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Assessment Of Physicochemical Properties Of Abbatoir Effluent On Oko Oba River In Agege, Lagos Nigeria

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ABSTRACT
Activities of Abattoir and its impact on the ecosystem has been an issue of major concern. This study delves into the assessment of physicochemical properties within Oko-Oba River in Agege, Lagos, Nigeria, with a specific focus on the potential influence of abattoir effluent on the quality of Oko-Oba River in Agege. The study involved the collection of water samples from strategic locations along the river, including the Point of Discharge (POD) of the abattoir and stream sites. An array of physicochemical parameters were analyzed, encompassing temperature, pH, turbidity, conductivity, total dissolved solids (TDS), total suspended solids (TSS), total hardness, dissolved oxygen, chemical oxygen demand (COD), and biochemical oxygen demand (BOD). Study's findings unveiled discernible variations in physicochemical parameters in Oko-Oba River. The Point of Discharge (POD) from the abattoir exhibited higher turbidity and lower dissolved oxygen, signifying potential pollution sources and environmental stress. The study found that Abattoir effluent have significant impact on the Oko-Oba River (R = 0.999). In order to mitigate the detrimental impacts of abattoir effluent on Oko-Oba River, recommendations include the implementation of efficient wastewater treatment systems, regular monitoring, community awareness campaigns, adoption of sustainable technologies, collaborative efforts among stakeholders, further research initiatives, and legislative reforms.
Keywords: Abattoir, Abattoir effluent, Point of Discharge, Stream Sites

INTRODUCTION

An abattoir, sometimes referred to as a slaughterhouse, is an establishment engaged in the butchering of animals for the purpose of meat processing and the production of other commercial items (Moreroa&Basitere, 2022). Various commercial commodities may be derived from different parts of animals. For instance, dung can be used for manure production, while the skin or hide can be utilized in the leather business. Bones can be processed into chicken food, as well as used for the creation of pharmaceuticals and cutlery. Fats can be utilized in the manufacture of tallow, and blood can be processed into blood meal.Abattoir is one of the largest consumers of water with over 2000 Gm3 of water required per year for the animal production (Akanni *et al.*, 2019). This high volume of water for the meat production yields considerably equal amount of wastewater to be discharged. This abattoir waste contains several compositional elements such as potential pathogens, biodegradable organic compounds and odor producing elements (Akanni *et al.,* 2019).

The wastewater discharged from Abattoir vary in pollution content ranging from organic to inorganic pollutants. The need for regular surveillance, pre-treatment and treatment of water bodies is of utmost importance in this generation so as to maintain the sustainability of the environment (Akanni *et al.,* 2019). Abattoir sludge which originates from high strength wastewater needs to be properly disposed of (Eryuruk *et al*., 2018). Abattoirs globally have been recognized for their potential to cause environmental pollution, either via direct or indirect means, as shown by Emmanuel and Odafivwotu (2023). Direct pollution refers to the act of disposing waste into water and land surfaces without prior treatment, often due to the lack of appropriate facilities. On the other hand, indirect pollution occurs when waste from abattoirs' dumpsites is transported by runoff into nearby water bodies or the surrounding environment (Ukoji & Ndakara, 2021).

Abattoir Effluent is undeniably a significant and immediate contributor to the pollution of surface and groundwater in developing nations, particularly in Nigeria. This is primarily due to the strategic placement of abattoirs in close proximity to river bodies, aiming to facilitate convenient access to water for processing operations (Emmanuel &Odafivwotu, 2023). Similar to other types of waste, the improper management and disposal of agricultural waste (AW) may provide significant risks to both the environment and human health (Ohwo&Ndakara, 2022).According to Emmanuel and Odafivwotu (2023), a significant number of byproducts, such as blood, flesh, and fat, are lost as waste during the processing of meats at abattoirs. These waste materials are often disposed of in designated waste areas inside the slaughterhouse premises or directly discharged into nearby rivers.

Therefore, the aim of this study is to determine the physiochemical properties of abattoir discharge (Wastewater) on Oko-Oba River in Agege, Lagos, Nigeria. This is a critical endeavor with significant implications for environmental protection, human health, and sustainable industrial practices, the findings of this study can inform policy decisions, drive responsible industrial practices, and ultimately contribute to the well-being of both ecosystems and communities impacted by abattoir operations.

MATERIALS AND METHODS

Study Area

The study area for the assessment of water quality in the Oko-Oba River in Agege, Lagos, is a critical environmental and geographical region within Nigeria. It encompasses a specific stretch of the Oko-Oba River and its surrounding environment.The Oko-Oba River is situated in Agege, a suburban area located in Lagos State, Nigeria, with coordinates approximately 6.3964° N latitude and 3.1906° E longitude. This river is a notable watercourse in the Lagos metropolitan area, serving as a vital natural resource for the local communities. It flows through a mix of urban, semi-urban, and rural landscapes, making it susceptible to various environmental pressures.The specific study area along the Oko-Oba River covers a defined segment of its course, including multiple sampling points. The extent of the study area may encompass the riverbanks, adjacent land areas, and relevant nearby infrastructure.

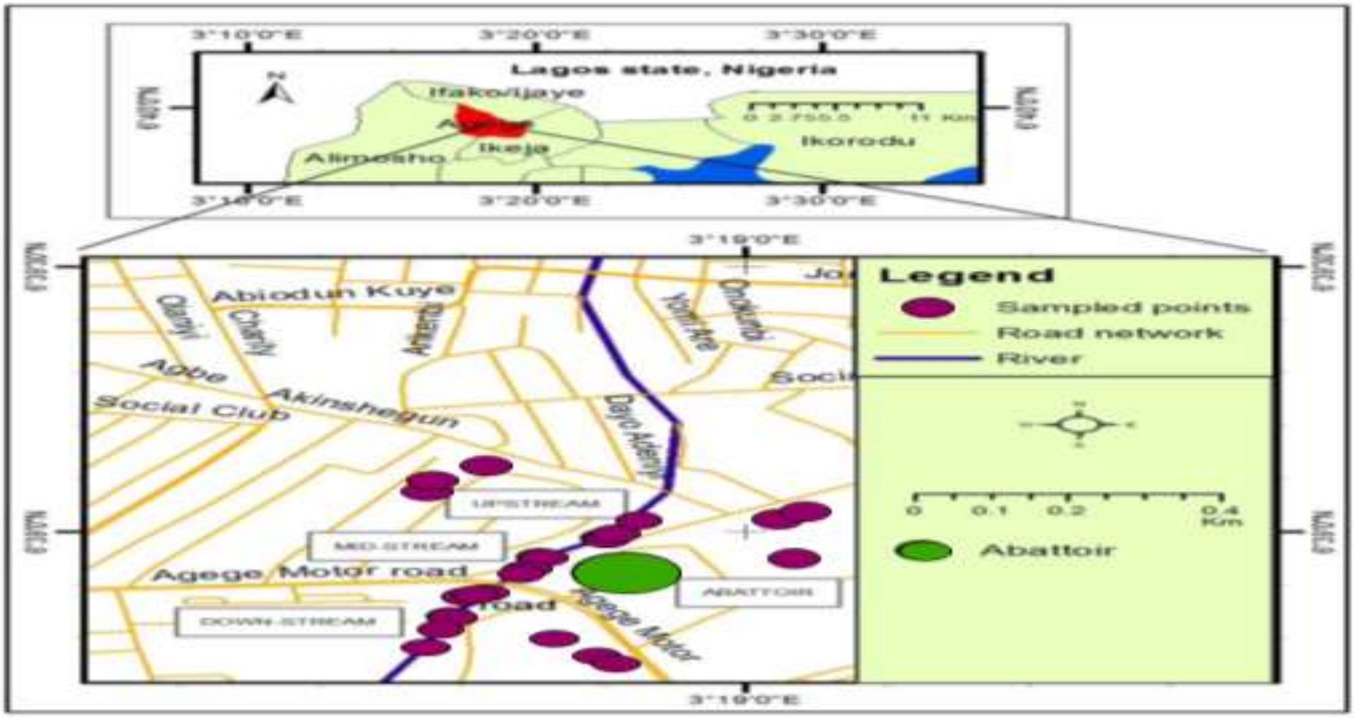

Figure 1: Map of the study area showing sampling points on the Oko-Oba River

Procedures

An experimental research design was used for assessing the water quality of the Oko-Oba River in Agege, Lagos. It encompasses both experimental aspects, such as laboratory analyses of water samples for physicochemical parameters and observational components, field surveys to assess environmental conditions and human activities near the river.Water samples from the Oko-Oba River and the Abattoir point of discharge were included in the study. This study excluded water samples from all other water body in and out of Agege.

The study utilized a convenience sampling technique in selecting water sampling points around the river and point of discharge. For the collection of water samples from the river, four sample points were utilized namely; Close to Upper River, Upper River, Mid-River and Down River.

Water samples from 7 different points and areas were collected for water quality analysis. The water samples were collected from the river in well-labeled 1-litre plastic bottles. The samples were labeled US1, US2, US3, MS1, MS2, MS3, DS1, DS2, DS3, LPOD1, LPOD2, LPOD3, LPOD4, LPOD5, RPOD1, RPOD2, RPOD3, RPOD4, RPOD5, POD1 POD2, CUS1, CUS2, CUS3, CUS4 and CUS5. Water samples were immediately transported to laboratory for analysis in accordance with Association of Official Analytical Chemists [AOAC, 2015] recommendations. Results Obtained was also compared with World Health Organization (WHO 2015) standard.

This study examined twenty (10) parameters of physical and chemical from each of the samples analyzed namely, Temp(^{0}C), pH, Turbidity (NTU), Conductivity(µs/cm), TDS(mg/L), TSS(mg/L), Total hardness, DO (mg/L), COD (mg/L), BOD (mg/L). The criteria behind the selection of these parameters are based on the Physiochemical parameters being the common pollutant elements in surface water.

Method of Data Analysis

The obtained data were coded and then subjected to descriptive statistical analysis such as mean, standard deviation, coefficient of variation, table, range as well as inferential statistics like correlation and regression. Correlation analysis was used to verify the relationship between examined parameters with the aid of IBM-SPSS (v27), Microsoft Excel 2019 edition and ArcGIS 2021 edition.

RESULTS

Table 2: Physio-chemical parameters observed in water samples

Level of Physio-chemical

P	POD	UPPER RIVER	MID RIVER	DOWN RIVER	C.UPPER RIVER	L.POD	R.POD	WHO LIMIT
Temp	26.96±0.12	28.22±0.46	27.32±0.39	28.04±0.58	27.14±0.29	27.67±0.44	27.56±0.52	40
PH	7.04±0.13	7.55±0.08	6.58±0.11	6.95±0.07	6.84±0.22	7.28±0.13	7.22±0.16	6.5-8.5
Turbidity	52.61±4.67	9.01±0.42	24.22±2.25	14.15±0.84	6.19±0.9	5.66±0.92	8.57±0.66	5
Conductivity	661.2±20.74	538.2±22.6	547.3±12.65	453±9.34	505±22.83	482.5±10.59	411.5±39.01	1000
TDS	263.9±2.9	263.2±11.92	241.1±3.53	215.1±4.43	262.2±11.85	235.8±5.32	202.3±19.58	500
TSS	90.21±2.2	91.65±7.05	80.66±1.68	68.71±1.42	87.4±3.95	77.09±1.24	65.53±4.81	35
Total hardness	14.73±1.24	14.31±0.72	14.31±0.29	13.92±0.57	15.38±0.69	13.76±0.41	11.88±1.18	150
DO	6.99±0.18	8.18±0.19	6.9±0.17	8.04±0.32	7.41±0.11	6.6±0.13	5.61±0.48	5
COD	48.98±9.09	41.6±2.02	39.36±0.97	50.45±2.04	17.08±0.26	45.6±0.88	38.72±3.33	1000
BOD	26.58±5.88	21.5±0.81	22.54±0.56	27.73±1.12	12.3±0.19	25.3±0.4	21.61±1.67	0

The physio-chemical properties of the water samples are shown in table 4.1. The temperature of water samples varies across the different sampling points. At the Point of Discharge (POD), the water temperature is recorded at 26.96°C, while upRiver, it is slightly higher at 28.22°C. This suggests that the water becomes slightly warmer as it flows downRiver. The pH levels of the water samples also exhibit variations at different locations. The Point of Discharge (POD) shows slightly acidic conditions with a pH of 7.04, while upRiver, the water is slightly more alkaline at 7.55. A more acidic environment downRiver (pH 6.95) could have implications for aquatic life, potentially affecting the health of aquatic organisms. Turbidity levels in the water samples vary significantly across the sample points. The Point of Discharge (POD) exhibits the highest turbidity at 52.61, indicating a high concentration of suspended particles. High turbidity reduces light penetration in water, affecting photosynthesis and aquatic habitats. Lower turbidity levels

Conductivity measures the ion concentration in water and provides insights into its salinity. The highest conductivity is observed at the Point of Discharge (POD) with a value of 661.2 µS/cm. The lowest conductivity is observed at right point of POD. High conductivity may indicate the presence of pollutants or dissolved salts, potentially originating from industrial or anthropogenic sources. TDS (Total Dissolved Solids)levels in water samples vary across the sample points. The Point of Discharge (POD) records the highest TDS concentration at 263.9 mg/L, indicating a higher presence of dissolved solids. Elevated TDS levels may result from pollution or natural geological factors. Lower TDS values upRiver and in the branches of the point of discharge suggest relatively cleaner water with fewer dissolved solids.The highest TSS is observed at the upper River with a value of 91.65 mg/L. Elevated TSS levels can degrade water quality and harm aquatic life. Lower TSS values upRiver and in the branches of the point of discharge suggest better water quality in those areas, with fewer suspended particles.

Total hardness measures the concentration of calcium and magnesium ions in the water. The Point of Discharge (POD) shows the highest total hardness at 14.73 mg/L as $CaCO_3$. Elevated hardness levels may result from geological factors or the presence of calcium and magnesium ions. Lower hardness values upriver and in the branches of the point of discharge suggest potentially softer water in those areas.Dissolved oxygen levels vary across the sample points. Upriver, the water is well-oxygenated with the highest DO of 8.18 mg/L. However, the Point of Discharge (POD) and the right POD exhibit lower DO values OF 5.61, indicating potential oxygen depletion due to pollution or organic matter decomposition. Low DO levels can harm aquatic organisms and signify poor water quality in those areas.The highest COD concentration is observed at the downRiver at 50.45 mg/L. Elevated COD levels suggest the presence of organic and inorganic pollutants, which can degrade water quality downRiver. Lower COD values up River and in the branches of the point of discharge indicate relatively cleaner water in those areas.

Concerning the BOD, the highest BOD is recorded at the Point of Discharge (POD) with a value of 26.58 mg/L. Elevated BOD indicates the presence of biodegradable organic matter, which can deplete oxygen levels and harm aquatic ecosystems downRiver. The lowest BOD of 12.3 mg/L is observed at the Close upper River.In summary, the physio-chemical parameters of the water samples exhibit variations across different sample points, indicating potential differences in water quality and environmental conditions. The highest concentrations of various parameters, such as turbidity, TDS, TSS, COD, and BOD, at the Point of Discharge (POD) and downRiver locations, may suggest a higher level of pollution and environmental stress in these areas. These findings underscore the importance of continued monitoring and potential remediation efforts to safeguard water quality and protect aquatic ecosystems in the affected regions.

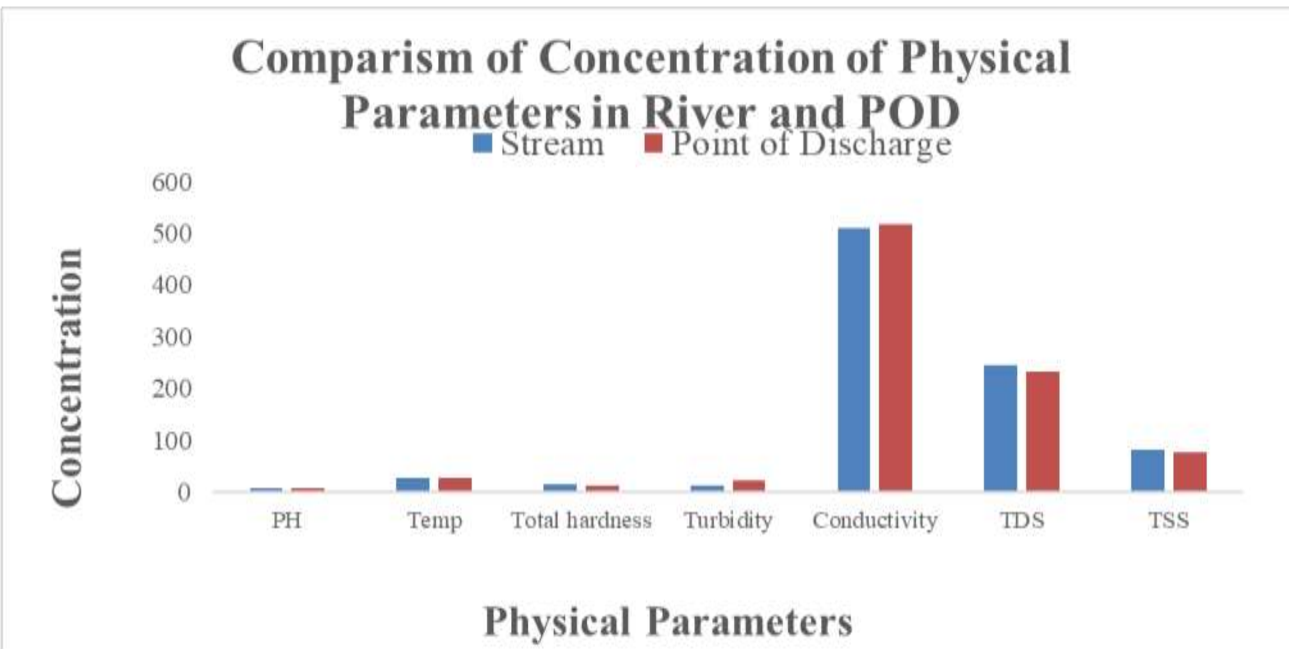

Figure 3: Concentration of physical parameters in water samples from POD and River

Concentration of Physio-chemical in River and POD

The physical parameters as shown in figure 3 above, shows that the River has a slightly acidic pH of 6.98, while the point of discharge has a slightly higher pH of 7.18. The lowest pH is at the River, indicating mildly acidic conditions, which could be due to natural factors. The higher pH at the point of discharge may suggest an influence from industrial or human activities, potentially indicating the release of alkaline substances. Water temperature is a crucial parameter that influences aquatic life and the overall health of a waterbody. In the data, both the River and point of discharge have relatively similar temperatures, with the River being slightly cooler at 27.14°C and the point of discharge at 27.4°C. The minor temperature difference may not have significant ecological implications, but it's essential to monitor temperature to ensure it remains within acceptable ranges for local aquatic organisms.

Total hardness measures the concentration of calcium and magnesium ions in water. It can affect water quality and the suitability of water for industrial or domestic use. The River has a higher total hardness of 14.48, while the point of discharge has a slightly lower value of 13.46. The River's higher hardness may result from natural geological factors, while the lower hardness at the discharge point might indicate dilution or the absence of calcium and magnesium ions. Turbidity measures the cloudiness or haziness of water caused by the presence of suspended particles. In the data, the River has a lower turbidity of 13.39, whereas the point of discharge shows significantly higher turbidity at 22.28. The high turbidity at the point of discharge suggests the presence of a substantial amount of suspended particles or sediment in the water.

Conductivity measures the ability of water to conduct electrical current, which is influenced by dissolved salts and ions. The River has a slightly lower conductivity of 510.88, while the point of discharge has a slightly higher value of 518.4. These differences in conductivity may be due to variations in ion concentrations or the introduction of specific chemicals at the point of discharge. High conductivity can indicate contamination by industrial or agricultural runoff, which could have adverse ecological implications down-River. TDS measures the total concentration of dissolved substances in water, including minerals, salts, and organic matter. The River has a higher TDS value of 245.4, while the point of discharge has a slightly lower TDS value of 234. These differences could be due to the natural variability of dissolved substances in the environment.

TSS measures the concentration of suspended particles in water, such as silt, sediment, and organic matter. The River has a higher TSS value of 82.11, while the point of discharge has a slightly lower TSS value of 77.61. Elevated TSS in the River might result from natural erosion processes, while the lower TSS at the discharge point suggests the potential for sediment settling or filtration in the discharge system. In summary, different parameters provide slightly different perspectives on water contamination. Turbidity and TSS suggest that the point of discharge is more contaminated due to higher levels of suspended particles and sediment. However, TDS suggests that the River may have a higher concentration of dissolved substances.

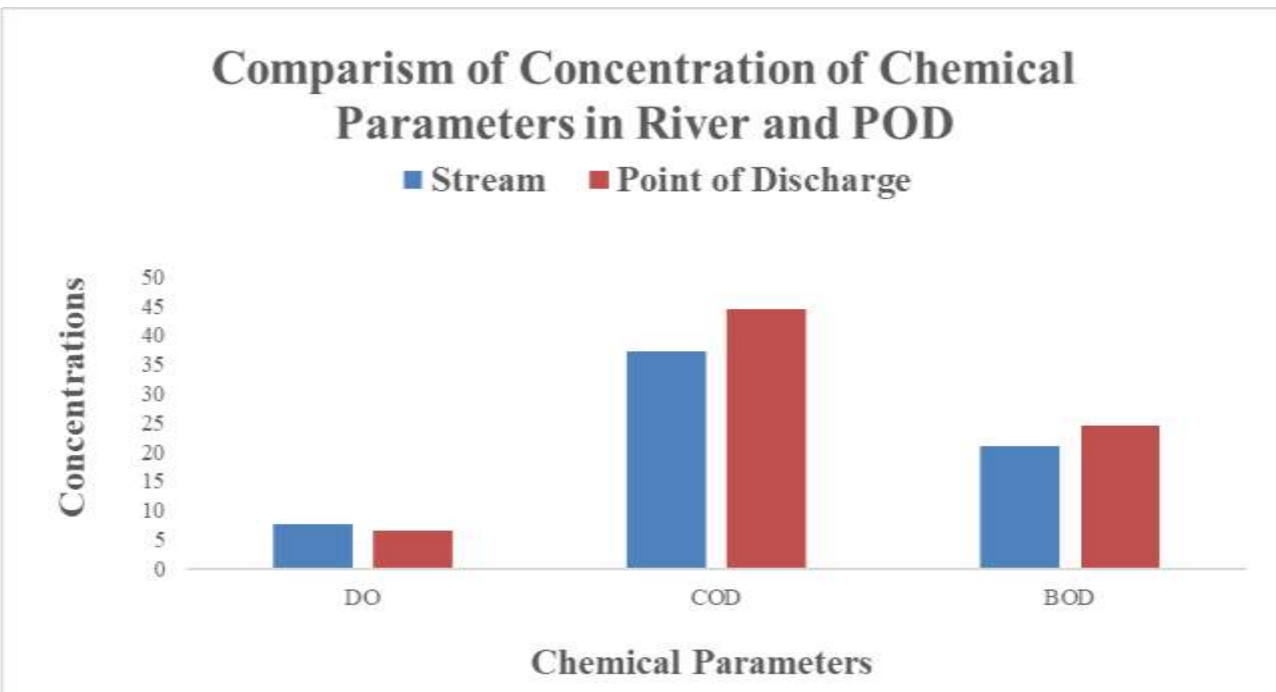

Figure 4: Concentration of chemical parameters in water samples from POD and River

In figure 4. Above, the chemical parameters observed from samples from the POD and point of discharge shows that at the River, the DO concentration is recorded at its highest level of 7.63 mg/L. This signifies that the water at this location is well-oxygenated, suggesting a healthy aquatic environment. In contrast, the lowest DO concentration of 6.4 mg/L, observed at the point of discharge, raises concerns about the oxygen availability in the water. Lower DO levels can be detrimental to aquatic life, potentially indicating an area with oxygen depletion and a need for further investigation.Moving on to COD, the data reveals that the point of discharge exhibits a notably higher COD concentration of 44.43 mg/L compared to the Rivers' 37.12 mg/L. This elevated COD level at the discharge point suggests the presence of a higher load of organic and inorganic pollutants in the water. Such an increase may indicate potential pollution sources in the vicinity, such as industrial or municipal discharges. The higher COD concentration points towards environmental concerns, as it implies that the water at the second discharge location is more contaminated, posing a potential threat to the aquatic ecosystem.

Finally, considering BOD, the point of discharge records the highest BOD value of 24.5 mg/L, whereas the River exhibits a lower BOD concentration of 21.02 mg/L. A higher BOD value indicates a greater load of biodegradable organic substances in the water, which can lead to increased microbial activity and oxygen consumption. In this context, the elevated BOD level at the point hints at a higher input of organic matter, potentially originating from anthropogenic sources. This situation can result in oxygen depletion, negatively impacting aquatic organisms and overall water quality.

Table 5: ANOVA test of significance of Physio-Chemical parameters

Significance of Chemical parameters between River and POD

Source of Variation	SS	df	MS	F	P-value	F crit.
Chemical Parameters	1141.455	2	570.7276	62.38335	0.015777	19
River vs POD	15.23227	1	15.23227	1.664962	0.325988	18.51282
Error	18.29743	2	9.148717			
Total	1174.985	5				

Significance of Physical parameters between River and POD

Source of Variation	SS	df	MS	F	P-value	F crit.
Physical Parameters	428379	6	71396.49	2985.842	3.75E-10	4.283866
River vs POD	0.000179	1	0.000179	7.47E-06	0.997908	5.987378
Error	143.4701	6	23.91168			
Total	428522.4	13				

Conformity of Physio-chemical with WHO standards

This shows the comparison of physical parameters from River and POD with WHO standard. In the case of the River water source, several key parameters deviate from WHO standards. Firstly, the pH level of 6.98 falls slightly below the recommended standard of 7.18, indicating a slightly acidic condition. Additionally, the turbidity level in the River is quite high at 13.39 NTU, significantly surpassing the WHO standard of 5 NTU. This elevated turbidity can potentially affect water quality and aquatic ecosystems. Furthermore, the Total Suspended Solids (TSS) in the River are notably elevated at 82.11 mg/L, exceeding the WHO standard of 35 mg/L, indicating a higher concentration of suspended solids in the water. However, other parameters such as temperature, total hardness, conductivity, and Total Dissolved Solids (TDS) generally remain within acceptable ranges based on WHO standards.

Conversely, the Point of Discharge (POD) water source demonstrates some notable differences from River. The pH level at the POD, 7.18 the WHO standard of 8.5, meeting the recommended pH standard of 8.5. Similarly, the water temperature at the POD, 27.4°C, falls within the WHO standard and remains well below the maximum permissible temperature of 40°C. Total Hardness at the POD is 13.46, conforming precisely to the WHO standard of 150, indicating an acceptable mineral content. However, turbidity levels at the POD are considerably high at 22.28, significantly exceeding the WHO standard of 5. Additionally, the TSS at the POD is elevated at 77.61 mg/L, surpassing the WHO standard of 35 mg/L.

DISCUSSION

Significant Concentration of Physio-chemical

Based on the results, some physio-chemical properties exhibit concentrations that exceed the WHO limits, indicating potential water quality concerns.The average turbidity level of 13.39 in River and 22.28 at POD exceeds WHO standard of 5. The average TSS concentration in the River water was 82.11 mg/L and 77.61 at POD, exceeding the WHO standard of 35 mg/L. The average BOD concentration in the River water was 21.02 mg/L and 24.5mg/L, above the WHO standard of 25 mg/L. Based on the results, physio-chemical properties such as Turbidity, TSS, DO, BOD, exhibit concentrations that exceed the WHO limits, indicating potential water quality concerns.

Several studies have supported the findings of this study. Angiro *et al.* (2020) states that turbidity values recorded in water samples from an industrial park in Uganda exceeded the WHO recommended limit of 5 FTU for water used for domestic purposes. High turbidity levels indicate the presence of bacteria, pathogens, or particles that can shelter harmful organisms from disinfection processes (Angiro *et al*., 2020).Adesina *et al*. (2018) mentions that abattoir effluents can increase levels of total solids in receiving water bodies, leading to eutrophication. This suggests that TSS levels in abattoir effluent can exceed the WHO limits. Eze & Eze (2018) reported that the biochemical oxygen demand (BOD) in abattoir waste was measured at 5009 mg/L, which is significantly higher than the WHO limit. BOD is an indicator of organic pollution and high levels can deplete dissolved oxygen in water, negatively impacting aquatic life.Adekanmbi&Falodun (2015) discusses the presence of heavy metals, including Ni, Cr, and Pb, in abattoir effluent. The study subjected Staphylococcus aureus strains to increasing concentrations of these heavy metals, indicating their presence in the effluent.

Eze&Eze (2018) presents laboratory test results of an abattoir waste study in Enugu, Nigeria. The results show that the levels of BOD, TSS, and DO in the effluent exceeded the WHO standards. The BOD level was measured at 5009 mg/L, which is significantly higher than the WHO limit. Additionally, the TSS level was measured at 97.3 mg/L, exceeding the WHO limit. The DO level was measured at 8.60 mg/L, which is within the WHO limit but indicates a potential decrease in oxygen levels.Badejo*et al.* (2021) discusses the evaluation of two-stage subsurface flow constructed wetlands for abattoir wastewater management. The study found that the concentration of BOD5, TSS, and TDS in the abattoir wastewater was reduced by 88.71%, 72.27%, and 56.89% respectively. Although the reduction is significant, the effluent still did not meet the standards set by the Federal Environmental Protection Agency (FEPA) for wastewater discharge into rivers.Therefore, based on these references, it can be concluded that the levels of turbidity, TSS, DO, and BOD in abattoir effluent in Nigeria exceed the WHO limits.

CONCLUSION

In conclusion, this study has provided valuable insights into the impact of abattoir effluent on the Oko-Oba River in Agege, Lagos, Nigeria, by assessing physicochemical parameters. The findings demonstrate a clear influence of the abattoir effluent on the river's water quality. Notably, the Point of Discharge (POD) exhibited elevated levels of turbidity, suggesting a high concentration of suspended particles, which can reduce light penetration, affecting aquatic ecosystems. Furthermore,. These findings underscore the detrimental effect of the effluent on water quality, which can have adverse consequences for both aquatic life and human health. Therefore, it is imperative to implement effective pollution control measures and continuous monitoring to mitigate the impact of abattoir effluent on the Oko-Oba River and ensure the preservation of this vital water resource for the community and the environment.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

i. The abattoir should invest in effective wastewater treatment systems to reduce the concentration of suspended particles, heavy metals, and organic pollutants in their discharge.

ii. Continuous monitoring of water quality in Oko-Oba River and the abattoir's Point of Discharge is essential. Regular testing for physicochemical parameters will help in early detection of pollution and allow for prompt corrective measures.

iii. Government authorities and environmental agencies should enforce existing regulations and standards for effluent discharge. Stringent penalties should be imposed on industries, including abattoirs that violate these regulations to ensure compliance.

iv. The local community should be educated about the potential health risks associated with contaminated water from the river.

v. Exploring and adopting environmentally friendly and sustainable technologies within the abattoir can reduce the generation of hazardous waste and pollutants. This may include better waste disposal methods and efficient water use practices.

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