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Full Length Research Paper

Impact of effluent from Bodija abattoir on the physico-chemical parameters of Oshunkaye stream in Ibadan City, Nigeria

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The problem of getting quality drinking water is increasing as untreated effluents are discharged into surface water bodies. The impact of effluent from Bodija abattoir, the biggest abattoir in Ibadan, western Nigeria on the physico-chemical parameters of Oshunkaye stream was investigated. The qualities of effluent and stream water (before and after mixing with effluent) were studied using the basic water quality parameters. The ranges of the physico-chemical parameters studied were as follows: pH 6.92 – 8.18, temperature 31 – 34^oC, total solids 7726 – 47 630 mg/l, total suspended solids 1498 – 6803 mg/l, chemical oxygen demand 947 - 2566 mg/l, oil and grease 2500 –12590 mg/l, nitrate 62 – 159 mg/l, phosphate 142 - 180 mg/l, chloride 1052 – 1727 mg/l, lead 0.08 – 0.2 mg/l, nickel 0.18 – 0.49 mg/l, copper not detected – 0.14 mg/l, zinc 0.67 – 6.08 mg/l and cadmium (not detected). Using Prati's et al classification of surface water quality, Oshunkaye stream fell in the class of grossly polluted water after mixing with effluent from the abattoir. While before mixing, it fell in class of slightly polluted. Hence the abattoir effluent needs to be treated before discharge into the receiving stream to reduce health hazard.

Key words: Bodija, Oshunkaye, abattoir, effluent, physico-chemical parameters, heavy metals.

INTRODUCTION

Environmental problems have increased in geometric proportion over the last three 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. Abattoirs are generally known all over the world to pollute the environment either directly or indirectly from their various processes (Adelegan, 2002). Quinn and Mcfarlane (1989) observed that effluent discharged from slaughterhouses has caused the deoxygenation of rivers. Effluent from slaughterhouses has also been known to contaminate ground water (Sangodoyin and Agbawhe, 1992). Sayed (1987) also showed that the pollution potential of meat processing and slaughterhouse plants has been estimated at over one million population equivalent in the Netherlands. Tritt and Schuchardt (1992) reported during a study in Germany that blood, one of the major dissolved pollutants in slaughter effluent, has a chemical oxygen demand (COD) of 375,000 mg/l. This impacts high organic pollutants on receiving waters consequently creating high competition for oxygen within the ecosystem. This COD value is far higher than the maximum limit of 80 mg/l set by Federal Environmental Protection Agency/Federal Ministry Environment (FEPA/FMENV, 1991), Nigeria.

In Nigeria, many abattoirs dispose their effluents directly into streams and rivers without any form of treatment and the slaughtered meat is washed by the same water (Adelegan, 2002). Such is the situation in several private and government abattoirs in most parts of the country. 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. Coker et al. (2001) identified seven pathogenic species of bacteria species in abattoir effluent in Southwestern Nigeria. These species among others included *Staphylococcus* sp., *Streptococcus* sp., in harsh environmental conditions; hence they affect animal

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Table 1. Source and Site description for the sampling points.

Sampling point	Description	Surrounding activities
SA1	Slaughter house for cows	Skin processing, meat sellers, cooking of food, stores
SA2	Slaughter house for goat/sheep	Bathroom, cooking, mosque, Saloon and stores.
SA3	Roasted cows, goats and Sheep section	Tomato sellers, diesel engine generator, mosque and bore hole
SA4	A point some distance away from the abattoir after the combination of SA1, SA2 and SA3.	Shops selling electrical appliances
SA5	A point just before the effluent mixes with the stream	Residences, saw dust from saw mill, human faeces along the flow path
SA6	Seasonal stream flowing through residences	Residences, domestic dump site, primary school along flow path
SA7	A point just after the effluent mixes with the stream	Bush, human faeces along the flow path.

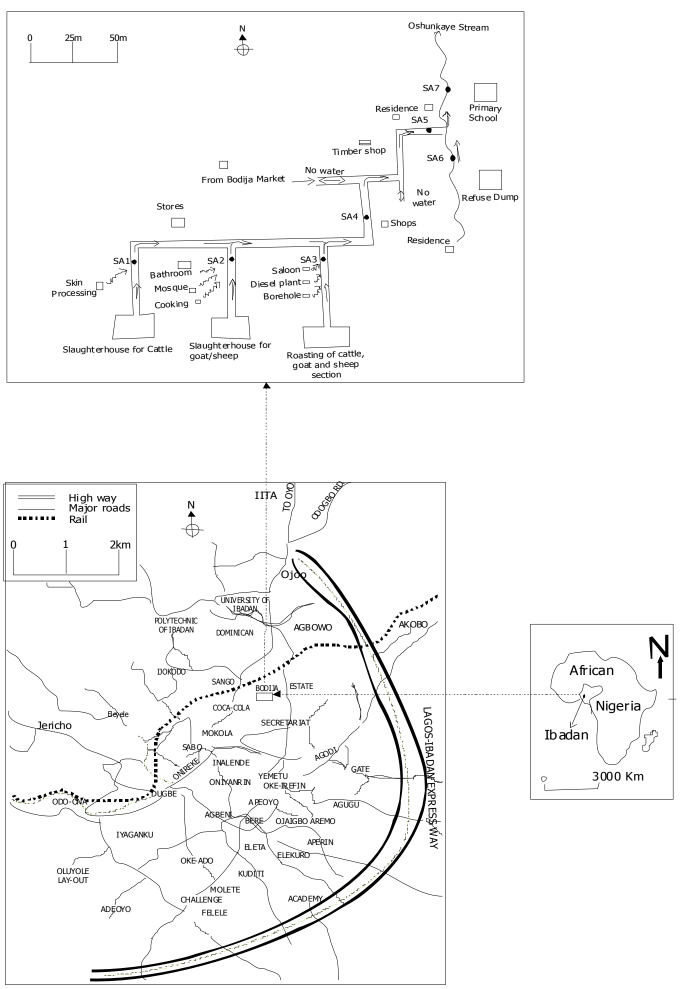

Figure 1. Location of Bodija abatoir

and human health. Sangodoyin and Agbawhe (1992) have also investigated the pollution load of effluent from four abattoirs at Ibadan, and found that all other parameters except pH were higher than the permissible limits set by national and international regulatory bodies.

This study investigated the pollution status of effluent from Bodija abattoir, the second biggest abattoir in western Nigeria and its impact on the physico-chemical parameters of Oshunkaye stream.

MATERIALS AND METHODS

Description of study area

Bodija abattoir is located beside the ever-popular Bodija market in Ibadan, western Nigeria. The map describing the location is shown in Figure 1. The abattoir has existed for several decades with an average daily kill of 300 - 350 cattle, 50 - 100 pigs and 150 - 200 goats/sheep (Personal observation).

Sampling design

Grab samples were conducted at five points along the flow paths of the effluent from the abattoir (Figure 1). The description of sampling points and the activities going on are indicated in Table 1. Samples were picked with clean plastic containers and glass containers (for oil and grease) at points where there were no human activities to interfere with its quality status. Five effluent samples were collected to depict different activities within the abattoir while two samples were collected upstream and downstream of Oshunkaye stream into which the abattoir effluent is discharged. Sampling was done between the hours of 12.19 and 2.10 pm when the discharge of effluent into the stream always occurred.

Quality assurance

Plastic and glassware used were soaked in 1 M nitric acid over night (Onianwa, 2001) and washed with teepol, rinsed with tap water and finally with deionised water. Unstable parameters like pH and temperature were determined on field. Samples were transported to the laboratory in a cooler filled with ice. Nitrate nitrogen was preserved by acidifying with H_2SO_4. All glassware, balances and other instruments were calibrated before use.

Table 2. Results of the physico-chemical parameters of effluent from bodija abattoir.

Parameter*		SA1	SA2	SA3	SA4	SA5
pH		7.97	6.92	8.18	7.52	7.43
Temperature	Ambient °C	34	32	32	32	33
	Sample °C	31	34	34	32	32
Total Solids		11925	47630	9355	11100	7725
Total Suspended Solids		2822	6803	1498	2443	1498
Chemical Oxygen Demand		1367	2566	947	1014	1093
Oil and Grease		2500	6500	7600	12590	5000
Nitrates		80	97	62	71	159
Phosphates		164	180	151	176	142
Chloride		1151	1052	1727	1648	1092
Lead		0.12	0.20	0.1	0.10	0.08
Cadmium		ND	ND	ND	ND	ND
Nickel		0.18	0.19	0.49	0.38	0.31
Copper		ND	ND	0.14	ND	ND
Zinc		ND	6.08	0.67	ND	ND

*All parameters in mg/l except pH and temperature (°C).
ND: Not detected.

Analyses

The analytical methods used for the determination of the parameters except for nitrate were from the American Public Health Association (APHA) series of Standard Methods of Examination of Water and Effluent, 20th Edition (1998). Nitrate was determined using phenol disulphunic acid method (Marczenko, 1986).

RESULTS AND DISCUSSION

The pH of the effluent from the abattoir ranged from 6.92 - 8.18 (Table 2). The pH range of this study is comparable to pH ranges of 6.9 - 8.8 of previous studies on effluent from similar abattoirs in Nigeria. It also falls within the Federal Ministry Environment (FMENV) effluent limit of 6 - 9 (Table 3). Sample temperature range of this study was 32 - 34°C. The temperature values are also comparable with previous works (Table 3) and in compliance with the FMENV effluent permissible limits of <40°C.

The total solids (TS) ranged from 9355 – 47630 mg/l. The high values of solids could be due to lack of sedimentation facility to separate the solid wastes from the liquid wastes before discharge. SA2 (slaughter house for goat/sheep) had the highest value of 47630 mg/l for total solids. This could be due to the fact that lesser water was used for washing animal carcass in this section. SA5 (a point just before the effluent mixes with the stream) had the lowest value of 7725 mg/l for total solids. All the effluent points had total solids values much higher than the FMENV effluent limit of 2000 mg/l. Total suspended solids (TSS) ranged from 1498 – 6803 mg/l. TSS values were strongly correlated to TS (0.99) (Table 4). This showed proportional increase in TSS as TS values increased. TSS values in this study are comparable with previous works (Table 3) and are far in excess of maximum permissible effluent limit of 30 mg/l set by FMENV. The Reason(s) for increased TSS could be same with total solids.

The chemical oxygen demand (COD) ranged from 947 – 2566 mg/l. High COD values could be due to high organic load as shown by TS and TSS values. COD values are comparable with previous works (Table 3) and were higher than 80 mg/l permissible limit set by FMENV. COD was strongly correlated to solids (0.96). This affirmed the linear relationship between solids and COD. It is worthy of note that the COD for SA4 (point after the effluents combined) was 1014 mg/l. This show-ed a reduced COD value. This could be due to net dilution from points (SA1-SA3) and also decomposition of organic load as they move away from source(s). Oil and grease also showed high values (2500 – 12590 mg/l). A high value of 7600 mg/l shown by SA3 could be as a result of the source (cattle roasting section) where most of the fats would have melted to oils during roasting. SA2 also showed a high oil and grease value of 6500 mg/l. This could be due to the fat released during roasting and dressing of goats/sheep carcass. SA1 showed reduced value of 2500 mg/l. This may be because no roasting took place here; hence most fats from this section were bound to animal tissues and therefore unavailable. Point SA4 showed highest value of 12590 mg/l. This could probably be from the combined fat released from SA1, SA2 and SA3. Oil and grease showed much higher values for all points compared to previous works (Table 3) and also FMENV permissible limits of 10 mg/l.

Phosphate values ranged from 142 - 180 mg/l. SA2 and SA3 showed higher values. The reason could be that much detergent was used to wash the roasted carcass.

Table 3. Comparison of abattoir effluent data from present study with data from previous studies as well as national standards.

Parameter*	Present study	Data from previous studies				Maximum permissible limits (FMENV)
		A	B	C	D	
pH	6.92– 8.18	7.1- 7.4	4.9–7.2	6.9–8.8		6 –9
Temperature	32 – 34	24 – 35				< 40
Total solids	7 725– 47 630		2 244– 5 748			2 000
Total suspended solids	1 498– 6 803	900– 3 200	736– 2 099	5 750– 15 784	1 200– 2 400	30
Nitrate	62–159			75– 120		20
Phosphate	142– 180		20 – 80	19– 175		< 5
Chloride	1 052- 1 727					250
Oil and grease	2 500– 12 590	600– 2 000				10
Dissolved oxygen	NA					
BOD	NA					50
COD	947 – 2 566		778 – 4 753	2 200 – 2 935	8 000	80
Lead	0.08– 0.20					0.05
Cadmium	ND					0.01
Nickel	0.18– 0.49					0.05
Copper	0.00– 0.17					0.1
Zinc	0.67– 6.08					3.0

*All parameters in mg/l except pH and temperature (°C).
A, Gurnham (1965); **B**, Masse and Masse (2002); **C**, Sangodoyin and Agbawhe (1992) and **D**, Ruiz et al. (1997).
NA: Not analyzed**.**

Table 4. Correlation of the physiochemical parameters.

Parameter*	pH	Temp	TS	TSS	COD	O&G	NO_3^-	PO_4^{3-}	Cl^-	Pb	Ni
pH											
Temp	-0.18										
TS	-0.58	0.57									
TSS	-0.64	0.44	0.99								
COD	-0.70	0.43	0.96	0.9651							
O & G	-0.13	0.27	-0.01	0.14	-0.20						
NO_3^-	-0.46	-0.20	0.01	0.06	0.07	-0.37					
PO_4^{3-}	-0.14	0.23	0.62	0.64	0.46	0.30	-0.25				
Cl^-	0.47	0.30	-0.02	-0.03	0.26	0.05	-0.42	0.66			
Pb	-0.34	0.48	0.89	0.90	0.80	-0.02	-0.12	0.89	0.34		
Ni	-0.28	0.04	-0.28	-0.36	-0.51	0.54	-0.25	0.23	0.86	-0.03	

*All parameters in mg/l except pH and temperature (°C).
Temp, Temperature; TS, total solids; TSS, total suspended solids; COD, chemical oxygen demand; O and G, oil and grease.
Correlation Rating: > 0.91 = very Strong; 0.90 – 0.81 = Strong; 0.80 – 0.31 = moderate; < 0.30 = weak

Another source for SA2 could be from effluents from saloons, bathrooms and kitchen located along the flow path of this point (Figure 1). Phosphate level was comparable with previous works as shown in (Table 3), but the values were far higher than permissible limits. Nitrate values ranged from 62 – 159 mg/l. Sources of nitrate could be from oxidation of other forms of nitrogen compounds like ammonia and nitrite into nitrate. Nitrate values (62 - 97 mg/l) for SA1 – SA3 were comparable with previous work (Table 3). These values were far higher than the limit of 20 mg/l set by FMENV. Chloride values ranged from 1052 – 1727 mg/l. Chloride sources could be soluble salts (NaCl and KCl) from blood discharged into the effluent; salt from kitchen dishes and salt used in skin processing (Lawal and Mahielbwala, 1992). Effluents from skin processing activities are discharged along pathway of SA1 (Figure 1), which has a value of 1151 mg/l. This affirmed the claim above. The high value of 1727 mg/l showed by SA3 could be from different human activities nearby including canteens. All chloride values

Table 5. Quality of stream water before (SA6) and after mixing (SA7) with the effluent from abattoir compared with WHO and European Community (EC).

Parameter*	SA 6	SA 7	WHO (1993)	EC (1998)
pH	7.06	7.45		6.5-9.5
Temperature	32	32	25	
Total Solids	1155	4200	1000	
Total Suspended Solids	ND	1223		
Chemical Oxygen Demand	41	1143		
Oil and Grease	5450	6100		
Nitrate	1.77	93	30	50
Phosphate	17	107		
Chloride	33	457	250	250
Lead	0.01	0.02	0.01	0.01
Cadmium	ND	ND	0.003	0.005
Nickel	0.22	0.15	0.02	0.02
Copper	ND	ND	2.0	2.0
Zinc	ND	ND	3.0	-

*All parameters in mg/l except pH and temperature (°C).
ND: Not detected.

Table 6. Parameters used in classification of surface water quality.

Parameter	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 (mg/l)	7.8	6.2	4.6	1.8	< 1.8
BOD	1.5	3.0	6.0	12.1	> 12.1
NH_3 (mg/l)	0.1	0.3	0.9	2.7	> 2.7
COD (mg/l)	10	20	40	80	>80
SS (mg/l)	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).

were higher than acceptable limits of 250 mg/l by FMENV. Almost all the heavy metals analyzed showed values higher than permissible limits set by regulatory agencies (Table 3). Sources of heavy metals could arise from bioaccumulation of the metals in the blood and fats of the animals.

Table 5 showed the quality of Oshunkaye stream water before (SA6) and after (SA7) mixing with the abattoir effluent. The stream water itself was polluted perhaps because it served as dumping ground for refuse from domestic activities along its bank (Figure 1). Comparing the parameters of the stream water with World Health Organization (WHO) (1993) and European Community (1998) standards for drinking water (Table 5), the stream water could not pass for drinking water. SA7 was a point that showed the quality of the Oshunkaye stream after mixing with the effluent (Table 5). The physico-chemical parameters showed the negative impact of the abattoir effluent on the stream thus rendering the water of worthless value to humans. Furthermore, using Prati et al (1971) classification of surface water quality (Table 6), Oshunkaye stream fell in the class of grossly polluted water after mixing with effluent from the abattoir. While before mixing, it fell in class 3 (slightly polluted). 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 Oshunkaye stream receiving the effluent.

Conclusion

There is no doubt that the pollution generated by Bodija abattoir effluent is a clear evidence that the meat processing industry in Nigeria has a potential for generating large quantities of effluent with high chemical oxygen demand (COD) which would worsen scarcity of clean water availability to the generality of the population. Comparing the quality of Oshunkaye stream before and after discharge as shown on Table 6, it could be concluded that the abattoir effluent has further polluted the stream. Swift intervention by the government and other stakeholders by putting in place effluent treatment facilities to treat wastes from abattoirs in Nigeria as well as adoption of cleaner technologies will go a long way to curb the environmental health risks posed by these hazardous effluents from abattoirs.

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