Original Research Article

Environmental Impact of Abattoir Waste Discharge on the Quality of Water body and Soil in Ado Ekiti, Ekiti State

ABSTRACT

Introduction: Wastes generated from abattoirs are an increasing source of pollution of water bodies.
Aims: This study emphasizes on identifying environmental impacts caused by the abattoir along Iworoko Road, Ilokun Ado-Ekiti facility on its receiving water body and its users.
Methodology: Wastewater, stream water, and soil samples were collected twice from the abattoir over a two-month period (June and August). Heavy metals, physiochemical and microbial analyses were carried out on the samples.
Results: The sample collected in June from the study area showed mean bacterial count which ranges from 8.0 – 55.0x10^3 cfu/ml, and sample obtained in August showed mean bacteria count and this indicated that wastewater sample has the highest bacteria count of 8.0 x 10^3 cfu/ml. The lowest bacterial count was found in the stream water sample with 1.7 x 10^3 cfu/ml. The mean bacterial count in the contaminated soil sample was 2.8 x 10^3 cfu/ml. The results also show the occurrence of potentially pathogenic organisms such as *Escherichia coli* and *Staphylococcus aureus*. The heavy metals and physiochemical properties of samples collected from the study area are as follows; Fe (3.806 and 2.812), Cu (1.070 and 0.95), Cd (0.001 and 0.001), Ni (0.0055 and 0.0025), Pb (0.13 and 0.107), Zn (0.37 and 0.406), pH (8.475 and 8.600), temperature (26.250 and 27.750 ^oC), total dissolved solid (267.05 and 212.8), dissolved oxygen (1.65 and 2.45) for waste water sample; Fe (0.402 and 0.519), Cu (0.277 and 0.3095), Cd (0.0 and 0.001), Ni (0.002 and 0.003), Pb (0.04 and 0.016), Zn (0.126 and 0.16), pH (6.82 and 7.235), temperature (26.600 and 27.700 ^oC), total dissolved solid (103.4 and 125.95), dissolved oxygen (4.85 and 5.00) for stream water sample; and Fe (122.85 and 98.500), Cu (0.694 and 0.4745), Cd (0.004 and 0.001), Ni (0.02 and 0.010), Pb (0.3675 and 0.2885), Zn (0.3255 and 0.525), pH (6.200 and 6.495), temperature (23.300 and 27.800 ^oC) for soil sample – each figure representing June and August respectively.
Conclusion: The concentration of the heavy metals reported in this study indicates that there is significant difference in the concentration of the pollutants taken at different sample points.

Keywords: Heavy metals, Physiochemical, Abattoir, Wastewater, Microbiological

1. INTRODUCTION

In Nigeria, the abattoir industry is an important component of the livestock industry providing domestic meat supply to over 150 million people and employment opportunities for teaming population [1]. Ademosoye *et al*. [2] reported that cities face serious problems of high volume of wastes from abattoir due to inadequate disposal technologies and high cost of management.

In Nigeria, adequate abattoir waste management is lacking in all public abattoirs such that large solid wastes and untreated effluents are common sites unlike in developed countries

where these facilities are adequately provided [2]. These abattoir wastes could be a source of embarrassment since conventional methods of waste management have been grossly neglected [3].

Wastewater or effluent generated from the abattoir is characterized by the presence of a high concentration of whole blood of slaughtered food animals and suspended particles of semi- digested and undigested feeds within the stomach and intestine of slaughtered and dressed food animals [4]. There may also be the presence of pathogenic microorganisms, such as *Salmonella*, *Escherichia coli* (including serotype 0157:H7), *Shigella*, parasite eggs and amoebic cysts which are of public health importance [2].

Several other pathogenic bacteria and fungi species has been isolated from abattoir wastewater and surface water; including *Staphylococcus, Escherichia coli, Penicillium* species. These pathogens might threaten public health by migrating into ground water or surface water; wind or vectors like animals, birds and arthropods can transmit diseases from these microorganisms [5]. Abattoir activities provide a highly suspended solid and liquid which consists of pollutants such as animal faeces, blood, fat, animal trimming, paunch content and urine. This study emphasizes on identifying environmental impacts caused by the abattoir along Iworoko Road Ilokun Ado-Ekiti facility on its receiving water body and its users.

2. MATERIAL AND METHODS

2.1 Study area

The study area is Ado-Ekiti, Ekiti State, Southwestern Nigeria. Ado Ekiti is the capital and largest city of Ekiti State with Coordinate: Latitudes (7° 37' 23.84'' N and Longitudes 5°13' 15.13"E)

2.2 Collection of samples

Wastewater and stream water samples were collected from the abattoirs with sterile sample bottles. The sample bottles were used to aseptically draw part of the wastewater running off the drainage system just as it was leaving the slaughter pavement, and there were transported to the laboratory for analysis. Soil samples were also collected from the abattoir contaminated area aseptically. Whatever contamination observed from the soil samples was therefore attributed to the wastewater. Samples were collected at an interval of two months (June and August). All samples were transported to the laboratory for analyses immediately after collection.

2.3 Analyses of samples for physicochemical properties and heavy metals

Samples were analyzed for the following physico-chemical parameters: Temperature, ~~PH~~pH, total dissolved solid and dissolved oxygen. The following heavy metals were also analyzed; iron, copper, cadmium, nickel, lead and zinc. Heavy metals were determined by instrumental methods and conducted following standard analytical method. Cationic and anionic constituents were determined by standard titrimetric and spectrophotometric methods, trace and heavy water were determined by Atomic Adsorption Spectrophotometer. The physico-chemical analysis of the various water quality parameters results as well as other heavy and microbial load will be compared with World Health Organization (WHO) [6] drinking water quality guideline.

Comment [N'BJ1]: Please state the standard use.

2.4 Preparation of media and total viable count

All the media used in this study were prepared and sterilized according to manufacturer's instructions. The media used include nutrient agar and eosin methylene blue (EMB).

2.5 Identification of the isolated bacteria

The identification of bacteria was based on morphological characteristics and biochemical tests carried out on the isolates. Morphological characteristics observed for each bacteria colony after 24h of growth included colony appearance; shape, elevation, colony surface and pigmentation. Biochemical characterizations were done according to the method of Fawole and Oso [7].

3. RESULTS AND DISCUSSION

3.1 Results

Table 1: Physiochemical parameters for the month of June and August

Parameters	Waste water		Stream water		Soil	
	June	August	June	August	June	August
pH	8.475	8.600	6.82	7.235	6.200	6.495
Temperature(^{o}c)	26.250	27.750	26.600	27.700	23.300	27.800
Total dissolved solid	267.05	272.800	103.4	125.95	Nil	Nil
Dissolved oxygen	1.65	2.45	4.85	5.0	Nil	Nil

Comment [N'BJ2]: Parameter unit for TDS and DO

Table 2: Heavy metals parameter of abattoir wastewater, stream water and soil from the study area

Parameters	Wastewater (ppm)		Stream water (ppm)		Soil (ppm)	
	June	August	June	August	June	August
Iron (Fe)	3.806	2.812	0.402	0.5185	122.85	98.500
Copper (Cu)	1.070	0.95	0.277	0.3095	0.694	0.4745
Cadmium (Cd)	0.001	0.001	Nd	0.001	0.004	0.001
Nickel (Ni)	0.0055	0.0025	0.002	0.003	0.02	0.010
Lead (Pb)	0.13	0.1065	0.04	0.0155	0.3675	0.2885
Zinc (Zn)	0.37	0.4035	0,1255	0.16	0.3255	0.525

Nd – Not detected

Table 3: Microbiological analysis of abattoir waste water, soil and nearby stream for the month of June

Samples	Tbc	CP	Colony surface	Gr	Cs	Cat	Mot	Suspected bacteria
$Soil_1$	3.3	Irregular	Rough	+	Rod	+	+	*E. coli*
$Soil_2$	8	Irregular	Smooth	-	Rod	+	+	*E. coli*
$Water_1$	1.0	Irregular	Rough	+	Rod	+	+	*E. coli*
$Water_2$	1.8	Irregular	Rough	+	Cocci	+	+	*Staph. aureus*
$Wastewater_1$	4.6	Regular	Smooth	+	Cocci in cluster	+	+	*Staph. aureus*
$Wastewater_2$	5.5	Regular	Smooth	+	Rod	+	+	*E. coli*

Tbc = Total bacterial count (x10^3 cfu/mL; Gr = Gram's reaction; Cat = Catalase; Mot = Motility; Cs= Colony shape; Cp = Colony pigmentation; – = negative; + = positive

Table 4: Microbiological analysis of abattoir waste water, soil and nearby stream for the month of June

Comment [N'BJ3]: June? Or August? As table 3 already present data for June

Samples	Tbc	CP	Colony surface	Gr	Cs	Cat	Mot	Suspected bacteria
$Soil_1$	40	Irregular	Rough	+	Cocci in chain	+	+	*Staph. aureus*
$Soil_2$	28	Irregular	Rough	-	Cocci in cluster	+	+	*Staph. aureus*
$Water_1$	17	Regular	Smooth	+	Rod	+	+	*E. coli*
$Water_2$	31	Regular	Smooth	+	Cluster	+	+	*Staph. aureus*
$Wastewater_1$	70	Irregular	Rough	-	Rod	+	+	*E. coli*
$Wastewater_2$	60	Irregular	Rough	+	Rod	+	+	*E. coli*

Tbc = Total bacterial count (x10^3 cfu/mL; Gr = Gram's reaction; Cat = Catalase; Mot = Motility; Cs= Colony shape; Cp = Colony pigmentation; – = negative; + = positive

3.1 Discussion

The results of the physico-chemical analysis of the abattoir wastewater, nearby stream and soil samples for the month of June and August are presented in Table 1. The wastewater sample collected in the month of June had the highest total dissolved solid (TDS) 267.05 ppm compared to the one collected in the month of August. The value is also higher when compared to the ones obtained from nearby stream 103.4 ppm, June 125.95 ppm August while TDS is not detected in the soil sample for both months. The high content observed in the abattoir wastewater may be due to the fact that there is high activity of the waste on the water than the surrounding environment. Coker *et al.,* [4] reported that high TDS is an indication that the presence of suspended particles is very high; therefore it is not suitable for drinking water as well as agricultural point of view.

Comment [N'BJ4]: Please refer to the present data. The explanation seem contradict.

Oxygen is dissolved in water in varying concentrations. It is a very important water quality parameter and is also an index of physical and biological processes going on in water. Analysis of dissolved oxygen is very important in water pollution control. The guideline value for dissolved oxygen is >5 mg/L according to WHO [6]. Dissolved oxygen of the wastewater sample was found to be 1.65 ppm in June and 2.45 ppm in August. These values were lower than the values obtained in nearby stream sample of 4.85 ppm in June and 5.00 ppm in August. The reason for the low dissolved oxygen content was due to decomposition of organic matter, which indicates a pollution load in the water. The deficiency of the oxygen in the water is shelter for bacteria and other pathogens, which are anaerobic.

Zinc and iron metal concentration values ranged from 0.37 to 0.4035 ppm and 3.806 to 2.812 ppm respectively from June to August in waste water and nearby stream respectively as shown in Table 2. Cd was not detected in nearby stream for the month of June while all the metals were detected in appreciable amount in abattoir soil sample. Iron, copper, nickel and lead were higher in the month of June than August for abattoir waste water sample. This is the opposite when compared to abattoir nearby stream samples as August recorded high values of iron, copper, nickel, lead and zinc than in June.

The results of the total bacteria count (TBC) of bacteria in the abattoir wastewater, nearby stream and soil sample for the month of June and August are presented in Table 3 and 4. The wastewater samples collected in the month of august had the highest counts of 8.0 x 10^3 cfu/mL while the lowest count of 8 x10^3 cfu/ml was recorded for the month of June. The high count of these organisms in the abattoir is due to the fact that the wastewater has a

high content of whole blood which served as a rich protein medium for microbial growth. Similar findings were reported by Asamudo *et al.* [8], in which they reported a mean bacterial population of 3.32×10^7 cfu/mL from wastewater collected from Agege (Agege, Nigeria) abattoir. Also, Ogbonna and Igbenijie [9] reported a total bacterial population of 2.08×10^3 cfu/mL from wastewater collection sites in Port Harcourt City, Nigeria. Similar pathogenic microorganisms were isolated from abattoir wastewater indifferent parts of the country. For example, Coker *et al*. [4] isolated *Salmonella* spp., and *Escherichia coli* among many microorganisms from Bodija abattoir wastewater in Ibadan, Nigeria. According to International standards, any water contaminated to this level is neither good for domestic use nor is it supposed to be discharged directly into the environment without treatment [6].

The wastewater from the abattoir is washed into open drainages untreated and the leachates from the series of decomposition of these wastes can introduce enteric pathogens into the environment and thus serve as a vehicle for gastrointestinal infections. Also it may introduce excess nutrients into surface water and percolates into the underlying aquifers to contaminate hand-dug wells. The high levels of organic matter in the wastewater encourage rapid proliferation of O_2 consuming microorganisms to deplete the water of its dissolved oxygen leading to septic condition or anoxia which is lethal to aquatic fauna. The amount of heavy metals found in all the samples do not corresponds to the required amount according to WHO, SON, and NAFDAC which made all the samples to be toxic to the surrounding environment.

Comment [N'BJ5]: Abbreviations to what agencies? Not stated earlier in the introduction.

4. CONCLUSION

The major source of surface water and environmental pollution is indiscriminate discharge of untreated abattoir effluents directly into the ground surface or the surface water bodies resulting in serious surface and groundwater contamination. This loss of water quality is causing health hazards and death of human beings. This problem is aggravated by inadequate awareness, scarce financial resources, lack wastewater treatment facilities, and the inefficient ineffective environmental laws. The concentration of the heavy metals verification like Cd, Pb, Cu reported above 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 sample water was discovered to be significantly higher than the permissible limits of WHO standard, 2006. Although some of the results like Electrical conductivity and Total dissolved solid are slightly in line with permissible limits of WHO standard, 2006. However, our environment is under threat if the present habit of discharging untreated abattoir wastes continues. The toxic level of harmful materials can aggravate due to the continuous generation of the effluents. This calls for concern, as most of the analyzed values were above the recommended standards, which obviously signals danger to human health and that of plants life. ~~to~~ To say that the abattoir effluent from the production meat has its impact on the quality of both the shallow well and river water in the sampling site of the study area.

Comment [N'BJ6]: This parameter not in authors discussion.

COMPETING INTERESTS

Authors have declared that no competing interests exist. the products used for this research are commonly and predominantly use products in our area of research and country. there is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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