cooper et al. (1979) and Sangodoyin et al. (1992) showed that abattoir effluents reaching streams contribute significant levels of nitrogen, phosphorous and biochemical oxygen demand, as well as other nutrients, resulting in stream pollution.

At present Onyearugbulem abattoir in Akure, Ondo State, Nigeria, is one of the slaughter houses which serve Akure City. Its location beside the stream has facilitated easy disposal of the wastes into the stream channel even without proper treatment. This paper therefore aims to examine the effect of the continuous discharge of abattoir wastes on surface water quality and to determine the effect of the constituents on soil and water conservation in the area. Also to deduce the effect of the activities of the abattoir generally on the environment in order to give possible methods of their prevention on the water body and the ground water of the environment. 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.

2. Materials and Methods

2.1 Description of the Abattoir

Onyearugbulem Market abattoir, Akure, Ondo State, lies approximately on latitude 7.281080 and longitude 5.190528 with elevation of 324.6m (Google Maps, 2016: Ajayi et al., 2010). The abattoir is sited very close to the Onyearugbulem Market along the Akure-Ilesha Express Road. Figure 1 shows the map site of the abattoir. It is constructed in such away to accommodate more than four slaughtering at a time. The abattoir is divided into three section, the slaughtering section, the processing section (skin and bone removal/ skin burning) and waste dumping site.

2.2 Sampling

Water samples were collected at three different locations along the receiving water body namely the Upper Course (UC), Middle Course (MC) and the Lower Course (LC), nine samples were collected during sampling at 10:00am. The UC samples were collected at the point of entry of the abattoir wastes; the MC samples were taken about 50 m from the point of entry while LC samples were taken about 100 m away from the point of entry of the abattoir waste.This is shown in Figure 2. Waste samples were collected from each sampling site with a clean polyethylene bottles. The containers were leached with dilute HCl and then rinsed with the waste water from the abattoir so as to neutralize or reduce the effect of external contaminants. The samples were labeled and transported to the laboratory, stored in the refrigerator at 4OC prior to the analysis for the physical, chemical and biological parameters present.

2.3 Analysis

Standard analytical methods (APHA, 2005) were used to determine of the quality parameters. Nitrate was determined using direct spectrophotometric method as described by Ralkos et al., (1988).

2.3.1 Determination of Physicochemical and Biological Parameters of the Samples

The pH, salinity and Temperature were determined on the site using a pH meter (Setra pHS-25); while other parameters were determined in the laboratory. Dissolved oxygen (DO) and Biochemical Oxygen Demand (BOD) were determined by dissolved oxygen meter model Acorn DO using standard methods 4500-OG and 5210B, respectively. The levels of total dissolved solid (TDS) and conductivity were determined by using a C0150 conductivity meter at the point of sample collections. Turbidity was estimated by nephelometeric method using Lamotte 2020 portable turbidity meter. Chemical Oxygen Demand (COD) was determined using closed reflux method. Total Suspended Solid (TSS), 100ml of the wastewater samples were filtered through a pre-weighed filter paper. The filter papers were dried at 103-105oC. TSS,TS, and TDS was determined by using the following formula Anon (1992).

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$$Totalsolid\ (TS)_{(mg/l)} = \frac{Totalsolid\ (mg)}{Amountofsampletaken(l)} \times 1000 \qquad i$$

$$Totaldissolvedsolid(TDS)_{(mg/l)} = \frac{Totaldissolvedsolid\ (mg)}{Amountofsampletaken(l)} \times 1000 \qquad ii$$

$$Totalsuspendedsolid(TSS)_{(mg/l)} = \frac{Finalweight - Initialweight\ (mg)}{Amountofsampletaken(l)} \times 1000 \qquad iii$$

In the determination of chloride, 100ml of the waste water sample was measured into a 250ml conical flask and pH was adjusted to 8 with 1M NaOH. One ml of K2CrO4 indicator was then added and titrated with the AgNO3 solution. A blank titration was carried out using distilled the AgNO3 solution. A blank
titration was carried out using distilled water. Chloride (mg/l) was calculated as follows Ademoroti (1996).

$$Chloride\ (mg/l) = \frac{70900 \times M\ (V_1 - V_2)}{V_s} \qquad iv$$

Where:
V_1 = Volume of titrant for the sample
V_2 = Volume of titrant for the blank
M = Molarity of $AgNO_3$
V_s = Volume of sample used (100ml)

The heavy metals present in the samples were determined using digestion method described by Hseu et al. (2002). The heavy metals determined include chromium, iron, copper, lead, cadmium, chlorine and nitrate.

3. **Results and Discussion**

The results of the physicochemical and biological parameters of the abattoir waste samples are shown on Table 1.

The pH of the abattoir waste sample ranged from 6.9 - 7.2. The pH range is comparable to 6.9 - 8.8 of previous studieson effluent from similar abattoirs in Nigeria and within the tolerance level of WHO (2004) and FEPA (1991) for the discharge of waste water from all industries into river. The temperature ranged from 25-26oC and it was within the tolerance limit. The value of Dissolved Oxygen (DO) obtained from the abattoir wastewater ranged from 0.6-3.0. The DO is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as the self purification capacity of the water body. According to WHO (2004) and FEPA (1991), the standard for sustaining aquatic life is stipulated at 5mg/l, and a concentration below this value adversely affects aquatic biological life, while concentration below 2mg/l may lead to death for most fishes (Chapman, 1997).

The concentration of TDS in the abattoir wastewater sample of this study ranged from 1400 -2000 mg/l and that of TSS ranged from 200 -1000 mg/l. The BOD level values were not detectable, while COD values ranged from 947-2566mg/l. Both BOD and COD are important water quality parameters and are very essential in water quality assessment (Chapman, 1997). Therefore, the more organic material presents in the abattoir wastewater, the higher the BOD and COD.

From the results of this study, the COD was higher than the recommended standard limits of WHO (2004) and FEPA (1991) limits of N/Amg/l and 80mg/l for the discharge of wastewater into surface water and COD was strongly correlated to total solids. The total solids (TS) ranged from 1600 – 3000 mg/l.

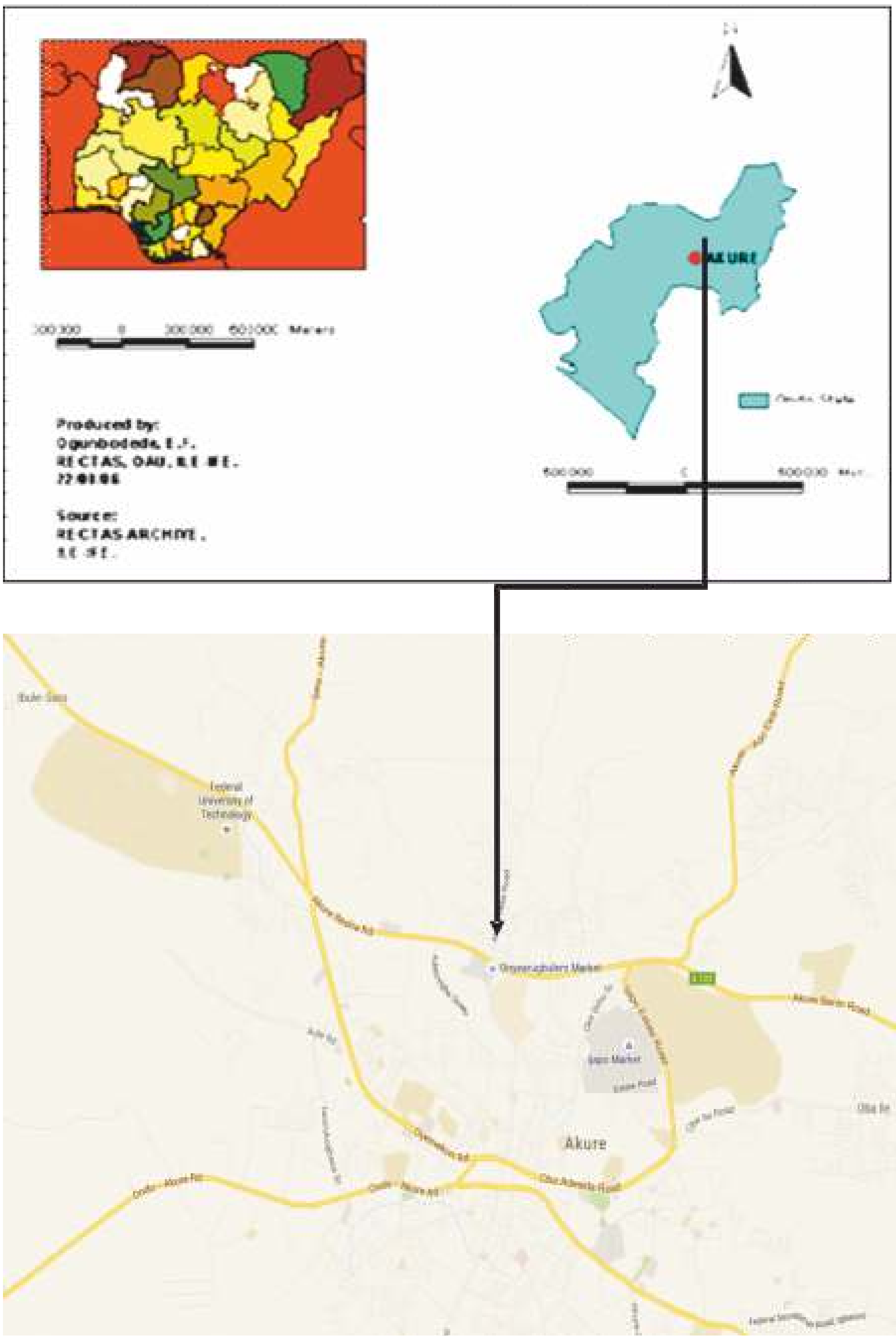

Figure 1: Map of the study area (Source: Google Map (2016))

Channel for flow of waste water into the stream | Water body (receiving stream) | Waste water flow channel into the water

Figure 2:The studied sites

The high values of total solids could be due to lack of sedimentation facility to separate the solid wastes from the liquid wastes before discharge. UC had the highest value of 3000 mg/l for total solids. This could be due to the fact that lesser water was used for washing animal carcass in this section. All the effluent points had total solids values much higher than the WHO and FEPA effluent limit of 1000 mg/l and 500 mg/l (Table 1). Such elevated value for TSS in the abattoir wastewater might be attributed to various materials of solid waste from the slaughtered animals.

Table 2 shows the quality of the stream water in terms heavy metals present in the water as a result of abattoir effluent. Comparing the parameters of the stream water with World Health Organization WHO (2004) standards for drinking water (Table 2), the stream water could not pass for drinking water. The range was a point that showed the quality of the stream before and after mixing with the effluent (Table 2). The heavy metals parameters showed the negative impact of the abattoir effluent on the stream thus rendering the water unfit for human consumption. The heavy metal parameter ranges are as follows: Cr 0.16-0.24 mg/l, 0.01-0.02 mg/l Pb, 0.08-0.12 mg/l Fe, 33-457 mg/l Cl and 1.77-93 mg/l N. The concentration of Cd and Cu in the abattoir wastewater were not detectable, while Cl showed the highest concentration. The highest concentration of 457 mg/l for Cl was higher than the WHO standard of 250 mg/l for the discharge of wastewater into river. Also, the concentration of 0.02 mg/l Pb and 0.24 mg/l Cr exceeded the WHO standard of 0.01 mg/l Pb and 0.10 mg/l Cr for the discharge of wastewater into river. Furthermore, using Prati et al.

(1971) classification of surface water quality (Table 3), stream water fell in the class of grossly polluted water after mixing with effluent from the abattoir. Hence 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 stream receiving the effluent.

Table1 : Mean values of physiochemical parameters of analyzed Samples

Parameters	UC	MC	LC	WHO	FEPA
Acidity	356	350	554		N/A
Total alkalinity	69.2	68	72	30-500	30-500
BOD	N/A			=5	30
COD	1367	2566	947	N/A	80
DO	0.6	2.1	3.0	=5	30
Ph	7.12	6.9	7.2	6.5-8.5	6.0-9.0
TS	3000	1600	1800	1000	500
TDS	2000	1400	1600	500	
TSS	1000	200	200	500	30
Temperature	26	26	25	25	40

Hints:

UC- Upper course, MC- Middle course, LC- Lower course, N/A- Not available

Maximum allowable level (WHO, 2004) + Maximum allowable level (FEPA, 1991)

Table 2:Heavy metals values q uality of stream water

Elements	Range	**WHO (2004)**
Nitrate	1.77-93	30
Chloride	33-457	250
Cadmium	ND	0.003
Copper	ND	2
Lead	0.01-0.02	0.01
Iron	0.08-0.12	
Chromium	0.16-0.24	0.1

Table 3 **:** Parameters used in classification of surface water quality.

Parameters	Class 1	Class 2	Class 3	Class 4	Class 5
pH	6.5-8.0	6.0-8.4	5.0-9.0	3.9-10.1	=3.9=10.1
DO	7.8	6.2	4.6	1.8	=18
BOD	1.5	3	6	12.1	=12.1
NH_3	0.1	0.3	0.9	2.7	=2.7
COD	10	20	40	80	=80
TSS	20	40	100	278	=278

Value of Classes:
Class 1 = Excellent; Class 2 = acceptable; Class 3 = slightly polluted; Class 4 = polluted; Class 5 = heavily polluted.
Source: Prati *et al*. (1971).

4. Conclusion

An appraisal of the effects of abattoir wastewater on surface water quality in Akure was carried out. The TDS, BOD, TSS and DO levels were higher than WHO (2004), FEPA (1991) and Prati et al. (1971) classification of regulatory limits for discharge of wastewater from abattoir into river or streams. There is no doubt that the pollution generated by Onyearugbulem abattoir wastewater is a clear indication that the meat processing industry in Nigeria has a potential for generating large quantities of wastes with high chemical oxygen demand (COD) which would severely impact the availability of clean water to the generality of the population. It could be concluded that the abattoir effluent has further polluted the stream. Hence, the discharge of the Onyearugbulem abattoir wastewater into the river would raise the levels of contaminants thereby making the water from the river unsafe for use by people who reside close to the river and for farming activities. Based on the results obtained, the Abattoir Practice Regulatory body should be put in place by the Environmental Protection Agency to regularly regulate and monitor abattoir activities in order to prevent environmental pollution in their localities. Also, abattoir operators and users should be regularly enlightened on waste management and impact of such on public health.

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