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Analyzing the Meteorological Parameters in the Vicinity of Slaughterhouses

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Abstract
This study investigates the influence of meteorological factors on pollutant concentrations around slaughterhouses in Port Harcourt, Nigeria. The aim is to assess how temperature, relative humidity, and wind speed affect air quality in these industrial areas. A descriptive research design was employed, and data on meteorological parameters were collected at five slaughterhouse sites during morning and evening periods over twelve months. The results reveal significant variations in meteorological parameters across slaughterhouses, with Eleme consistently exhibiting higher relative humidity and temperature values. These values often exceeded the standards set by the World Health Organization, indicating potential health risks due to poor air quality. Wind speed, crucial for pollutant dispersion, also varied significantly among locations. The interconnectedness of these factors underscores their complex influence on pollutant concentrations. Elevated temperatures, likely influenced by prevailing winds and combustion activities, contributed to increased pollutant concentrations, while higher wind speeds facilitated faster dispersion. In conclusion, the study highlights the urgent need for stricter regulations and enforcement measures to control emissions from slaughterhouse activities. Enhanced air quality monitoring, public awareness campaigns, and collaborative efforts among stakeholders are recommended to mitigate the adverse effects of air pollution on public health and the environment. Further research is warranted to understand the long-term impacts of air pollution from slaughterhouses and devise targeted strategies for improving air quality in urban settings.

Keywords: Slaughterhouses, Air quality, Meteorological parameters, Temperature, Relative humidity, Wind speed

Introduction

Slaughterhouses play a crucial role in processing animals and their meat products, providing sustenance to communities globally (Faribal et al., 2012). However, these facilities also present significant environmental challenges, particularly regarding air pollution and its detrimental effects on human health and the ecosystem. The atmospheric composition, including nitrogen, oxygen, and trace gases, along with variable water vapour concentrations, underscores the complexity of the air surrounding slaughterhouses (Keir, 2017). Air pollution, stemming from both natural processes and human activities, poses a substantial burden, with anthropogenic sources being particularly problematic. Vehicular emissions, industrial activities, and certain practices within slaughterhouses contribute significantly to this issue, impacting air quality and public health (Barman et al., 2011).

In regions like Port Harcourt, Nigeria, where slaughterhouses are prevalent, understanding the meteorological parameters in their vicinity becomes imperative. Temperature, wind speed, and relative humidity are major variables of interest, as they directly influence atmospheric conditions and pollutant dispersion (Faribal et al., 2012). Despite the evident environmental and health concerns posed by slaughterhouses, there remains a gap in research regarding the specific meteorological conditions in their proximity. Investigating these parameters can provide valuable insights into the extent of atmospheric pollution and its potential impacts on surrounding communities. Therefore, this study aims to analyze meteorological parameters in the vicinity of selected slaughterhouses in Port Harcourt, shedding light on a critical yet understudied aspect of environmental health in this populous Nigerian city.

Materials and Methods

The study, conducted in Port Harcourt, Nigeria, the study focuses on five slaughterhouse sites—Trans-Amadi, Eleme, Rumuokoro, Eagle-Island, and Okuru—each with documented geographical coordinates. Trans-Amadi, situated at 04° 48' 53" N, 07° 02' 42" E; Eleme at 04° 95' 43.92" N, 07° 01' 26.25" E; Rumuokoro at 04° 90' 43.12" N, 07° 04'

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44.15" E; Eagle-Island at 04° 47' 39" N, 06° 58' 75" E; and Okuru at 04° 42' 13" N, 07° 04' 42" E. These precise locations within Port Harcourt underline the significance of studying meteorological parameters in close proximity to these slaughterhouses, providing valuable insights into the environmental dynamics and potential impacts on the local populace and ecosystem.

This study utilized a descriptive research design to examine the phenomena under investigation. Drawing from principles outlined by Zar (1984), the study aimed to provide a comprehensive portrayal of the selected variables without manipulating them. By observing and documenting characteristics or behaviours in their natural settings, this approach seeks to understand relationships and patterns. Unlike experimental designs, descriptive studies do not involve the manipulation of variables or randomization but focus on thorough observation and analysis to conclude.

Temperature, relative humidity, wind speed, and wind direction were assessed using a handheld environmental meter at five slaughterhouses: Trans-Amadi, Eleme, Rumuokoro, Eagle-Island, and Okuru. Data were collected during morning and evening periods over twelve months, from February 2020 to January 2021. The EXTECH Environmental Meter (EN150) measured these parameters. The collected data underwent analysis using SPSS software (version 27.0) for Windows, calculating mean concentrations and standard deviations. Analysis of variance (ANOVA) and Duncan Multiple Range Test were applied to compare means. The concentrations were also compared with air quality standards established by the Rivers State Government, NAAQS, WHO, and FMENV.

Table.1: Mean±SD concentrations of RH (%) in the various slaughterhouses in the morning and evening.

LOCATION (STUDY AREA)	MEAN MORNING	MEAN EVENING	STANDARD DEVIATION MORNING	STANDARD DEVIATION EVENING	COEFFICIENT OF VARIATION MORNING	COEFFICIENT OF VARIATION EVENING	STANDARD ERROR MORNING	STANDARD ERROR EVENING
TRANS AMADI	53.00	43.20	5.45	4.41	4.32	2.32	12.44	10.42
ELEME	65.20	33.25	7.66	5.61	6.44	6.14	13.56	11.12
RUMUOKORO	63.20	43.24	6.90	4.40	6.30	3.10	13.32	11.15
EAGLE ISLAND	60.15	30.16	5.30	3.10	5.45	2.15	12.77	11.23
OKURU	45.65	25.63	3.65	2.17	2.44	2.14	10.43	10.11

The analysis of relative humidity (RH%) across slaughterhouses in Port Harcourt during morning and evening periods reveals distinct patterns. In the morning, Eleme exhibited the highest mean RH% at 65.20, with Rumuokoro following closely at 63.20, while Okuru recorded the lowest at 45.65. Conversely, during the evening, Trans-Amadi registered the highest mean RH% at 43.20, followed by Rumuokoro at 43.24, Eleme at 33.25, Eagle Island at 30.16, and Okuru at 25.63. Standard deviations ranged from 2.17 to 7.66 in the morning and from 2.15 to 5.61 in the evening, indicating varying degrees of dispersion around the mean values. Coefficients of variation ranged from 2.14% to 6.44% in the morning and from 2.15% to 6.14% in the evening, suggesting the relative variability of RH% within each location.

Table.2: Mean±SD concentrations of Temperature (°C) in the various slaughterhouses in the morning and evening.

LOCATION (STUDY AREA)	MEAN MORNING	MEAN EVENING	STANDARD DEVIATION MORNING	STANDARD DEVIATION EVENING	COEFFICIENT OF VARIATION MORNING	COEFFICIENT OF VARIATION EVENING	STANDARD ERROR MORNING	STANDARD ERROR EVENING
TRANS AMADI	36.40	30.82	2.45	1.15	4.55	1.13	7.77	2.14
ELEME	37.50	31.22	2.90	1.19	6.76	2.13	5.88	2.25
RUMUOKORO	37.25	30.95	2.88	1.18	4.65	2.12	3.80	1.23
EAGLE ISLAND	36.70	30.61	2.55	1.15	4.89	2.15	3.65	1.23
OKURU	34.55	30.50	1.85	1.10	2.56	1.12	3.00	2.11

Table 2 presents the mean ± standard deviation concentrations of temperature (°C) in various slaughterhouses in Port Harcourt during morning and evening periods. In the morning, Eleme exhibited the highest mean temperature at 37.50°C, while Okuru recorded the lowest at 34.55°C. Conversely, during the evening, Eleme again showed the highest mean temperature at 31.22°C, with Okuru remaining the lowest at 30.50°C. Standard deviations ranged from 1.10 to 2.90 in the morning and from 1.13 to 1.23 in the evening, indicating varying degrees of dispersion around the mean values. Coefficients of variation ranged from 2.12% to 6.76% in the morning and from 1.13% to 2.25% in the evening, suggesting the relative variability of temperature within each location.

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Table. 3: Mean±SD concentrations of WS (m/s) in the various slaughterhouses in the morning and evening.

LOCATION (STUDY AREA)	MEAN MORNING	MEAN EVENING	STANDARD DEVIATION MORNING	STANDARD DEVIATION EVENING	COEFFICIENT OF VARIATION MORNING	COEFFICIENT OF VARIATION EVENING	STANDARD ERROR MORNING	STANDARD ERROR EVENING
TRANS AMADI	1.44	1.07	0.84	0.16	0.30	0.10	0.04	0.02
ELEME	2.34	1.08	1.43	0.16	0.26	0.18	0.06	0.04
RUMUOKORO	1.42	1.03	0.63	0.14	0.21	0.16	0.03	0.02
EAGLE ISLAND	1.51	1.02	0.42	0.15	0.34	0.15	0.02	0.01
OKURU	1.38	1.05	0.11	0.09	0.22	0.10	0.01	0.01

Table 3 presents the mean ± standard deviation concentrations of wind speed (WS) in various slaughterhouses in Port Harcourt during morning and evening periods. In the morning, Eleme exhibited the highest mean wind speed at 2.34 m/s, while Okuru recorded the lowest at 1.38 m/s. Conversely, during the evening, Trans-Amadi showed the highest mean wind speed at 1.07 m/s, with Okuru remaining the lowest at 1.05 m/s. Standard deviations ranged from 0.09 to 1.43 in the morning and from 0.01 to 0.16 in the evening, indicating varying degrees of dispersion around the mean values. Coefficients of variation ranged from 0.10% to 0.34% in the morning and from 0.01% to 0.18% in the evening, suggesting the relative variability of wind speed within each location

Discussion

The major findings from Table 1 reveal significant disparities in relative humidity (RH%) levels across various slaughterhouse sites in Port Harcourt during morning and evening periods. However, direct alignment with stringent standards set by the World Health Organization (WHO) or other regulatory entities is not evident. Notably, Eleme's morning RH% exceeds values typically recommended by WHO for indoor air quality, indicating potential moisture-related complexities within slaughterhouse environments. Plausible rationales for these variations may include differences in ventilation systems, proximity to water sources, and unique meteorological dynamics. Elevated RH% levels can have various consequences, including increased microbial proliferation, equipment corrosion, and discomfort for workers. These observations underscore the importance of further investigation into environmental conditions within slaughterhouses to ensure optimal indoor air quality and occupational health standards.

The findings presented in Table 2 depict the mean ± standard deviation concentrations of temperature (°C) across various slaughterhouses in Port Harcourt during morning and evening periods. While the data don't directly align with stringent standards, they provide valuable insights into temperature variations within slaughterhouse environments. Notably, Eleme consistently exhibits higher mean temperatures compared to other slaughterhouse locations, with morning temperatures peaking at 37.50°C. Conversely, Okuru consistently records lower mean temperatures, particularly in the morning, where the temperature drops to 34.55°C. Standard deviations vary across locations and periods, indicating differing degrees of temperature variability. Plausible reasons for these variations may include differences in geographical location, building materials, and local climate conditions. Elevated temperatures can impact worker comfort and productivity, as well as affect the quality of meat processing operations. Further research is warranted to explore the implications of temperature variations within slaughterhouse environments and their potential effects on occupational health and safety standards.

The data presented in Table 3 outline the mean ± standard deviation concentrations of wind speed (WS) in various slaughterhouses across Port Harcourt during morning and evening periods. While there isn't a direct alignment with stringent standards, such as those set by regulatory bodies like the World Health Organization (WHO), notable patterns emerge. Eleme exhibits the highest mean wind speed values consistently across both morning and evening periods, peaking at 2.34 m/s in the morning. Conversely, Okuru consistently records lower mean wind speeds. Standard deviations and coefficients of variation indicate varying degrees of wind speed variability across locations and periods. Plausible reasons for these variations may include differences in geographical terrain, local topography, and microclimatic conditions. Understanding wind speed variations is crucial for assessing air quality and its potential impacts on worker health and environmental quality within slaughterhouse environments. Further investigation is warranted to explore the implications of wind speed variations and their potential effects on occupational health and safety standards within these settings.

Conclusion

In conclusion, our study underscores the profound impact of meteorological factors on pollutant concentration in the vicinity of slaughterhouses in Port Harcourt, Nigeria. The observed higher concentrations of meteorological parameters, particularly in the morning compared to the evening, raise concerns about air quality standards set by the World Health Organization (WHO) being exceeded, posing potential risks to public health. Temperature, relative

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humidity, and wind speed were identified as interconnected factors influencing pollutant dispersion. Elevated temperatures, likely influenced by prevailing winds and combustion activities, contributed to increased pollutant concentrations. Notably, relative humidity levels were highest in the Eleme slaughterhouse and lowest in Okuru, with temperature variations recorded across slaughterhouses. Wind speed, critical for pollutant dispersion, varied significantly among locations. These findings emphasize the urgent need for stricter regulations and enforcement to control emissions from slaughterhouse activities, enhanced air quality monitoring, public awareness campaigns, and collaborative efforts among stakeholders. Further research is imperative to understand the long-term impacts of air pollution from slaughterhouses and devise targeted strategies for improving air quality and safeguarding public health in urban settings like Port Harcourt.

Recommendations

1. Implement stricter regulations and enforcement measures to control and reduce emissions from slaughterhouse activities, including the adoption of cleaner production technologies and waste management practices.
2. Enhance monitoring and surveillance of air quality in the vicinity of slaughterhouses, employing advanced instrumentation and techniques to accurately assess pollutant levels and identify hotspots.
3. Promote public awareness and community engagement initiatives to educate residents about the health risks associated with air pollution from slaughterhouse operations and encourage active participation in pollution prevention efforts.
4. Collaborate with relevant stakeholders, including government agencies, industry representatives, and community organizations, to develop comprehensive air quality management strategies that address the complex interplay of meteorological factors, industrial activities, and environmental health concerns.

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Appendices

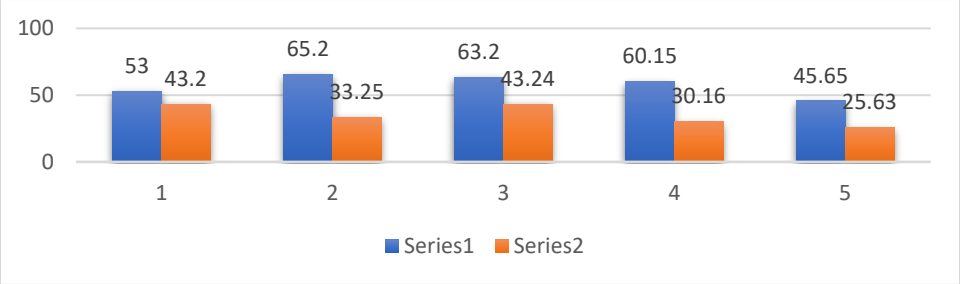

Fig.1: Mean concentrations of RH (µg/m^3) in the various slaughterhouses in the morning and evening.

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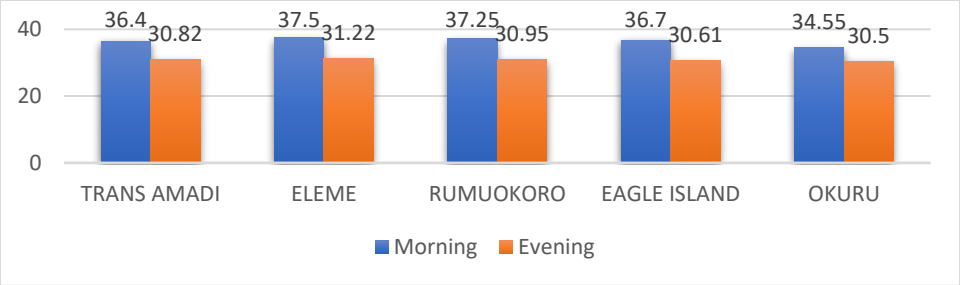

Fig.2: Mean concentrations of Temp. (℃) in the various slaughterhouses in the morning and evening.

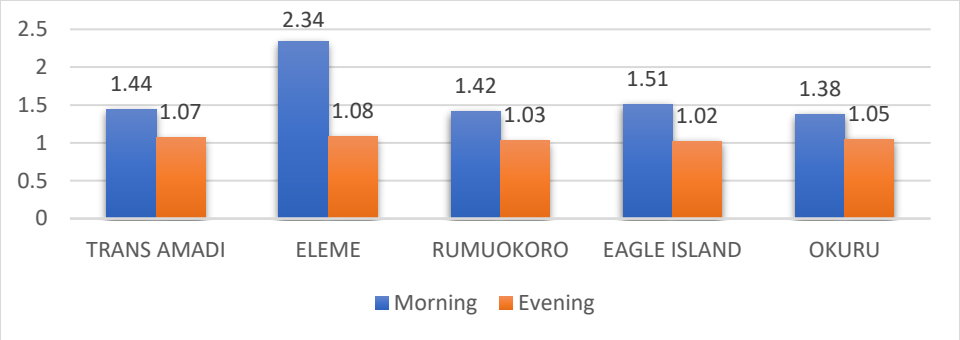

Fig.3: Mean±SD concentrations of Wind Speed (µg/m^3) in the various slaughterhouses in the morning and evening.

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