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Physicochemical Characteristics and Heavy Metal Composition of Abattoir Wastewater in Yenegoa, Bayelsa State, Nigeria

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ABSTRACT

Abattoir wastewater in Nigeria is widely characterized as a high-strength effluent. However, abattoir effluents are usually discharged into surrounding land and receiving water bodies, without treatment thereby increasing the potential for environmental degradation. This study characterized the physicochemical properties and selected heavy metals in wastewater from the Swale and Tombia abattoirs in Yenagoa, Bayelsa State, to establish baseline evidence for pollution control and wastewater management. Nine samples were collected from discharge, upstream/reference, and downstream/impact locations and analysed for pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, salinity, dissolved oxygen (DO), and Fe, Zn, Pb, Cd, and Cu using standard analytical procedures and atomic absorption spectrophotometry. Significant differences between the abattoirs occurred for pH, TDS, salinity, DO, Fe, and Zn ($p < 0.05$), whereas EC, turbidity, Pb, Cd, and Cu showed no significant differences. Swale recorded higher pH (7.83 ± 0.10), EC (4222.00 ± 2.00 µS/cm), and Fe (19.45 ± 0.48 mg/L), while Tombia had higher TDS (2364.67 ± 66.58 mg/L), salinity (2.59 ± 0.03 ppt), and Zn (0.57 ± 0.04 mg/L). Dissolved oxygen remained low at both sites (1.14–1.22 mg/L), while Pb (0.11–0.14 mg/L) and Cd (0.04 mg/L) were detected. These findings establish a site-specific pollution baseline and demonstrate the need for systematic abattoir wastewater treatment and monitoring. Environmental regulators and abattoir operators should prioritize effluent treatment, routine surveillance, and pollution-prevention measures to protect receiving waters and public health.

Keywords: Abattoir Wastewater; Physicochemical Characteristics; Heavy Metals; Environmental Pollution; Yenagoa, Nigeria.

Introduction

Abattoir wastewater in Nigeria is widely characterized as a high-strength effluent containing blood, gut contents, suspended solids, nutrients, organic matter, and potentially toxic contaminants. In many cases, inadequate waste-management practices result in the direct or insufficiently treated discharge of these effluents into surrounding land and receiving water bodies, thereby increasing the potential for environmental degradation (Ariyo & Obire, 2022; Bakare-Abidola et al., 2025). Consequently, studies conducted across different parts of Nigeria have consistently reported elevated levels of key physicochemical parameters, including biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, electrical conductivity, nitrate, phosphate, total dissolved solids (TDS), and Total Suspended Solids (TSS), with several parameters exceeding applicable permissible limits, although pH may remain within guideline ranges in some locations (Ugbune & Aregbor, 2024; Anab-Atulomah et al., 2025). In parallel with these physicochemical concerns, heavy metals such as Pb, Cd, Cr, Ni, Fe, Mn, Zn, and Cu have been detected in Nigerian abattoir wastewater, and elevated concentrations of some of these metals have been associated with potential ecological and public-health risks (Bakare-Abidola et al., 2024; Ayisa et al., 2025; Anab-Atulomah et al., 2025).

Importantly, this pattern is not confined to individual abattoirs, as review-level evidence indicates that heavy-metal contamination and associated ecological risks recur across multiple Nigerian abattoir facilities (Nandomah & Tetteh, 2023).

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Despite this growing body of evidence, the spatially specific characteristics of abattoir wastewater remain inadequately documented in parts of the Niger Delta, particularly Yenagoa, Bayelsa State. Differences in local hydrology, slaughtering intensity, wastewater-generation rates, drainage connectivity, and waste-handling practices can influence the composition and environmental behaviour of abattoir effluents; therefore, findings from other Nigerian locations cannot necessarily be assumed to represent conditions in Bayelsa State. Although previous research has established the occurrence of contaminants in the region, Ariyo & Obire (2022) investigated PAHs and selected heavy metals in wastewater from four abattoirs in Yenagoa LGA and demonstrated the occurrence of contamination, but the study did not provide the comprehensive physicochemical characterization required to establish an integrated local wastewater-quality profile. Accordingly, an important knowledge gap remains regarding the combined physicochemical and heavy-metal characteristics of abattoir wastewater in the area.

Against this background, the present study provides site-specific baseline data on the physicochemical characteristics and heavy-metal composition of abattoir wastewater in Yenagoa, Bayelsa State. By integrating physicochemical measurements with metal concentrations, the study evaluates the extent of contamination, and establishes evidence that can support wastewater monitoring, pollution-control measures, and improved treatment and management practices in the study area.

Materials and Methods

Study Design and Sample Collection

A cross-sectional field sampling design was adopted to assess the physicochemical characteristics and selected heavy-metal composition of wastewater associated with Yenagoa Abattoir at Swale (S), and Tombia (T). Sampling was conducted on 6 August 2026 at 10:00 am. Three sampling sites were established along the abattoir wastewater-receiving environment at 30-m intervals. PJ1 represented the abattoir wastewater/ discharge point; PJ2 represented the upstream/ reference location, positioned 30 m from PJ1; and PJ3 represented the downstream/impact location, positioned 30 m from PJ2. Three independent replicates were collected at each sampling site, giving a total of nine samples (n = 9; three replicates per site).

Samples were collected from the 0–10 cm sampling depth using pre-cleaned sampling containers. Separate containers were used for physicochemical and heavy-metal analyses. Each sample was immediately labelled with its site code (PJ1, PJ2 or PJ3), replicate number and sampling date. Samples were transported to the laboratory in an insulated ice chest and maintained under chilled conditions (approximately 4 ± 2 °C) until analysis. Parameters susceptible to alteration during storage, particularly pH, electrical conductivity and dissolved oxygen, were measured as soon as practicable following collection.

Physicochemical Analysis

The physicochemical parameters analysed were pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, salinity and dissolved oxygen (DO). Analytical procedures followed the methods described by the American Public Health Association (APHA 2017).

The pH was determined using an Oakton Model PCD 650 digital pH meter, Singapore according to APHA (2017). The meter was calibrated with standard buffer solutions before measurement, while the electrode was rinsed with deionized water between samples. The electrode was immersed in each sample and the stabilized reading recorded.

Electrical conductivity and TDS were determined using a HANNA Model HI9835 conductivity/TDS meter according to APHA (2017). The probe was calibrated using a conductivity standard solution, rinsed with deionized water and immersed in the sample until a stable reading was obtained. EC was expressed in µS/cm and TDS in mg/L.

Turbidity was measured according to APHA (2017) using a calibrated turbidity meter and expressed in NTU. Salinity was determined using the electrical conductivity method and expressed in ppt. Dissolved oxygen was measured using a Horiba Model DO210 meter following APHA (2017) and expressed in mg/L.

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Heavy-Metal Analysis

The concentrations of iron (Fe), zinc (Zn), lead (Pb), cadmium (Cd) and copper (Cu) were analysed using an Atomic Absorption Spectrophotometer (BUCK Scientific Atomic Absorption Spectrophotometer Model 230ATS, USA) according to APHA (2017).

Prior to instrumental determination, samples intended for metal analysis were preserved with nitric acid and maintained under refrigerated conditions. The samples were subjected to acid digestion to release metals from the aqueous matrix before instrumental analysis. The digested samples were analysed using a BUCK Scientific Atomic Absorption Spectrophotometer Model 230ATS, USA, following calibration with standards of known concentrations. Metal concentrations were obtained from the resulting calibration curves and expressed as mg/L. The supplied laboratory procedure confirms the use of calibration standards and AAS for metal determination.

Quality Assurance and Quality Control

To minimize analytical error and contamination, sampling containers and laboratory glassware were thoroughly cleaned before use, while distilled water was used for rinsing analytical equipment. Instrument calibration was performed using appropriate certified standards before sample analysis. Calibration performance was checked throughout the instrumental analysis, and samples falling outside the established calibration range were appropriately diluted and reanalyzed.

Statistical Analysis

Data were analysed using one-way analysis of variance (ANOVA) to determine whether physicochemical and heavy-metal parameters differed significantly between Swale and Tombia abattoirs. Each parameter was analysed independently using three replicate observations per abattoir (n = 3). Results were expressed as mean ± standard deviation (SD).

Prior to ANOVA, data were assessed for normality using the Shapiro–Wilk test and homogeneity of Variance using Levene's test. Statistical significance was established at $p < 0.05$. Effect size was quantified using eta-squared (η^2), representing the proportion of total variance attributable to differences between abattoirs.

Results

The physicochemical characteristics of the wastewater samples collected from Swale and Tombia abattoirs are presented in Table 1. The results showed clear differences between the two abattoirs for several measured parameters. The pH of the Swale samples ranged from 7.72 to 7.90, with an overall mean of 7.83 ± 0.10, whereas Tombia recorded a lower mean pH of 6.53 ± 0.26. The difference between the two abattoirs was statistically significant (F = 65.22, p = 0.0013), with a very large effect size (η^2 = 0.942). Electrical conductivity was 4222.00 ± 2.00 µS/cm at Swale compared with 3648.33 ± 574.21 µS/cm at Tombia.

Table 1: Comparison of physicochemical characteristics of wastewater from Swale and Tombia abattoirs

Parameter	Abattoir Location (Mean ± SD)		F-value	*p*-value	η^2
	Swale	Tombia			
pH	7.83 ± 0.10	6.53 ± 0.26	65.22	0.001	0.942
EC (µS/cm)	4222.00 ± 2.00	3648.33 ± 574.21	2.95	0.161	0.424
TDS (mg/L)	2091.67 ± 75.20	2364.67 ± 66.58	21.92	0.009	0.846
Turbidity (NTU)	140.67 ± 6.81	142.67 ± 0.58	0.26	0.639	0.060
Salinity (ppt)	2.42 ± 0.02	2.59 ± 0.03	58.56	0.002	0.936
DO (mg/L)	1.14 ± 0.03	1.22 ± 0.03	12.26	0.025	0.754

Note: Values are mean ± SD (n = 3). F = one-way ANOVA statistic; η^2 = eta-squared effect size. Bold p-values indicate statistical significance at $p < 0.05$.

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Although the mean EC was higher at Swale, the difference was not statistically significant (F = 2.95, p = 0.161). TDS, however, differed significantly between the abattoirs, with Swale recording 2091.67 ± 75.20 mg/L and Tombia 2364.67 ± 66.58 mg/L (F = 21.92, p = 0.0094; η^2 = 0.846).

Turbidity showed relatively similar values between Swale (140.67 ± 6.81 NTU) and Tombia (142.67 ± 0.58 NTU), and the difference was not significant (F = 0.26, p = 0.639). In contrast, salinity was significantly higher at Tombia (2.59 ± 0.03 ppt) than at Swale (2.42 ± 0.02 ppt) (F = 58.56, p = 0.0016; η^2 = 0.936). Dissolved oxygen also differed significantly, increasing from 1.14 ± 0.03 mg/L at Swale to 1.22 ± 0.03 mg/L at Tombia (F = 12.26, p = 0.0249; η^2 = 0.754).

The generally low DO values recorded at both locations, together with the high TDS and turbidity values, indicate substantial physicochemical loading in the sampled abattoir-associated waters.

However, interpretation of environmental quality should be made against the relevant regulatory or guideline values rather than from individual parameters in isolation.

The concentrations of the investigated heavy metals are presented in Table 2. Iron was the predominant metal at both locations, although its concentration was significantly higher in Swale samples (19.45 ± 0.48 mg/L) than in Tombia samples (17.42 ± 0.02 mg/L; F = 52.61, p = 0.0019; η^2 = 0.929). Zinc showed the opposite pattern, with Tombia recording a significantly higher concentration (0.57 ± 0.04 mg/L) than Swale (0.32 ± 0.12 mg/L; F = 13.12, p = 0.0223; η^2 = 0.766). Lead concentrations were relatively low in both locations, averaging 0.11 ± 0.01 mg/L at Swale and 0.14 ± 0.02 mg/L at Tombia.

The observed difference was not statistically significant (F = 3.37, p = 0.140). Cadmium concentrations were identical in terms of their mean value (0.04 mg/L) across the two abattoirs, although Swale exhibited greater within-group variation (0.06, 0.03 and 0.03 mg/L) than Tombia (0.04, 0.04 and 0.04 mg/L). Consequently, no significant difference was detected for Cd (F ≈ 0.00, p = 1.000).

Copper concentrations were also very similar between the two locations, with means of 0.063 ± 0.006 mg/L at Swale and 0.063 ± 0.006 mg/L at Tombia. The ANOVA therefore indicated no difference between the two groups (F = 0.00, p = 1.000).

Table 2: Comparison of heavy-metal concentrations in wastewater from Swale and Tombia abattoirs

Heavy Metal (mg/L)	Swale (Mean ± SD)	Tombia (Mean ± SD)	F-value	p-value	η^2
Iron (Fe)	19.45 ± 0.48	17.42 ± 0.02	52.61	**0.002**	0.929
Zinc (Zn)	0.32 ± 0.12	0.57 ± 0.04	13.12	**0.022**	0.766
Lead (Pb)	0.11 ± 0.01	0.14 ± 0.02	3.37	0.140	0.457
Cadmium (Cd)	0.04 ± 0.02	0.04 ± 0.00	0.00	1.000	0.000
Copper (Cu)	0.063 ± 0.006	0.063 ± 0.006	0.00	1.000	0.000

Note: Values are mean ± SD (n = 3). F = one-way ANOVA statistic; η^2 = eta-squared effect size. Bold p-values indicate statistical significance at $p < 0.05$. Values were calculated from the three observations reported for each abattoir in the supplied dataset.

Across the eleven parameters examined, eight showed moderate-to-large effect sizes ($\eta^2 \geq 0.424$), while six showed statistically significant differences between the two abattoirs. Significant differences occurred in pH, TDS, salinity, DO, Fe and Zn. The largest between-abattoir effects were observed for pH (η^2 = 0.942), salinity (η^2 = 0.936), Fe (η^2 = 0.929) and TDS (η^2 = 0.846).

Conversely, turbidity, Cd and Cu exhibited minimal statistical evidence of between-abattoir differences. The results therefore demonstrate that the physicochemical and metal profiles were parameter-specific rather than uniformly different between Swale and Tombia. In particular, Swale was characterized by higher pH, EC and Fe, whereas Tombia exhibited higher TDS, salinity, DO and Zn.

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Discussion

The present study demonstrates marked differences in the physicochemical characteristics of wastewater from the Swale and Tombia abattoirs, particularly for pH, TDS, salinity and dissolved oxygen. Such variability is consistent with the heterogeneous nature of slaughterhouse wastewater, which is influenced by animal numbers, slaughtering operations, washing practices, blood and tissue residues, gastrointestinal contents, and the quantity of water used during processing. Recent reviews emphasize that slaughterhouse wastewater is typically characterized by substantial organic, nutrient and particulate loads and that its composition can vary considerably according to operational and site-specific conditions (Pereira et al., 2024).

The pH values showed the clearest between-abattoir difference, with Swale recording 7.83 ± 0.10 compared with 6.53 ± 0.26 at Tombia ($F = 65.22$, $p = 0.001$; $\eta^2 = 0.942$). The near-neutral to mildly alkaline condition at Swale contrasts with the mildly acidic condition at Tombia. The Tombia value falls within the broad pH range of 6.2–7.9 reported for slaughterhouse wastewater in a recent synthesis, whereas the Swale mean is at the upper end of this reported range (Choudhury et al., 2024). Similar mildly acidic conditions have been reported in Nigerian abattoir wastewater, including pH values of approximately 5.8–6.2 in Sagamu and 6.30 at Ogbunike (Jegede et al., 2022). The difference between the two study locations may reflect differences in wastewater composition, dilution, cleaning practices and the relative contribution of blood and organic residues. However, because the present study represents a single sampling occasion, these possible mechanisms should be regarded as plausible explanations rather than experimentally demonstrated causes.

Electrical conductivity was high at both sites, although the difference between Swale (4222.00 ± 2.00 µS/cm) and Tombia (3648.33 ± 574.21 µS/cm) was not statistically significant ($p = 0.161$). The high EC indicates substantial ionic loading in the wastewater. Comparable high conductivity has been documented in Nigerian abattoir wastewater; for example, Ogbunike wastewater had a reported conductivity of approximately 4560 µS/cm (Chukwura *et al.,* 2025). The relatively high conductivity observed here is therefore consistent with the broader Nigerian literature. Importantly, the large variability at Tombia compared with the extremely small variation at Swale suggests greater heterogeneity among the Tombia replicates. This distinction is important because EC reflects the aggregate concentration and mobility of dissolved ionic constituents and should not be interpreted as evidence of a particular contaminant without supporting chemical analyses.

TDS differed significantly between the abattoirs, increasing from 2091.67 ± 75.20 mg/L at Swale to 2364.67 ± 66.58 mg/L at Tombia ($F = 21.92$, $p = 0.009$; $\eta^2 = 0.846$). The elevated TDS is consistent with the substantial dissolved load expected in slaughterhouse wastewater. A recent review reports a very broad TDS range for slaughterhouse wastewater, reflecting considerable variability among facilities and wastewater streams (Bakare-Abidola et al., 2025). The present values are also within the broad environmental context reported for Nigerian abattoir wastewater, although they are lower than the 3420 mg/L (Chukwura et al., 2025). The significantly higher TDS at Tombia, despite its lower mean EC, suggests that EC and TDS should not be assumed to vary proportionally across the two facilities; wastewater chemistry and the composition of dissolved constituents may differ between sites.

Turbidity was statistically similar at Swale (140.67 ± 6.81 NTU) and Tombia (142.67 ± 0.58 NTU; $p = 0.639$). The consistently high turbidity is compatible with the particulate-rich character of slaughterhouse wastewater. Recent work on abattoir reported markedly elevated turbidity, illustrating the potential for slaughterhouse discharges to carry substantial suspended and colloidal material (Bliss et al., 2026). The absence of a significant difference between Swale and Tombia suggests that particulate loading was broadly comparable at the time of sampling, despite differences in several dissolved parameters. This finding reinforces the importance of considering multiple indicators rather than relying on a single physicochemical parameter when evaluating abattoir wastewater quality.

Salinity differed significantly between the two locations, with Tombia (2.59 ± 0.03 ppt) exceeding Swale (2.42 ± 0.02 ppt) ($F = 58.56$, $p = 0.002$; $\eta^2 = 0.936$).

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Although salinity is less frequently reported than EC and TDS in Nigerian abattoir studies, its elevation at Tombia is consistent with the higher TDS observed at that site. The concurrence of higher TDS and salinity suggests a greater dissolved-solute burden in the Tombia samples. Nevertheless, the relationship should be interpreted cautiously because salinity and TDS represent different aspects of dissolved material and the present dataset does not identify the specific ions responsible.

Dissolved oxygen (DO) was low at both abattoirs, although Tombia recorded a significantly higher concentration (1.22 ± 0.03 mg/L) than Swale (1.14 ± 0.03 mg/L) ($F = 12.26$, $p = 0.025$; $\eta^2 = 0.754$). Low DO is environmentally important because slaughterhouse wastewater commonly contains biodegradable organic matter derived from blood, faecal material, tissue residues and other slaughtering wastes. Recent reviews identify high organic loading as a defining characteristic of slaughterhouse wastewater and emphasize the need for appropriate treatment before discharge (Ng *et al.,* 2022). The low DO observed in the present study is therefore consistent with the expected oxygen-demanding nature of untreated slaughterhouse effluent. However, DO alone cannot quantify organic pollution; BOD and COD measurements would strengthen this interpretation. This is particularly relevant because recent Nigerian investigations have reported very high BOD and COD in abattoir wastewater (Ayisa et al., 2025).

Iron was the dominant metal measured in both wastewater sources, with concentrations of 19.45 ± 0.48 mg/L in Swale and 17.42 ± 0.02 mg/L in Tombia. The difference was statistically significant ($F = 52.61$, $p = 0.002$; $\eta^2 = 0.929$). The substantially higher Fe concentrations observed in the present study may reflect the composition of blood and animal tissues entering the wastewater stream, although the study design does not permit attribution to a specific source. The large η^2 further indicates that the difference between Swale and Tombia accounts for a substantial proportion of the observed variance in Fe.

Zinc showed the reverse pattern: Tombia recorded 0.57 ± 0.04 mg/L, compared with 0.32 ± 0.12 mg/L at Swale, producing a significant difference ($F = 13.12$, $p = 0.022$; $\eta^2 = 0.766$).

A 2023 systematic review of Nigerian abattoir liquid wastes found substantial heterogeneity in heavy-metal contamination and ecological-risk indicators among facilities, highlighting the importance of local conditions when interpreting metal concentrations (Nandomah & Tetteh, 2023).

Lead concentrations were 0.11 ± 0.01 mg/L at Swale and 0.14 ± 0.02 mg/L at Tombia, but the difference was not statistically significant ($p = 0.140$). Cadmium showed virtually identical mean concentrations at the two abattoirs (0.04 mg/L), and the ANOVA indicated no difference ($p = 1.000$). The Swale observations showed slightly greater within-site variability, whereas Tombia values were identical across the three replicates. Copper concentrations were almost identical between Swale and Tombia (0.063 ± 0.006 mg/L at each location), with no evidence of a between-abattoir difference ($p = 1.000$). The comparatively low Cu concentration in the present samples may indicate a lower Cu contribution from the particular slaughterhouse operations or surrounding environment, although source attribution would require additional measurements.

The combined physicochemical and metal profile indicates that wastewater from the Swale and Tombia abattoirs represents a potential environmental and public-health concern**,** particularly where untreated effluent enters receiving waters. Slaughterhouse wastewater commonly contains organic matter, suspended solids, nutrients and metals, and its uncontrolled discharge can impair aquatic ecosystems and water quality (Pereira *et al.,* 2024). The low dissolved oxygen concentrations observed in both abattoirs (1.14–1.22 mg/L), together with high turbidity and TDS, suggest conditions capable of imposing stress on oxygen-dependent aquatic organisms. The presence of Fe, Zn, Pb and Cd adds a toxicological dimension. Of particular concern are because both are non-essential toxic metals capable of accumulating in environmental compartments and biological tissues. WHO identifies lead as a major public-health toxicant with neurological, cardiovascular, renal and haematological effects, and states that no level of lead exposure is known to be without harmful effects. Cadmium is also recognized as a priority chemical hazard, with the kidney being a critical target following prolonged exposure (WHO, 2015, 2026).

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Conclusion

The study demonstrates that abattoir wastewater from Swale and Tombia in Yenagoa, Bayelsa State, exhibits substantial physicochemical loading and contains potentially toxic metals, underscoring the need for improved wastewater management before discharge into the environment. Significant differences occurred in pH, TDS, salinity, dissolved oxygen, Fe, and Zn, while Fe was the predominant metal, reaching 19.45 ± 0.48 mg/L at Swale and 17.42 ± 0.02 mg/L at Tombia. Low dissolved oxygen (1.14–1.22 mg/L), together with elevated turbidity and TDS, indicates wastewater conditions capable of imposing stress on receiving aquatic environments, while the occurrence of Pb and Cd adds potential toxicological concern. The findings provide site-specific baseline evidence for Yenagoa and demonstrate that abattoir wastewater quality can vary substantially between facilities, reinforcing the need for location-specific monitoring rather than reliance on generalized assumptions. There is therefore the urgent need by the relevant authorities for routine characterization, effective treatment, regulatory oversight, and pollution prevention. Consequently, abattoir operators and environmental authorities should prioritize treatment and continuous monitoring to protect receiving waters, ecosystems, and public health.

References

Anab-Atulomah, C., Nwachukwu, E., Eze, V., Kanu, V. N., & Uwanu-Mecha, E. G. (2025). Evaluation of physicochemical properties and bacteriological quality of abattoir wastewater. *South Asian Journal of Research in Microbiology*,

APHA. (2017). Standard Methods for the Examination of Water and Wastewater (23RD ed.). Washington DC: American Public Health Association.

Ariyo, A. B. & Obire, O. (2022). Polycyclic aromatic hydrocarbons (PAHs) and heavy metal content of abattoir wastewater in Bayelsa and Rivers States. *International Journal of Scientific and Management Research*. *5 (5)* 25 – 33.

Ayisa, T. T., Muhammad, R. G., & Mohammed, J. N. (2025). Heavy metals levels and physicochemical characteristics of abattoir effluent from Bangaie and New Market regions in Bida, Niger State, Nigeria. *Journal of Applied Sciences and Environmental Management, 29*(5), 1522.

Bakare-Abidola, T., Elabor, I., Onwuchekwa, N., Onwuchekwa, C., Oladeji, J., Olawale, A. O., & Adeiza, A. A. (2025). Environmental impact assessment of abattoir wastewater. *Path of Science, 11*(6), 5001–5014.

Bliss, O. U., Anao, E. O., Chibuike, P. P., Agatha, U. C., Agu, P. C., & Oke, E. A. (2026). Bioaccumulation and human health risk assessment of potentially toxic elements in commercial fish species (*Oreochromis niloticus, Clarias gariepinus, Mugil cephalus*) from slaughterhouse wastewater-impacted rivers in Nigeria. *International Journal of Environmental Research and Public Health, 23*(7), 827.

Choudhury, A. R., Singh, N., Kulkarni, V. V., Vishal, Gupta, A., Fernandes, C. J., Sahoo, S., Palani, S. G., & Chakraborty, S. (2024). A comprehensive review of slaughterhouse wastewater treatment and concomitant resource recovery. In M. P. Shah & N. Shah (Eds.), *Development in wastewater treatment research and processes* (pp. 385–418). Elsevier.

Chukwura, I., Uba, E., Dibua, B. O., Chude, N. A., Okoye, C. O., Chikaodili, E. C. S., Ubajekwe, C., Eleanya, L. C., Agbo, B. C., & Nwajiobi, F. O. (2025). Physicochemical and bacteriological quality assessment of Ogbunike abattoir wastewater, Anambra State, Nigeria for irrigation purpose. *Journal of Global Ecology and Environment, 21*(3), 378–385.

Jegede, D. O., Oluyomi, J. F., Shokunbi, O. S., Oyewola, O. J., Ogunnowo, A. A., Animashaun, R. O., & Afolabi, M. D. (2022). Assessment of physicochemical parameters and heavy metals in Sagamu abattoir waste water, Ogun State, Nigeria. *Journal of Applied Sciences and Environmental Management, 26*(5), 955–960.

Nandomah, S., & Tetteh, I. K. (2023). Potential ecological risk assessment of heavy metals associated with abattoir liquid waste: A narrative and systematic review. *Heliyon, 9*(8), e17359.

Pereira, A. K. dos S., Teixeira, K. C., Pereira, D. H., & Cavallini, G. S. (2024). A critical review on slaughterhouse wastewater: Treatment methods and reuse possibilities. *Journal of Water Process Engineering, 58*, 104819.

Ugbune, U. U., & Aregbor, O. (2024). Hydrophysiochemical examination of waste water collected from Effurun abattoir. *FUDMA Journal of Sciences, 8*(3), 145–147.

World Health Organization. (2011). *Cadmium: Chemical fact sheet*. WHO Guidelines for Drinking-water Quality. WHO, Geneva, Switzerland 1-21.

World Health Organization. (2026). *Guidelines for drinking-water quality: Fourth edition incorporating the first, second and third addenda*. WHO, Geneva, Switzerland 1-664.

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