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Environmental Impacts of Agbara Abattoir Waste on the Ecosystem of Ologe Lagoon, Nigeria

T. Y. Jimoh [a*], A. A. Olayeri [a], T. E. Falebita [a], G. A. Reis [a], B. I. Olufowobi [a], A. O. Saba [a], B. P. Akinbode [a], O. T. Olorunfemi [a] and P. N. Nwabuisi [b]

[a] *Department of Zoology and Environmental Biology, Faculty of Science, Lagos State University, Ojo, Lagos State, Nigeria.*
[b] *Department of Chemistry, Faculty of Science, Lagos State University, Ojo, Lagos State, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. Authors TYJ, AAO, TEF, AOS, and BIO designed the study. Authors TYJ, AAO, BIO, BPA, OTO, PNN, GAR, AOS, and TEF conducted the experiments and generated the data. Authors BIO, AAO, TEF and GAR analyzed the data. Authors AAO, AOS, OTO, and PNN managed the literature searches. Authors TYJ, AAO, TEF, GAR, BIO, and BPA drafted the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This research was conducted to investigate the effects of Agbara abattoir wastes dumped into the Ologe lagoon.

Place and Duration of Study: The study was conducted at Ologe lagoon in Lagos, Nigeria from September 2019 - December 2019.

Methodology: Water samples from the lagoon were collected monthly from three sites in the lagoon for four months. 30m before the entry site, the entry site of the abattoir wastes, and 30m after the entry site. After collection, the samples were analyzed for 13 parameters following the guidelines of the American Public Health Association (APHA).

Results: The result showed that the conductivity ranged between 80.94 to 139.93 (µS/cm). The pH ranged between 7.84 to 9.23. The total dissolved solids ranged between 44.00 to 110.24(mg/l). The total suspended solids ranged between 20.12 to 70.82 (mg/l). The ammonia ranged from 0.01 to 0.04 (mg/l). The biological oxygen demand ranged from 50.72 to 107.41 (mg/l). The chemical oxygen demand ranged from 202.94 to 497.17 (mg/l). The chromium ranged from 0.04 to 0.06 (mg/l). The coliform level ranged from 33.62 to 82.50 (cfu/100ml). The *Escherichia coli* ranged from

Corresponding author: E-mail: jimohtaofeek20@gmail.com;

1.20 to 3.30 (cfu/ml). The nitrate ranged from 2.74 to 4.55 (mg/l). The nitrite ranged from 0.22 to 0.69 (mg/l). The phosphate ranged from 6.89 to 11.33 (mg/l).
Conclusion: This research showed that the ologe lagoon is polluted and unfit for human consumption and aquatic life. Therefore measures should be put in place to ensure proper disposal of the abattoir wastes in other to increase the quality of the lagoon.

Keywords: Ologe lagoon; agbara abattoir; water quality; wastes; physico-chemical parameters; EPA.

1. INTRODUCTION

A healthy environment is essential to the existence of all living things, and there has been a surge in the concerns of humans in general regarding the environmental degradation from pollution and depletion of natural resources in the last few decades [1]. Due to the incessant increases in population growth especially in a West African country like Nigeria, there has been a significant increase in urbanization, industrialization, agriculture, mining, etc, all of which lead to the exploitation of natural resources [2]. The effects of this increase in population have led to the release of a large proportion of solid and liquid wastes into the surrounding environment and thus contribute to the undesirable effects of such wastes on both man and its environment [2]. Most of these waste products are generated from anthropogenic activities and an improper waste management system has been a major challenge to developing countries like Nigeria. Hence, the waste products are often left untreated and deposited or channeled directly into the aquatic environment. This act often results in a concomitant increase in water-borne diseases like dysentery, and typhoid. Abattoirs have been implicated to contribute immensely to the pollution of the surrounding environment either directly or indirectly from their various activities [2].

Abattoirs are buildings where animals are slaughtered for their meat and byproducts for food consumption and other purposes. The word "abattre" is of French origin denoting "to strike down" [3]. The Abattoir is a premise registered and approved by the state's authority controlling sanitary operations [4]. The operations carried out in the abattoir are not limited to the slaughter of animals alone, animals like cattle, ram, goats, etc. are dressed post-slaughter, and supplied or distributed for consumption to various markets and other relevant meat-products-related industries. The abattoir industries supply meat to the larger population of the Nigerian economy, and simultaneously provide employment opportunities to the population at large [5-6]. In the last few decades, there has been an increase in the production of meat from slaughterhouses to meet the demand of the ever-growing human population meat and protein requirements. The meat processing industry oftentimes releases a large volume of slaughterhouse wastewater (SWW) due to the slaughtering, dressing, and processing of animals and also through the cleaning of the slaughterhouse facilities and meat processing plants (MPPs), hence, an increase in the release of wastewater to the surrounding environment [7-8].

The volume, microbiological, and chemical composition of the SWWs determine their negative impact on the quality of the receiving water bodies [1]. The wastewater released into the environment from various abattoirs contains high suspended solid contents, with significant inorganic and biodegradable organic loads including protein, fiber, fecal matter, urine, blood, oil, grease, etc. all of which could degrade the quality of the water in the surrounding environment and endanger public health [9-10]. The biodegradable organic matter present in the SWWs competes highly with oxygen in the aquatic ecosystem causing a significant increase in the biochemical oxygen demand (BOD) with a depletion in the level of dissolved oxygen in the water and also producing foul odors, sludge deposits, and floating scum which could affect the quality of life of the aquatic organisms [9,11]. The presence of elements like phosphorus and nitrogen in these SWWs could form a nutrient enrichment course in the receiving water bodies causing eutrophication through the growth-stimulation of algae (i.e. an algal bloom). Algae blooming and deaths could result in the significant deaths of invertebrates of the benthic region and fishes due to hypoxia or anoxia occurring as a result of aquatic oxygen depletion at distances beyond the contamination origin, as well as toxins resulting from blue-green algae in the water [1,12].

Quite many water bodies in Lagos State (Nigeria) are at the receiving end of both industrial and domestic effluent discharges. Ologe lagoon receives both industrial effluents from adjacent Agbara Industrial Estate, where brewery, paint, pharmaceutical, glass, and a few other industries are established, and domestic effluents from the neighboring abattoirs[13]. An improper disposal system of wastes from slaughterhouses has been a contributory factor to the transmission of pathogens to humans. These wastewaters if left untreated could endanger the health of all biotic components of the surrounding environment [10]. The discharge of abattoir wastewater could impact negatively on both aquatic and terrestrial biodiversities, species sensitive to variation as a result of pollution may perish, and undesirable alteration in the ecosystem could infer serious human health hazards. This study was aimed at evaluating the effect of point discharge of the Agbara abattoir effluents on the water quality of the Ologe lagoon at the Agbara axis. The Agbara abattoir is located along the Lagos-Badagry expressway in Ogun state just miles away from the Adeniran Ogunsanya College of Education Otto Awori, Ijanikin Lagos Nigeria while the Ologe lagoon is one of the most economically important aquatic ecosystems in Lagos State, as it is located near the Agbara Abattoir and the Agbara Industrial Estate.

2. MATERIAL AND METHODS

2.1 Study Area

Ologe Lagoon is situated in the eastern part of Lagos State (Fig. 1), Nigeria. It has a surface area of about 64.5 km² and lies between latitude 6°27'N longitudes 3°02'E and 3°07'E. Ologe lagoon (Fig. 2) gets most of it's water from River Owo and it opens up into the Atlantic ocean through the Lagos harbour [13]. It serves as a source of income for fishermen in the area and it also serves as a means of transportation and for recreational activities [14].

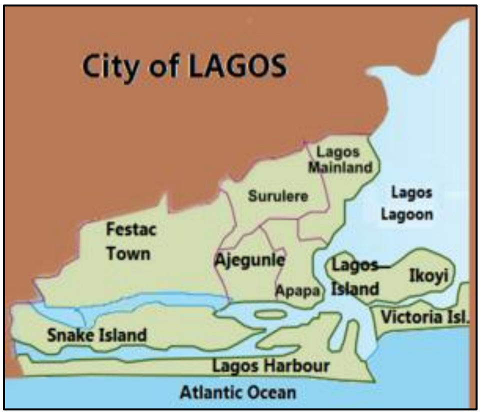

Fig. 1. Map of lagos

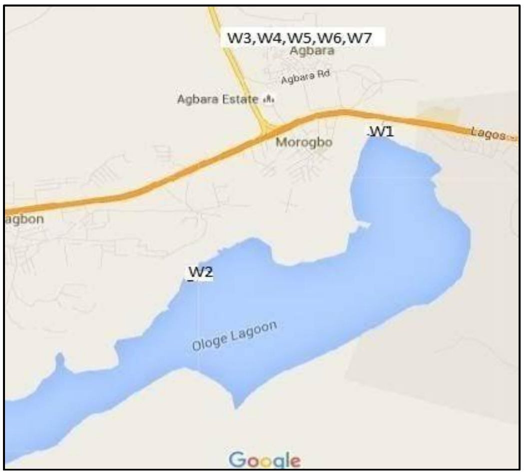

Fig. 2. Ologe Lagoon[15]

The Agbara abattoir is located at a mere 15 feet from the Ologe Lagoon. After the cattles are slaughtered and processed, their remains are dumped directly into the lagoon for it to be washed off. This has raised concerns as this could contribute to serious pollution of the lagoon.

2.2 Sample Collection

Water samples were collected from the Ologe Lagoon monthly from September 2019 - December 2019 at three sampling points which are in the vicinity of the Agbara abattoir. The first point of collection was 30m before the entry point of the abattoir effluent. The second point of collection was at the entry point of the abattoir effluent which is just about 5m away from the Agbara abattoir. The last point was 30m after the entry point of the lagoon effluent. Brand new 1L plastic containers were used to collect the samples at the three points. The samples were taken immediately to the laboratory for analysis.

2.3 Laboratory Analysis

Standard procedures were used to analyze collected water samples for chemical, physical and bacterial parameters in line with the guidelines [16-17]. Some of the parameters investigated include pH, biological and chemical oxygen demand, and *Escherichia coli.*

3. RESULTS AND DISCUSSION

13 parameters of the lagoon water samples were analysed and the results were compared against the World Health Organization [18], and the Federal Environmental Protection Agency of Nigeria [19] limits on safe water. The results are shown in the tables.

The water samples taken from Ologe Lagoon ranged in conductivity from 80.94 to 139.93 (µS/cm) (Table 1). The samples taken at the entry site had the maximum conductivity, while the ones taken 30 meters before the entry site had the lowest conductivity, measuring 80.94 (µS/cm). The conductivity levels at the three sites were well below the recommended limits of FEPA and WHO for safe water. This result is in line with [20] in which the conductivity of their study were well below FEPA and WHO limits and the point in where the abattoir waste came in contact with water had the highest conductivity. The water samples taken from Ologe Lagoon ranged in pH from 7.84 to 9.23 (Table 1). The samples taken at the entry site had the maximum pH, while the ones taken 30 meters before the entry site had the lowest pH, measuring 7.84. The pH of the sample from 30m to the entry point was within the acceptable limits set by FEPA and WHO, while the pH of the samples gotten from the entry site and 30m after the entry site were above the recommended limits set by FEPA and WHO. The pH of the water samples indicated alkalinity and this is in agreement with the work of [21].

The water samples taken from Ologe Lagoon ranged in total dissolved solids from 44.00 to 110.24(mg/l) (Table 1). The samples taken 30m before the entry site had the maximum total dissolved solids, while the ones taken 30 meters after the entry site had the lowest total dissolved solids, measuring 44.00(mg/l). The tds levels at the three sites were well below the recommended limits of FEPA and WHO for safe water. The water samples taken from Ologe Lagoon ranged in total suspended solids from 20.12 to 70.82 (mg/l) (Table 1). The samples taken 30m before the entry site had the maximum total suspended solids, while the ones taken 30 meters after the entry site had the lowest total suspended solids, measuring 20.12 (mg/l). The tss levels at the three sites were well below the recommended limits of FEPA for safe water. The results showed that the abattoir wastes reduced both parameters and this is in line with [20]. From the results it can be inferred that the Agbara abattoir waste raised the level of conductivity and pH in the Ologe lagoon. Thus, the point at 30m before the entry site had the lowest levels because they had not become contaminated. The total dissolved solids and total suspended solids were lowest at 30m after the entry site and it could be as a result of biodegradation caused by the introduced bacteria from the wastes, self purification, and diffusion.

The water samples taken from Ologe Lagoon ranged in Ammonia from 0.01 to 0.03 (mg/l) (Table 2). The samples taken at the entry site had the maximum ammonia because of the effluent discharge, while the ones taken 30 meters before the entry site had the lowest ammonia, measuring 0.01 (mg/l). The ammonia levels at the three sites fell within the acceptable limits recommended by FEPA for safe water.

Table 1. Results of the physical parameters of Ologe water samples

Parameters	30m before entry site	Entry site	30m after entry site	WHO limits [18]	FEPA limits [19]
Conductivity (µS/cm)	80.94	139.93	126.79	-	1000
pH	7.84	9.23	8.66	6.5-8.5	6-9
Total dissolved solids (mg/l)	110.24	70.1	44.00	600	1500
Total suspended solids (mg/l)	70.82	31.33	20.12	-	30

Table 2. Results of the biological and chemical parameters of the Ologe water samples

Parameters	30m before entry site	Entry site	30m after entry site	WHO limits	FEPA limits
Ammonia (mg/l)	0.01	0.04	0.03	-	0.5
Biological Oxygen Demand (mg/l)	50.72	107.41	80.36	-	30
Chemical Oxygen Demand (mg/l)	202.94	497.17	350.67	-	80
Chromium (mg/l)	0.06	0.04	0.05	0.05	-
Coliform (cfu/100ml)	33.62	82.50	71.80	10	10
E. coli (cfu/ml)	1.20	3.30	1.80	0	0
Nitrate (mg/l)	2.74	4.55	3.99	50	-
Nitrite (mg/l)	0.22	0.41	0.69	3	-
Phosphate (mg/l)	6.89	11.33	9.36	-	-

The water samples taken from Ologe Lagoon ranged in Biological Oxygen Demand from 50.72 to 107.41 (mg/l) (Table 2). The samples taken at the entry site had the maximum BOD, while the ones taken 30 meters away from it had the lowest BOD, measuring 50.72 (mg/l). The BOD levels at the three sites well exceeded the recommended limits of FEPA for safe water. The water samples taken from Ologe Lagoon ranged in Chemical Oxygen Demand from 202.94 to 497.17 (mg/l) (Table 2). The samples taken at the entry site had the maximum COD, while the ones taken 30 meters away from it had the lowest COD, measuring 202.94 (mg/l). The COD levels at the three sites well exceeded the recommended limits of FEPA for safe water. The high level of BOD and COD at the entry point was as a result of the waste dumped there from the abattoir. This is in line with the work of [22]. The BOD level was highest at the entry point because of the discharged untreated abattoir wastes, and lowest 30m before the entry point as it had not been contaminated. The COD levels in the lagoon also showed a positive correlation with the BOD levels, as it increases when concentration of organic matter increases. The water samples taken from Ologe Lagoon ranged in Chromium from 0.04 to 0.06 (mg/l) (Table 2). The samples taken at 30m before the entry point had the maximum chromium, while the ones taken at the site of entry had the lowest chromium, measuring 0.04(mg/l). The chromium level at 30m before the entry site was above the WHO acceptable limits while the chromium level at the other sites were within the acceptable limits. The water samples taken from Ologe Lagoon ranged in Coliforms from 33.62 to 82.50 (cfu/100ml) (Table 2). The samples taken at the entry site had the maximum coliforms, while the ones taken 30 meters away from it had the lowest coliforms, measuring 33.62 (cfu/100ml). The coliforms levels at the three sites well exceeded the recommended limits of FEPA and WHO for safe water. The water samples taken from Ologe Lagoon ranged in *E. coli* from 1.20 to 3.30 (cfu/ml) (Table 1). The samples taken at the entry site had the maximum *E. coli,* while the ones taken 30 meters away from it had the lowest *E. coli,* measuring 1.20 (cfu/ml). The *E. coli* levels at the three sites well exceeded the recommended limits of FEPA and WHO for safe water. The high level of coliforms and *E. coli* at the entry site was normal because the wastes from the abattoir were not treated before they were dumped. It could also be because the fecal wastes of the abattoir workers, were dumped directly into the lagoon. This two factors would have made the water contaminated.This result is comparable to the study of [23] who showed that abattoir wastes are a great source of coliforms and *E. coli.*

The water samples taken from Ologe Lagoon ranged in Nitrate from 2.74 to 4.55 (mg/l) (Table 2). The samples taken at the entry site had the maximum Nitrate, while the ones taken 30 meters away from it had the lowest Nitrate, measuring 2.74 (mg/l). The Nitrate levels at the three sites were well below the recommended limits of WHO for safe water. The water samples taken from Ologe Lagoon ranged in Nitrite from 0.22 to 0.69 (mg/l) (Table 2). The samples taken at 30m after the entry site had the maximum Nitrite, while the ones taken 30 meters away from it had the lowest Nitrite, measuring 0.22 (mg/l). The Nitrite levels at the three sites were well below the recommended limits of WHO for safe water. The nitrate and nitrite levels were at their peak at the entry site and this is in line with the work of [24] when they studied the impact of abattior wastes on a waterbody. The water samples taken from Ologe Lagoon ranged in Phosphate from 6.89 to 11.33 (mg/l) (Table 2). The samples taken at the entry site had the maximum Phosphate, while the ones taken 30 meters away from it had the lowest Phosphate, measuring 6.89 (mg/l).

4. CONCLUSION

This study has shown that untreated wastes from the Agbara lagoon contaminated the Ologe lagoon, and caused an increase in some parameters such as the ammonia, BOD, COD, conductivity, coliforms, *E. coli*, pH, and nitrate. This could be seen as the highest levels of many parameters were detected the entry point while the lowest were detected at 30m before the entry point. Thus, the contamination has made the lagoon water exceed the recommended limits on parameters like BOD, COD, coliforms, and E. coli set by the World Health Organization and the Nigerian Federal Environmental Protection Agency. This has made the Ologe lagoon unsafe for both human consumption as it could result in a disease outbreak, and for aquatic life. It is recommended that there should be a stop to the indiscriminate dumping of abattior wastes into the lagoon. The liquid waste should be collected, treated and used for irrigation as a means to put the wastes into good use, and therefore ensure good quality of the lagoon water and the environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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