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Assessment of Air Quality Around Selected Abattoirs In Port Harcourt Metropolis, Rivers State, Nigeria

[1]Wokoma, O. A. F., [1]Edoghotu, A. J., [1]Gboeloh, L. B., [1]Onyeche, E. C., [2]Alikor, E. and [3]Owoh, A. A.

[1]*Department of Biology, Ignatius Ajuru University of Education, Rumuolumeni, P. M. B. 5047, Port Harcourt*
[2]*Department of Biochemistry, Rivers State University, P. M. B. 5344, Port Harcourt.*
[3]*Department of Animal and Environmental Biology, Rivers State University, P. M. B. 5344, Port Harcourt.*

Aabstract :
Background*: The quality of life we live is directly and or indirectly related to the quality of air we breathe. Man could survive days without water, weeks without food but cannot survive a few seconds without clean and quality air.There are growing concerns particularly from developing countries like Nigeria that airborne emissions from slaughter houses, industries, transportation etc. influences both air quality and climate change. These emissions degrades air quality and threatens both human and ecosystem health.*
Materials and Methods*: The completely randomized block design was adopted for this study, in which Abattoirs located at Rumuokoro, Mile 3, Oil Mill, Trans-Amadi and Ogbunabali were selected for the investigation while Choba(without an abattoir) served as a control site. Assessment was carried once monthly (morning and evening) for 4 months using a portable aeroqual gas monitor for gases, extech weather monitor for meteorological variables andaeroqual PM 2.5/10 for particulate matter. Measurement was done by fixing the required gas sensor to the processor and holding the equipment to a breathing height of about 1.5 meters in the direction of the prevailing wind and reading was recorded when the monitor has warmed up and stabilized for about 3 minutes.*
Results*: The mean ± SE values obtained for gases are carbon dioxide (434.069±154.244-734±146.042), ozone (0.023±0.021-0.128±0.045), methane (0-124.625±106.933), carbon monoxide (0.01825±0.005-0.2675±0.097µg/m^3), nitrogen dioxide (0.014±0.09-0.057±0.027µg/m3), Sulphur dioxide (0±0.000-0.0125±0.025µg/m^3), ammonia (0±0.000-0.030±0.041µg/m3), hydrogen sulphide (0.26 ±.0.00-0.2625±0.805µg/m3), volatile organic compound (2.05±1.45-7.3±2.75µg/m^3), $PM_{2.5}$ (0.011±0.05-0.136±0.0.74µg/m^3), PM10 (0.011324±0.004-0.048625±0.047µg/m^3), Relative humidity (27.962524±4.493%-54.275±8.668%), wind speed (9875±7.229-2.05±9.566m/s) and Temperature (27.275±4.1.025-34.988±3.900^{o}C).*
Conclusion: *Spatial distribution of carbon monoxide, ozone, nitrogen dioxide, volatile organic compound, temperature, all implicates abattoirs as contributors to adverse air quality standard. It is therefore recommended that existing regulatory provisions should be strengthened and enforced so as to meet up with minimum operating standards.*
Key words*: Air quality, Meteorology, Abattoir, Aeroqual, Cow*

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I. Introduction

Man's ability to survive depends on the quality of the air he breaths. He could go for days without food and weeks without drink, but only a few seconds without pure, healthy air. Every day the average individual breathe more than 3,000 litres of air. Man has a tough time breathing when the air is contaminated because everyone who breathes it in deeply experiences asthma attacks, coughing, wheezing, and shortness of breath. Each day, thousands of illnesses and severe diseases brought on by air pollution result in lost workdays, school days, and lives. In addition to harming our ecosystem, air pollution causes strokes, irregular heartbeats, and heart attacks. Toxic pollutants from acid rain and ground-level ozone can harm trees, crops, wild animals, and other water bodies[1].

Due to insufficient environmental monitoring and planning, developing nations like Nigeria confront environmental problems including air pollution and desertification. In order to preserve life on earth from UV sun radiation, the atmosphere absorbs it. This warms the surface through the greenhouse effect and moderates day-and-night temperature swings. Human actions have the power to change these readily available atmospheric gases, which may have a significant impact on how well the atmosphere, which contains the air we breathe,

functions. Animals are murdered at abattoirs, which are also a significant source of air pollution worldwide[2]. When preparing meat for selling, animals like cows and goats are roasted with used tyres and kerosene, which contaminates the flesh and releases carbon monoxide into the atmosphere. The odorous blood of the murdered animals that pours on the ground pollutes the soil, natural water supplies, and the overall ecosystem. This contamination of the environment causes health issues for individuals who live close to the slaughterhouse sites [3].

Air quality and cleanliness are fundamental requirements for human wellbeing and health. Urban outdoor air pollution results in more than 1.3 million fatalities annually around the world [4]. Urban settings draw a variety of developmental processes to accommodate the population's constant growth, particularly in emerging nations. Along with their positive effects, these routine activities—which also include manufacturing, farming, construction, and agricultural processing and manufacturing—have adverse effects on the urban environment. Of particular concern is animal rearing and processing, which is a component of food production and a source of protein. According to Adeyemo OK, urbanization is linked to altered food consumption habits and is a significant factor in driving up demand for animal products worldwide.

The main reason abattoirs are required is to provide the expanding, mass demand for meat in metropolitan areas. Therefore, the production of meat and its byproducts, such as leather and skin, is linked to animal waste leaks, which, if specific safeguards are not followed, might be harmful to both humans and the environment [6].

Abattoir has polluted the environment directly or indirectly through the various processes involved in the killing of animals (Osibanjo and Adie[7]) most of these processes are done by untrained persons and in inadequate buildings, because of lack of awareness of sanitary principles by the butcher. Most of the cattle dung are dumped on the surface of the ground without evacuation, as well as the animal blood which in some cases is channelled to a soak away which later flows into the environment, (river) causing environmental hazard to man, fishes etc. The air, surface water, soil, ground water are also polluted through the roasting of cows, goat with kerosene and tyres which colour the ground surface black [5].

The release of these gases into the environment has a negative impact on people, causing major health issues that may result in emergency, increased hospital admissions, and early death. The cardiovascular and respiratory systems of the body are impacted by poor air quality. According to WHO[8], the degree of pollution exposure has an impact on each person's health.

The five most frequent types of air pollution—particulate matter, ozone, nitrogen dioxide, sulphur dioxide, and both indoor and outdoor air pollution—are responsible for over 3.3 million fatalities yearly. Children under the age of five and those over the age of 80 who reside in poor nations are particularly susceptible to this indoor and outdoor air pollution. According to the World Health Organization, air pollution is directly responsible for 2.4 million deaths worldwide each year**.**

II. Materials And Methods

Study Area: Port Harcourt metropolis where the study was carried is the Capital City of Rivers State, Nigeria and its geographical coordinates are; Latitude $4^0$46'38" N and Longitude: $7^0$00'48". It comprises two Local Government Areas namely Port Harcourt City and Obio/Akpor. The 2016 population projection from the 2006 National Census puts its population at 1,865,000 inhabitants. The City as the hub of the oil industry in Nigeria hosts several oil multinationals as well as other industrial and commercial concerns. Port Harcourt can be accessed by air, land, water and rail and being the major urban centre in Rivers State it is densely populated.

The study was carried out at five selected abattoirs in the Port Harcourt metropolis while one selected area (Choba- latitude $4^0$53'10" N and longitude $6^0$59'50" E) was used as the control. The study areas (abattoirs) and their geographical coordinates are; Trans-Amadi (latitude$4^0$48'53" N and longitude$7^0$2'14" E), Rumuokoro (latitude$4^0$45'N and longitude$6^0$50E), Mile 3 (latitude $4^0$48'23N and longitude $6^0$59'38'E), Ogbunabali (latitude $4^0$47'48" N and Longitude $7^0$1'50" E) and Oil mill (latitude $4^0$48'40'N and longitude $7^0$2'32" E) abattoirs respectively.

Air quality Sample collection: Air quality measurements were carried out in the mornings and evenings once a week for four weeks using hand held aeroqual gas monitor equipped with infrared sensor for the assessment of Ozone (O_3), methane (CH_4), Carbon dioxide (CO), Nitrogen oxide (NO_2), Sulphur dioxide (SO_2), Ammonia (NH_3), Hydrogen Sulphide (H_2S), Volatile organic compound (VOC) and Carbon monoxide (CO_2). Measurement was done by fixing the required gas sensor to the processor and holding the equipment to a breathing height of about 1.5 meters in the direction of the prevailing wind and reading was recorded when the monitor has warmed up and stabilized for about 3 minutes. In the same vein, Aeroqual $PM_{2.5/10}$ a portable particle counter was used to check the particulate matter in the air, and it is programmed to measure particle size 2.5 and 10 microns respectively depending on the sensor. Meteorological parameters (wind speed, temperature and relative humidity) were measured using a hand-held extech weather monitor. The instrument was held at a

height of 2m above ground level and wind speed, temperature, relative humidity values read off and recorded as shown on the visual display unit on the instrument after it has stabilized.

III. Result

The results of analysis of the ambient air from the study sites are as presented in Table 1below. From the study, noxious gases, particulate matter and meteorological parameters were recorded at the different stations.

Carbon dioxide was recorded as the most abundant gas in the study area varying from a low of 312µg/m^3in station 2 to a high of 1033 µg/m^3 observed in station 1 and 6, while the least is sulphur dioxide from 0.0 – 0.1 µg/m^3recorded in stations 2, 3, 5 and 6 and 1and 4 respectively.

IV. Discussion

The mean concentration of carbon dioxide in this study varied from 733.5± 169.720– 734±93.454µg/m3 this is higher than the 19 – 430 µg/m3 reported by Ngwabie M et al [9] in their study carried out on assessment of gaseous emissions from cattle in abattoir waste in Cameroon. The observed difference could be as a result of differences in the areas of study and or the severity of activities. The mean concentration of ozone in this study varied from 0.023±0.021– 0.128±0.045µg/m^3this is comparable to the 0.008 – 0.032 µg/m^3reported by Amaechi-Onyerinma[10] from a gas flare environment, it equally compares favorably with the range of 0.04-0.10µg/m3 recorded by Ishaya S et al.[11] in their study on urbanization gradient in Apo District of FCT. The low level of ozone observed in this study is as a result of the fact that ozone is unstable since it reacts with other pollutants and disappears. The value of methane in the ambient air of the study areas fluctuated from 0.25±0.5 – 124±8.746µg/m^3, this is comparable to the 0.73 – 20.48 µg/m3 reported by Ngwabie M et al.[9] in their study carried out on assessment of gaseous emissions from cattle in abattoir waste in Cameroon.

The mean concentration of carbon monoxide in this study varied from 0.01825±0.005 – 0.2675±.0.097µg/m^3 this is lower than the 0.2977 – 7.488 µg/m^3 reported by Kayes SA et al.[12] in their study carried out on the relationship between meteorological parameters and air pollution in an urban environment at Dhaka City. The observed higher concentration of carbon monoxide in the test stations and low concentration in the control station in this investigation corroborates the earlier conclusion of Adesemoye AO et al.[3] who stated that animals like cow and goat are roasted with condemned tyres and kerosene in course of processing the meat for marketing which leads to emission of gases into the atmosphere causing pollution of the air, natural water resources and the entire environment from the blood of the slaughtered animals which flows on the ground with offensive odour resulting in the pollution of the environment and causing health problems to those living around the abattoir areas.

Nitrogen dioxide mean values in the present investigation varied from 0.014±.0.09 – 0.057±.0.027 µg/m^3this is comparable to the 0.030 – 0.56 µg/m^3 reported by Ishaya S et al.[11] it is also in agreement with the 0.02 -0.025 µg/m^3 reported by Gobo AE et al.[13]. The outcome of this investigation corroborates the earlier conclusion of Magaji and Hassan[14] that abattoir leads to the production of higher concentrations of SO_2 and NO_2.

Table 1: Range & Mean Values (±SE) of noxious gases, particulate matter and meteorological parameters across the different Sample location

Throughout the period of investigation

Parameters	Station 1		Station 2		Station 3		Station 4		Station 5		Station 6	
	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
CO_2 (µg/m³)	420- 1033	720.75±84.86	312-622	499.375±92.975	428 – 800	628.625±46.727	418- 1005	734±73.021	510 –920	699.375±50.164	522-1033	733.5±60.71067
O^3 (µg/m³)	0.03- 0.014	0.053± 0.013	0.1-0.23	0.128± 0.022	0.01- 0.122	0.064±0.015	0.01–0.08	0.028±0.008	0.01-0.09	0.049±0.011	0-0.09	0.023±0.007
CH_4 ()µg/m³)	0– 392	124.625±53.466	1-32	14.125±14.373	0-0	0±0	0-0	0±0	0-0	0±0	0-2	0.25±0.25
CO (µg/m³)	0.17 – 0.35	0.268 ± 0.021	0.2-0.29	0.231±0.031	0.14- 0.32	0.225±0.024	0.12- 0.31	0.218±0.002	0.1- 0.47	0.253±0.048	0.004-0.029	0.018±0.003
NO2 (µg/m³)	0.09- 0.124	0.066± 0.013	0.008- 0.082	0.04± 0.009	0.11 – 0.081	0.046± 0.009	0.04 – 0.082	0.057± 0.005	0.08 – 0.089	0.04875±0.0114	0-0.036	0.014±0.048
SO2 (µg/m³)	0-0.1	0.013±0.013	0- 0	0± 0	0- 0	0±0	0- 0.1	0.035±0.013	0-0	0±0	0-0	0±0
NH3 (µg/m³)	0- 0	0±0	0- 0	0±0	0- 0	0±0	0- 0	0± 0	0- 0	0± 0	0.087-0.152	0.03±0.021
H2S (µg/m³)	0.11- 0.51	0.26±0.053	0.2- 0.24	0.1875 ±0.024	0.09- 0.45	0.286±0.042	0.06- 0.197	0.137±0.016	0- 0.149	0.157±0.055	0-197	0.695±0.402
PM2.5 (µg/m³)	0.16- 0.192	0.136±0.02	0.002-0.035	0.017±0.004	0.002- 0.022	0.011±0.025	0.02- 0.026	0.018±0.002	0.008– 0.026	0.016±0.003	0.002-0.052	0.032±0.013
RH (%)	58.5-83.6	68.9251±3.40325	35.2-61.3	48.4125±3.964009	30-60.6	46.1625±4.333834	2-40.8	27.9625±4.183682	65 –70.4	62.225±2.2464061	40.8-65.2	54.275±3.642936
WS (m/s)	23-27.6	14.4±3.859312	3.2-26.5	14.2625± 3.865181	3.2-26	13.9875±3.900386	4.7–34	1825.51±4.783246	4-32	20.225±3.614542	4.7-25	16.025 ±4.073247
TEMP (°C)	25.7–30.2	27.275±0.512609	26.5-32.3	29.95±0.83238	31.6-38	34.325±0.811469	28-36	31.5875±1.134277	31.8-39	34.8875±1.135379	21-36	28.8125±.1.950132

The mean concentration of sulphur dioxide in this study varied from 0.±.0.000 – 0.0125±.0.025µg/m^{3}this is lower than the 0.1 – 0.42 µg/m^3, 0.09 -0.26 µg/m^{3}and0.041 -0.44 µg/m^{3}reported respectively by Gobo AE. et al.[13] Godwin A et al.[15]and Ishaya S et al.[11] in their different studies. Ammonia in this investigation fluctuated from a low of 0.±.0.000 to a high of 0.030±.0.041µg/m^3 this is comparable to the 0.02 - 0.06 µg/m^{3}reported by Harrison[16] in his study carried out on spatial variation of air quality in Mpape area of Abuja. It is however lower than the reported concentration of 0.1 -0.510 µg/m^3 by Gobo AE et al.[13].

The value of hydrogen sulphide recorded by Godwin A et al.[15] and Ishaya S et al.[11] which respectively varied from 0.026 – 0.30 µg/m^3 and 0.19 -0.24 µg/m^3 are somewhat lower than the range of 0.137±.0.052– 0.695±.0.805 µg/m^3 recorded in this study. And the observed variation is thought to be as a result of prevalent activities in the study areas. The mean concentration of volatile organic compound ranged from 2.05±1.45 – 7.3±.2.75µg/m^3 this is comparable to the 2.174 – 7.0 µg/m^3 reported by Gobo AE et al.[13]. The observed concentration of volatile organic compound in the study area indicates poor air quality, and long exposure to volatile organic compound which according to Gobo AE et al.[13] could lead to throat, eyes and nose irritations as well as kidney damage.

$PM_{2.5}$ in this study varied from 0.011±0.05– 0.136±0.0.74µg/m^3 this is slightly higher than the 0.014 – 0.021 µg/m^{3}reported by Weli VE et al.[17] in their study on the relationship between atmospheric pollutants and meteorological parameters along major traffic corridors in Port Harcourt metropolis, Nigeria. Similarly, the outcome of the present investigation is significantly higher than the 0.0027 -0.0057µg/m^3 reported by Gobo AE et al.[13], but is slightly lower than the 0.25 – 0.26 µg/m^{3}reported by Harrison[16] in his investigation on the spatial variation of air quality in Mpape area of Abuja. The mean concentration of PM_{10} in this study varied from 0.048625±0.047 - 0.011324±0.004µg/m^3 this is lower than the 0.31– 0.46µg/m3 reported by Ishaya S et al.[11] in their study on the assessment of air quality along urbanization gradient in Apo district FCT.The study is also in contrast with that of Maggi and Hassan[14] who reported a range of 0.31 -0.46 µg/m^3, it is however comparable to the 0.055 - 0.19 µg/m^3 reported by Gobo AE et al.[13]. The observed concentration of PM_{10} in this study implies that the study areas are contaminated, and as noted byOsibanjo and Adie[7] human activities such as the operations of the abattoir could lead to the emission of respirable particulate matter 10 in the atmosphere and exposure to this PM_{10} results to respiratory and cardiovascular immobility[18].

The mean concentration of relative humidity in this study varied from 27.963±8.367%- 68.925±6.681%. This is comparable to the 22.6-42.3% reported by Khaled and Mahomound[19] in their investigation on the assessment of air quality in Dammam slaughter houses Saudi Arabia. The outcome of the present study is also comparable to the 19.30 -50.48% reported by Zhao D et al.[20] in their study carried out on

$PM_{2.5}/PM_{10}$ ratio in eight economic regions and their relationships with meteorology in China. The reported percentage of 34 - 97% recorded by Kayes SA et al.[12] is however, slightly higher than that of this present study. Mean wind speed in this study varied from 13.988±7.801 - 20.225±7.229m/s, this value is higher than the 2.9 - 4.7m/s reported by Adaramola and Oyewola[21] in their study on wind speed distribution and characteristics in Nigeria. Air temperature in this study varied from 27.275±4.1.025- 34.988 ±3.900^{o}C, this is comparable to the mean air temperature of 33.48±0.33^{o}C reported by Raheed and Morenirji[22] in their investigation on the impact of abattoir effluent on the surface waters of Alanuyo stream in Ibadan. It is equally comparable to the 26.8 - 44.2^{0}c reported by Khaled and Mahomound[19] in their study carried out on assessment of air quality in Dammam slaughter houses Saudi Arabia as well as the 10.4 -34.4^{o}C reported by Kayes S et al.[12] in their study carried out on the relationship between meteorological parameters and air pollutants in an urban environment at Dhaka City. The observed variation of temperature is as a result of the differences in the time of the day measurement was made and the dispersal of pollutant which affects the concentration of temperature[23].

V. Conclusion

The values obtained for all the gases, particulate matter and meteorological parameters in this investigation were all below the WHO and NESREA stated limits. However, carbon monoxide, ozone, nitrogen dioxide, volatile organic compound and temperature showed significant spatial variation with the higher concentrations observed in the test stations and the control station the lowest. Similar spatial variations have been reported by other investigators[13, 16]and may not be unconnected with the use of car tyres, waste plastics, kerosene and wood as fuel for roasting the skin and processing of slaughtered animals and therefore pose serious environmental and health problem in the area. It can therefore be inferred that the operations of the studied abattoirs in the Port Harcourt metropolis have and is still impacting the ambient air quality adversely.

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