Influence of Abattoir on Water Quality in Oko-Oba, Lagos State, Nigeria

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Abstract

Anthropogenic activity has the tendencies to negatively impact quality of natural resource in the neighbourhood. Water which is required of man for adequate, hygiene and proper sanitation is a typical example of resource that abattoir activity hardly leaves undisturbed. This prompted the current study to assess water quality around Oko-Oba area of Lagos State. Twelve water samples: ten (A-J) from residences, positive (abattoir effluent) and negative (500 m away from) control were randomly collected and analysed for physiochemical, trace and heavy metals using APHA methods of examination and bacteriological (total plate count, coliform count and confirmatory faecal coliform) analysis using Pour Plate method with serial dilution of tenfold (10^{-10}). The data obtained were descriptively (mean and standard deviation) and inferentially (Analysis of Variance) analysed using SPSS v23. The results showed that the total plate count test of sample G, and coliform and faecal coliform tests of sample B exceeded the WHO limit (100 cfu/mL). The negative control had 3 cfu/mL (total plate count) and (–ve) for both coliform and faecal coliform tests. The EC of sample G (3.4 µS/m) < WHO limit (1.0 µS/m) and pH of A-J indicated acidic (4.5 - 5.7). None of the heavy metals exceeded the limits in both drinkable water and abattoir effluent samples. The study showed that the abattoir activities minimally contributed to heavy metal loads in all the water samples, though affected the drinkable water compared with the negative control. The study recommended a need for measure to avoid prospective severe contamination.

***Keyword**: Bacterial loads, Chronic contamination, LASEPA, Drinkable water, WHO water limit*

Introduction

Abattoir (also known as slaughtering house) for provision of meat to the populace is a typical profession which cannot be neglected for its elixir roles in the society. However, it also harbingers impacts on the natural resources of the environment -- air due to burning and water due to washing (Singh *et al.,* 2014). Abattoir has been traced back to Roman civilization and in France. The act of sacrificing animals for community consumption is inevitable in most nations of the world and dated back to antiquity.

The Abattoir Act (1988) recognized that United Kingdom abattoir performs a vital role in processing cattle and sheep from farm and transforming them into carcass meat. Though slaughtering of animals result in meat supply and useful by-products like leather and skin, abattoir operations produce characteristic and highly organic waste with relatively high level of suspended solids, liquids and fat.

Livestock waste spills can introduce enteric pathogens and nutrient into surface water and also contaminates ground water (Omole and Longe, 2008; Kosamu, Mawenda and Mapoma, 2011). According to Adie and Osibanjo (2007), most abattoirs aim at optimising the recovery of edible portions from the meat processing for human consumption but significant quantities of secondary solid wastes were disposed to drain. Abattoir waste contamination can also increase level of nitrates in the ground water. The compound causes methaemoglobinemia or blue baby syndrome (De Ross, (2003). Leachates from the series of decomposition processes of the abattoir wastes percolate into the underlying aquifers to contaminate ground water which serves the dual purposes of drinking for the butchers working in the abattoir and dressing of the carcasses to be sold for human consumption.

Various studies had shown detrimental health risks that abattoir activities could pose human and environment across Nigeria. The studies of Ezeoha and Ugwuishiwu (2011) and Mamhobu-amadi *et al.* (2019) explored literature on how various waste generated from abattoir could be detrimental to our environment being hazardous to human health, living resources and ecological systems.

The former called for more concerns against the inadequate handling of abattoir waste for its detrimental effects while the latter solicited for alternative exploration of the generated abattoir waste. Makwe and Chup (2013) spatially analysed different groups of water samples for their deviant to wholesome quality expected of drinkable water around Karu abattoir in the Federal Capital Territory (Abuja) to ascertain the threats that abattoir could pose on water from its discharges.

Hassan, Campbell and Ademola (2014) investigated the possible effects of abattoir effluent on the underground water quality around the Ikotun area of Lagos State, and came up with various pieces of advice for the residential neighbours to the abattoir because of the disparity of water quality to the standards that could influence health risk. The research conducted by Njoku-Tony *et al.* (2018) tailored water pollution as a major environmental problem to the possible effects of abattoir effluent on a river water quality in Delta State and the authors expressed that the aquatic life could suffer detrimental effects from the abattoir discharged effluents.

Oboh *et al.* (2018) investigated a community for its possible groundwater quality defaced from the abattoir waste discharge and saw the necessities for abattoir effective hygiene practice and surroundings' groundwater monitoring. The research of Ojekunle *et al.* (2020) confirmed possible intrusion of abattoir discharge on water quality within Abeokuta metropolis and called on the regulatory agents to persuade the slaughters to exercise befitting care for water sources around them.

Thus, the environmental implications associated with the slaughtering activity are inevitable, whereas making an environment habitable is the sustainable development goal (SDG) of every human activities. The SDG 3 encourages good health and well-being. Good health starts from what every individual consumes which should not be polluted from human activities. Activity such as slaughtering of animals directly or indirectly affects the quality of environment and its resources such as water. Polluted water has no regards for the health of individual across all ages as it could shorten human life expectancy, thereby calling for water quality to be wholesome for human consumption.

Water for human consumption should not contain chemical substances or micro-organisms in amount that could cause hazard to health. Water becomes polluted when it is unfit for its intended use. The self–purification process of ground water is a function of the depth of the soil and the concentration of the pollutant percolating into the aquifer (Mbuligwe and Kaseva, 2005). Therefore, bacterialogical and physicochemical contents examination of water for its drinkability and quality is a scientific evidence and powerful tool to unravel presence of hazards that might constitute health risks.

UNESCO (2006) mentioned that microorganisms commonly used as indicators while Boyd (2020) outlined physicochemical parameters worthy of being investigated for water quality to be drinkable for human consumptions. The study chose Oko-Oba Abattoir in Agege Local Government Area of Lagos State, Nigeria.

Methodology

Study Area

The Oko-Oba abattoir is located at Agege (longitude 3° 17′ 01″N and latitude 6° 39′32″E), a suburb and Local Government Area in the Ikeja Division of Lagos State. Nigeria. Before ten decades ago, Agege locality was an agro area. It was a Local Government Area around 1954 but was linked with the state capital (i.e., Ikeja) in 1967. There had been migration persons into the area for various reasons. When the Lagos became capital of Nigeria in 1914, Agege became a comfortable settlement because of its nearness to the Lagos State capital, Ikeja (Emetere, Afolalu and Peters, 2021). Climate of Agege is tropical with mostly significant monthly rainfall throughout the year with minimal effect of short dry season. The mean temperature of Agege area is 26.4 °C (79.5 °F) while the yearly rainfall is 1645 mm (64.8 inch).

The Oko-Oba abattoir in Agege is one of the largest and best organized abattoirs in Nigeria and receives cattle from various mostly northern parts of Nigeria, even from the countries in West Africa sub-region that includes Niger, Chad, Burkina Faso, Mali and Cameroon (Cadmus, Olugasa and Ogundipe, 2006). Although the abattoir has the daily maximum handling more than one thousand and three hundred (1300) cattle, it presently operates on average one thousand (1000) cattle capacity daily. It provides meat to cosmopolitan population in Lagos State.

The wastes from the slaughtering and the dressing grounds in Oko-Oba abattoir are washed untreated into open drainages and carried into the nearby water channels. The animal wastes like intestinal contents are usually dumped in a designated place within the abattoir, they have formed a dunghill which generates odour. Table 1 shows coordinates of water collection points around the abattoirs.

Table 1: Coordinates of the Sampling Points

Samples	Latitude	Longitude
Effluent	6° 39′ 34″	3° 17′ 05″
Sample A	6° 39′ 38″	3° 17′ 04″
Sample B	6° 39′ 49″	3° 17′ 00″
Sample C	6° 39′ 26″	3° 17′ 01″
Sample D	6° 39′ 95″	3° 17′ 02″
Sample E	6° 39′ 55″	3° 17′ 03″
Sample F	6° 39′ 49″	3° 17′ 00″
Sample G	6° 39′ 50″	3° 17′ 01″
Sample H	6° 39′ 54″	3° 17′ 01″
Sample I	6° 39′ 48″	3° 17′ 02″
Sample J	6° 39′ 47″	3° 17′ 04
Negative control	6° 39′ 85″	3° 17′ 09″

Collection of Water Samples

Water samples were randomly and aseptically collected in 5 litre capacity amber bottles from ten (10) surrounding residences (A-J) around the abattoir. Two control samples, abattoir effluent (positive control) and another water located 500 m away (negative control), were also collected at the running taps for analyses and comparison with the ten groundwater samples around the Oko-Oba, Agege, Abattoir. The samples were not taken near the septic tanks and soak away across the locations. The containers were covered immediately to avoid contamination, kept in the cooler containing pieces of ice, and transferred immediately to the laboratory. The samples were later stored in the laboratory refrigerator at 4 ^{0}C before the commencement of analyses, which were carried out in the Lagos State Environmental Protection Agency (LASEPA) laboratory.

The standard analytical methods used for the determination of physicochemical parameters of the water samples and effluent were from series of standard methods of examination of water and effluent of the American Public Health Association (APHA, 2008).

Preparation of Culture Media and Samples Inoculation

The media used for this laboratory analysis were total plate count agar (for general isolation), MacConkey (MCA) for coliform test and eosin methylene blue (EMB) agar for confirmatory coliform test. All were prepared according to manufacturers' prescription. All samples were diluted serially in tenfold (10^{-10}) for bacteriological analysis. From tenfold serial dilution of each sample 1 mL each from a sample was pipetted and introduced into already washed petri dish (in triplicate), sterilized in the oven at 170 ^{0}C for one hour and with introduction of three media at 45^{0}C respectively using pour plate method under aseptic condition. The processes were repeated for all the samples and labelled accordingly. Thereafter, the plates were gently shaken/ rocked for each sample to mix thoroughly with the used medium and allowed to cool and set before being transferred into refrigerator at 4 ^{0}C for 48 hours. After 48 hours, plates were removed from refrigerator and read for colonies in each plate.

Statistical Analysis

Obtained data were descriptively (mean and standard deviation) and inferentially (ANOVA) analysed at the $p < 0.05$ level of significant difference using SPSS version 23.

Results

The results observed abattoir discharges to have polluting effects on the groundwater drinkable water within the abattoir study environment. Both microbial and heavy metal loads were assessed in April, 2021 when it is expected that rainy season should start from the indigenous knowledge of average Nigeria. The period was thought to have little impact on the activities of abattoir unlike when rain might have influence from erosion. Results of the bacteriological analysis in the positive control (abattoir effluent) did not fall below expectation. Hence, all parameters considered were (total plate count) positive comparing to the LASEPA standard of 350 cfu/mL for effluent. Coliform and faecal coliform were also positive.

The total plate count in all the ten groundwater water samples except G conformed to WHO specification (100 cfu/mL) for drinkable water. Sample B unlike others had no growth of coliform count. Samples B and negative control (NC) tested negative to the faecal coliform confirmatory test and conformed to the WHO standard (-ve) (Table 2).

The result of the current study agreed with the work carried out by (Omole and Longe, 2008) that reported high presence of coliform (2.0×10^3 cfu/mL) and positive due to faecal coliform confirmation. Comparing results of the positive control and ten groundwater water samples with the negative control (500 m away from the abattoir), it was noticed that the groundwater water samples might be contaminated with abattoir discharges while the negative control had no coliform and faecal coliform except total plate count of 3 cfu/mL that was within the WHO limit (2008) (100 cfu/mL).

It is manageable as it seemed to be from mismanagement and carelessness of the fetcher/ drawer being used at the negative control well. Physicochemical parameters of the positive control (the abattoir effluent) with high remarks indicated nonconformity to the LASEPA effluent standard (2014) and susceptibility to pose harm to the consumers if percolated the soil and penetrated neighbouring groundwater water sources.

The effluent dissolved oxygen (DO) indicated high (2.1 mg/L) and slightly above the LASEPA limit (2014) (2 mg/L). Among the parameters with values within the LASEPA limits (2014) were pH: 6.3 and temperature: 26.4 ^{0}C (Table 3).

For the physicochemical parameters of the ten groundwater water samples, none was higher than the WHO limits (2008) except the electrical conductivity (EC) of sample G (3.4 µS/m) higher in three manifolds than the WHO limit (2008) (1.0 µS/m). The pH values (4.5 - 5.7) of the ten groundwater water samples were acidic compared with the WHO limit (2008) (6.5-8.5). Parameters with the same superscripts across the rows were not significantly different with their *p values* > 0.05 (Table 4).

Table 2: Bacteriological Contents in Water Samples

Abattoir Effluent (Positive control)			
Bacteriological parameters	Effluent	LASEPA (2014)	Remark
Total plate count	50	350 cfu/ ml	— ve
Presence of coliform	+ve	—ve	+ve
Faecal coliform confirmation	+ve	—ve	+ve

Drinkable Water Samples	A	B	C	D	E	F	G	H	I	J	NC	WHO (2008)
Total plate count	5	80	10	100	100	80	TNTC	10	46	80	3	100 cfu/ ml
Presence of coliform	34	Nil	1200	1200	46	2400	2400	2400	2400	2400	– ve	Nil
Faecal coliform confirmation	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	– ve	– ve

A – J = ten ground water samples collected around abattoir; NC = negative control;
WHO = Word Health Organization; TNTC = too numerous to be count;
LASEPA = Lagos State Environmental Protection Agency.

Table 3: Physicochemical Parameters in Positive Control (Oko-Oba Abattoir Effluent)

Physicochemical parameter	Abattoir effluent	LASEPA (2014) limits	Remarks
Colour (Pt. Co. APHA)	3449.0±150	250.0	High
Odour	Bad odour	Odourless	High
Appearance	Brownish	Clear	High
Temperature (°c)	26.4±5.23	40	Low
pH	6.3±1.21	5.5-.9.0	Low
Turbidity (NTU)	8.4±3.2	4	Low
Conductivity (µS/m)	0.8±0.24	1.5	Low
Total Suspended Solids (mg/L)	1080.0±120	100.0	High
Total dissolved Solids (mg/L)	12,668.0±850	2100.0	High
Total Solids (mg/L)	13,748.0±970	2200.0	High
Total acidity (mg/L)	208.0±50	200	High
Total alkalinity (mg/L)	1045.0±124	200	High
Chloride (mg/L)	38.0±15	250.0	Low
Oil and grease (mg/L)	0.0	10.0	Low
Dissolved oxygen (mg/L)	2.1±0.9	2	High
Chemical oxygen demand (mg/L)	956.0±65	200.0	High
Biological oxygen demand (mg/L)	239.0±43	50.0	High

The physicochemical obtained values were comparable with the previous results of Omole and Longe (2008) where the groundwater surface (River Illo) water by abattoir got contaminated, having pH (6.64), EC (148.0 µS/cm), DO (2.24 mg/L), TS (620.8 mg/L), COD (78.2.9 mg/L) and BOD (312.9 mg/L). The obtained DO value was found to be good and conformed to the deduction of Hassan, Campbell and Ademola (2014). All physicochemical parameters of the groundwater water samples that were currently within the WHO limits (2008) could accumulate from minute (acute) to dangerous (chronic) levels prospectively. In turn, such levels could affect the life of abattoir workers and neighbouring people depending on the sources of the water. It can be deduced from the current results that negative control (500 m away from the abattoir) had better results such that the DO had higher value of 36.3 mg/L, indicating not being affected compared with the ten groundwater water samples (A-J) around the abattoir having lesser DO values of 4.5 – 5.8 mg/L.

Moreover, except pH value (7.1) of the negative control which was neutral and within the WHO limit (2008) (6.5-8.5), the ten groundwater water samples' pH values (4.5–5.7) were acidic to corroborate the findings of Makwe and Chup (2013) and not complied to be good for human consumption.

Trace and heavy metals of the abattoir effluent were observed to be minimally present and within the LASEPA limits (2014). The groundwater water samples were seemed to conform to the WHO limits (2008) but the macro elemental contents were too low to be neglected (Table 5). Presence of trace and heavy metals could be an indication of possible gradual seeping into the groundwater around the abattoir Hassan, Campbell and Ademola (2014) as the activities of butchers are daily handling nearly a thousand herds of cattle. The range of values (trace metals) obtained from ten sampled groundwater water compared with the negative control and the WHO limits (2008).

For the lead contents, all except sample of sites F (0.223 mg/L), and J and negative control (0.004 mg/L) had suspicious levels. The negative control also indicated nickel (0.01 mg/L) and cadmium (0.001 mg/L) which were tending towards the WHO limits (2008): 0.02 and 0.002 mg/L respectively. They may disappear as time goes on because of the self-purification ability of water (Mbuligwe and Kaseva, 2005). The current study observed that there were no serious anthropogenic activities that could pollute the water further as at the time the samples were taken.

The trace and heavy metals determined across the ten groundwater water samples were within the WHO limits (2008) (except location F, lead: 0.223 mg/L) for drinkable water. However, the study conceived that the water samples were contaminated but not at the chronic levels, which is gradually prospective. Such could be substantiated from the review of Ezeoha and Ugwuishiwu (2011) that abattoir discharges had inherent capacity to vilify groundwater water sources and the environment should proper care is lacked.

Table 4: Physiochemical Parameters of the Groundwater Samples

Parameter	A	B	C	D	E	F	G	H	I	J	NC	*p-values*	WHO (2008)
Appearance	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	NA	Colourless
Temperature°C	26.6±2.34b	26.6±2.26b	26.4±1.83b	26.1±4.10b	26.3±4.23b	26.5±5.05b	26.6±3.19b	26.1±7.00b	26.2±1.84b	26.5±4.57b	28.2±5.25a	0.049	35-40
pH	4.5±0.55c	5.0±1.20b	5.0±1.14b	5.7±1.32b	5.1±1.39b	4.5±1.05c	4.7±2.07c	4.6±2.34c	5.0±2.00b	5.0±1.25b	7.1±3.55a	0.046	6.5-8.5
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	NA	Odourless
Turbidity (NTU)	0.1±0.03a	0.1±0.04a	0.2±0.05a	0.2±0.05a	0.1±0.01a	0.1±0.01a	0.2±0.05a	0.2±0.05a	0.1±0.03a	0.1±0.03a	0.1±0.04a	0.062	5
Conductivity (µS/m)	0.2±0.04e	0.5±0.23c	1.0±0.54b	0.8±0.35c	0.1±0.02e	0.4±0.04d	3.4±2.70a	0.3±0.15e	0.1±0.04e	0.1±0.06e	0.1±0.34e	0.037	1
TSS (mg/L)	2.0±1.51c	BDL	BDL	1.0±0.58d	6.0±4.66b	1.0±0.75d	BDL	BDL	BDL	BDL	8.6±5.25a	0.027	30
TDS (mg/L)	986±320.0a	543±205.3c	365±93.6d	762±200.20b	824±250.3b	778±215.0b	221±55.0e	205±85.0e	469±125.0c	306±73.5d	102±33.0f	0.032	1200
Total solid (mg/L)	988±195.0a	543±62.0c	365±20.0d	763±154.0ab	830±155.0a	779±55.0ab	221±22.3e	205±19.3e	469±65.0c	306±13.0d	111±35.4f	0.048	NS
Acidity (mg/L)	39.0±1.5d	50.0±20.5c	49.0±29.2c	16.0±3.41e	43.0±5.43d	45.0±5.11d	85.0±17.4a	51.0±5.12c	58.0±20.50b	64.0±12.3b	40.0±12.0d	0.039	200
Alkalinity (mg/L)	9.0±2.90a	6.0±2.5b	7.0±1.30b	9.0±5.0a	6.0±1.90b	6.0±2.0b	3.0±1.5c	3.0±1.30c	5.0±2.90b	4.0±1.50c	4.0±2.10c	0.044	200
Total hardness (mg/L)	12±4.25f	32±4.9d	102±32.0b	114±35.4a	26±5.10e	32±6.3d	12±3.40f	50±5.10c	22±3.20e	20±4.20e	30±5.30d	0.028	100
Chloride (mg/L)	10.0±2.5d	33.0±6.20a	15.0±3.90d	27.0±8.2b	8.0±4.20e	20.0±2.20c	13±5.0d	16.0±3.10d	11.0±4.90d	8.0±3.90e	0.4±0.20f	0.036	250
Dissolved oxygen (mg/L)	4.9±2.40b	5.1±1.20b	5.3±3.14b	5.8±3.20b	5.2±2.35b	4.9±3.10b	4.5±2.30b	5.5±2.52b	5.4±3.42b	5.4±2.25b	36.3±16.30a	0.034	2
COD (mg/L)	136.0±30.15d	180.0±50.00b	178.0±39.51b	196.0±95.90a	150.6±30.40c	160.0±45.30c	170.0±51.20b	185.5±8.70b	193.2±95.60a	197.4±98.50a	120.8±35.60d	0.035	200
BOD (mg/L)	38.6±15.0b	48.3±5.55a	47.5±15.00a	48.7±11.62a	44.4±7.05a	46.2±2.55a	47.0±5.15a	48.6±10.43a	48.9±7.51a	49.1±10.00a	12.8±6.45c	0.46	50

Mean values with the same superscripts across the row were not significantly ($p > 0.05$) different.
A–J: ten groundwater water samples; NC: negative control; WHO: World Health Organization;
BDL: below detection limit of the analytical instrument; and NA: not applicable.

Table 5: Concentrations of Trace and Heavy Metals in Water Samples

Abattoir Effluent (Positive control)			
HM (mg/ L)	Abattoir effluent	LASEPA (2014)	Remarks
Magnesium	1.0±2.34	5.0	Low
Zinc	0.1±0.01	5.0	Low
Iron	0.6±0.23	10.0	Low
Sodium	0.2±0.11	NS	-
Manganese	0.1±0.05	5.0	Low
Lead	BDL	0.1	Low
Cadmium	BDL	2.0	Low
Potassium	1.5±0.65	200.0	Low
Nickel	BDL	3.0	Low
Silver	BDL	0.1	Low

Groundwater Water												
HM (mg/L)	A	B	C	D	E	F	G	H	I	J	NC	WHO (2008)
Magnesium	BDL	BDL	0.7c	0.1b	BDL	BDL	BDL	BDL	BDL	BDL	BDL	150.0
Sodium	BDL	0.6c	0.8cd	0.5c	0.3b	0.7bc	0.6c	0.8cd	0.3b	BDL	BDL	200.0
Potassium	BDL	BDL	1.1d	0.5c	BDL	0.1b	BDL	0.1b	BDL	BDL	BDL	20.0
Zinc	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
Manganese	BDL	BDL	0.2b	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5
Iron	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03
Nickel	0.01b	0.01b	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01b	0.02
Cadmium	0.001b	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001b	BDL	0.001b	0.002
Silver	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1
Lead	BDL	BDL	BDL	BDL	BDL	0.223c	BDL	BDL	BDL	0.004b	0.004b	0.015

HM: Heavy metal; NS: not specified; LASEPA: Lagos State Environmental Protection Agency; BDL: below detection limit of the analytical instrument; A–J: ten groundwater water samples; NC: negative control; WHO: World Health Organization.

Conclusion

This study concluded that abattoir discharges might have been direct into the surroundings without proper treatment because there were traces of the analysed parameters in the ten groundwater water samples comparing with the negative control.

Poor hygiene practices in the abattoir usually make the receiving ground water nearby unwholesome for domestic purposes. Thus, the study recommendations would revolve round the need for drainages to convey the abattoir wastewater to a safe and approved place to avoid environmental contamination, enforcement of the regular environmental sanitation in the abattoirs, proper generated waste from the abattoir activities before being discharged, waste management practices (reduction, re-use and recycling) through enabling government policies to convert abattoir wastes to useful products, abattoir inclusion among industrial or agricultural land use, the government to enforce abattoir to protect the nearby ground and surface water through existing or newly promulgated environmental laws, the environmental assessment to be conducted on abattoirs and its results be enforced for proper environmental action plan, and indiscriminate use of any unapproved place for abattoir should be stopped

Acknowledgements

The authors appreciate the prompt analysis of the Lagos State Environmental Protection Agency (LASEPA) Laboratory and cooperation of the residences surrounding the Oko-Oba abattoir.

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