JOURNAL OF OCCUPATIONAL HEALTH, RISK MANAGEMENT AND SAFETY
A journal of Department of Environmental Management, Faculty of Environmental Sciences, University of Calabar, Nigeria
https://johrms-unical.com.ng/

https://doi.org/10.60787/johrms.vol1no3.102 ONLINE ISSN: 3121-8806

Air Pollutant Distribution in Selected Wood-Fired Bakeries in Calabar Metropolis: Implications for Occupational Health

Atsa, Joy William Undie, Department of Environmental Management, Faculty of Environmental Sciences, University Calabar, Calabar, Nigeria. Email: jwuatsa@unical.edu.ng, https://orcid.org/0009-0007-9811-2471
Abang, Rebecca Inyang, Department of Hospitality and Tourism Management, Faculty of Administration and Management Sciences, University Calabar, Calabar, Nigeria. Email: abangrebecca@unical.edu.ng, https://orcid.org/0009-0002-2285-9492
Abang, Deborah Alice, Department of Hospitality and Tourism Management, Faculty of Administration and Management Sciences, University Calabar, Calabar, Nigeria. Email: deborahosang502@gmail.com
Lass, Kumo, Department of Environmental Management, Faculty of Environmental Sciences, University of Calabar, Calabar, Nigeria. Email:Lasskumo2015@gmail.com, https://orcid.org/0009-0009-7653-2031
Bassey, Theresa Inyang Department of Environmental Management, Faculty of Environmental Sciences, University Calabar, Calabar, Nigeria. Email: theresaidok@unical.edu.ng, https://orcid.org/0000-0002-5057-6994
Atsa, Praise William, Department of Public Health, Faculty of Allied Medical Sciences, College of Medicine, University of Calabar, Nigeria. Email: praiseatsa@gmail.com.

Abstract

Wood-fired bakery operations may generate particulate and gaseous pollutants that affect workplace air quality. This study assessed air pollutant distribution in selected wood-fired bakeries in Calabar metropolis, Cross River State, Nigeria. The objectives were to measure selected air pollutants, evaluate differences in measured values in comparison with NESREA/WHO standards among selected bakeries, and discuss potential occupational health relevance of the findings. Six (6) bakeries were selected within Calabar metropolis. Measurements were obtained using a portable multiparameter air quality detector. Measured parameters included $PM_{2.5}$, PM_{10}, carbon dioxide (CO_2), formaldehyde (HCHO), total volatile organic compounds (VOCs), temperature, and relative humidity. Readings at each point were taken for 8hours. Descriptive statistics were calculated, and exploratory one-way analyses of variance were reported to compare mean values for the six bakeries. Bakery-level means ranged from 14.33 to 52.33 µg/m³ for $PM_{2.5}$, 20.33 to 74.33 µg/m³ for PM_{10}, 549.33 to 1,099.67 ppm for CO_2, 0.025 to 0.310 mg/m³ for HCHO, and 0.102 to 1.112 mg/m³ for VOCs. Mean temperature ranged from 32.00 to 38.00 °C and relative humidity from 59.33% to 60.33%. Bakery B1 had the highest means for $PM_{2.5}$, PM_{10}, CO_2 and VOCs, while B5 had the highest mean HCHO concentration. The exploratory ANOVA indicated a difference in CO_2 among bakeries ($F = 3.119$, $p = 0.049$), while other comparisons were not statistically significant at $\alpha = 0.05$. The findings identify variability in measured air quality and recommends improved ventilation, dust control, oven maintenance and more rigorous repeated monitoring.

Keywords: Wood-fired bakeries, Air quality; Particulate matter; Formaldehyde; Volatile organic compounds, Occupational exposure; Calabar

Introduction

The use of wood in bakeries is particularly common in developing countries, which is an important source of indoor air pollution. The world health organization (WHO) in 2015 attributed about 4.3 million premature deaths, globally to air pollution from solid fuel combustion. Combustion of solid biomass can release particulate matter and a mixture of gaseous and organic pollutants, but the quantity and composition of emissions depend on fuel properties, combustion conditions, appliance design and operating phase. The growth of the bakery sector is increasingly exposing workers to high concentrations of fine particulate matter (Konan et al., 2026). Particulate matter is important in occupational and environmental health because inhaled particles can affect the respiratory and cardiovascular systems. In bakeries, exposure may arise from more than one source: wood combustion, flour handling, mixing, cleaning, re-suspension of settled dust, and infiltration of outdoor pollution. Research in commercial bakeries has evaluated controls

How to cAts, J. W.U,. Abang, R. I., Abang, D. A., Kumo, L., Bassey, T. I., & Atsa, P. W.**(2026)** Air Pollutant Distribution in Selected Wood-Fired Bakeries in Calabar Metropolis: Implications or Occupational Health, JOHRMS, Volume. 1, Issue 3, https://doi.org/10.60787/johrms.vol1no3.102, 107-115

creative commons

for inhalable flour dust, including low-dust flour and modified sieving practices (Pocock et al., 2023). A study of bakery workers in South-South Nigeria also reported particulate exposure and respiratory symptoms, highlighting the need to examine local bakery conditions (Oko-Ose & Oko-Ose, 2024).

Temperature and relative humidity are also important environmental conditions because they influence thermal comfort, ventilation, and the behavior of air pollutants. Recent studies in Nigeria have reported measurable concentrations of particulate and gaseous pollutants in residential, institutional and other indoor environments, demonstrating again that indoor air quality varies according to fuel use, building characteristics and ventilation conditions (Obiezi et al., 2023; Sakwe & Gbeinzi, 2023). Based on the reviewed studies, Occupational exposure in wood-fired bakeries represents a complex toxicological environment characterized by the synergistic effects of biomass combustion emissions and traditional bakery hazards (Pili et al., 2026).

Several studies have examined particulate exposure among bakery workers and indoor air quality in homes, universities, commercial buildings, and other environments, but relatively little attention has been given to the spatial distribution of $PM_{2.5}$, PM_{10}, CO_2, HCHO, and VOCs alongside temperature and relative humidity within wood-fired bakeries**.** Calabar Metropolis provides an important setting for such an investigation because differences in bakery design, ventilation, oven operation and production practices may produce different exposure conditions. Assessing these parameters across selected bakeries at a micro level can therefore provide locally relevant evidence on the quality of air to which bakery workers may be exposed and contribute to understanding the potential health concerns associated with wood fired bakery operations.

This study is guided by the source-pathway-receptor model, a conceptual framework used in environmental risk assessment to explain how contaminants originate from a source, move through an environmental pathway, and reach a receptor. In wood-fired bakeries, the oven serves as the pollution source, the surrounding air provides the pathway, and the bakery workers are the primary receptors through inhalation exposure. The model provides a basis for examining variations in air pollutant concentrations at different distances from the oven and discussing their potential occupational health implications.

Wood-fired bakery workers may encounter a mixture of combustion emissions and process-related dust, yet local evidence describing the distribution of selected air quality parameters across bakery work areas is limited. Differences in oven operation, ventilation, fuel use, building layout, and production practices may lead to different measured conditions. Without local measurements, it is difficult to identify which surveyed facilities and operational points warrant closer assessment. This study therefore provides an initial descriptive assessment of selected parameters in six bakeries in Calabar metropolis.

This study assessed selected air quality parameters at operational sampling points in six wood-fired bakeries in Calabar metropolis. The specific objectives were to measure $PM_{2.5}$, PM_{10}, CO_2, HCHO, VOCs, temperature, and relative humidity at three sampling points in each bakery; evaluate differences in measured values among the six bakeries in comparison with NESREA/WHO standards; and discuss the potential occupational health relevance of the findings.

Materials and Methods

Study Area

Calabar metropolis is located in Cross River State, Southern Nigeria, and serves as the state capital. Geographically, it lies approximately between latitude 4^{o} 55' and 5^{o} 05'N longitude 8^{o} 15' and 8^{o}25'E. The metropolis is made up of Calabar Municipality and Calabar South Local Government area. It shares boundaries with Odukpani Local Government Area to the north, Akamkpa Local Government Area to the west, and the Calabar River and Atlantic Ocean to the south and east, while its riverine boundary extends towards the Bakassi Peninsula. The capital city has an area of about 470.05$km^2$and is bounded in the east by the Republic of Cameroun and in the south-west by Akwa Ibom State (Atsa, et al, 2025). The area has a tropical climate characterized by high humidity, substantial rainfall, and wet and dry seasons.

Table 1: Selected Bakeries and Location

Bakery	Street name	Location
B1	Ballantyne	Calabar south
B2	Goldie	Calabar south
B3	Uwanse	Calabar south
B4	Old Odukpani Road	Calabar municipal
B5	Marian	Calabar municipal
B6	Atimbo	Calabar municipal

Source: Field survey, 2026

Socio-economic activities:

Calabar metropolis serves as an important administrative, commercial, tourism, and service center in the state. The growth of socio-economic activities creates continuous demand for residential buildings, offices, health facilities, roads, shopping facilities, and other infrastructure. Current development initiatives in Calabar include investment in tourism and several commercial activities.

Study design and sampling

A cross-sectional field assessment was conducted in six purposively selected wood-fired bakeries designated as B1-B6. Three operational points were sampled at each bakery: PT1, (3m away from the oven) PT2, (5m away from the oven) and PT3, (10m from the oven). In total, 18 point-level measurements were reported (six bakeries × three points).

Field measurements

A portable multiparameter air detector, model ZN-MT29, was used to measure $PM_{2.5}$, PM_{10}, CO_2, temperature, HCHO, VOCs and relative humidity. The air detector was calibrated as follows ; for $PM_{2.5}$ ($\mu g/m^3$), PM_{10} ($\mu g/m^3$),CO_2 (ppm), Temp. (°C), HCHO (mg/m^3), VOCs (mg/m^3, and RH (%) . The device was installed on a tripod at a breathing height of 1.5m above the ground

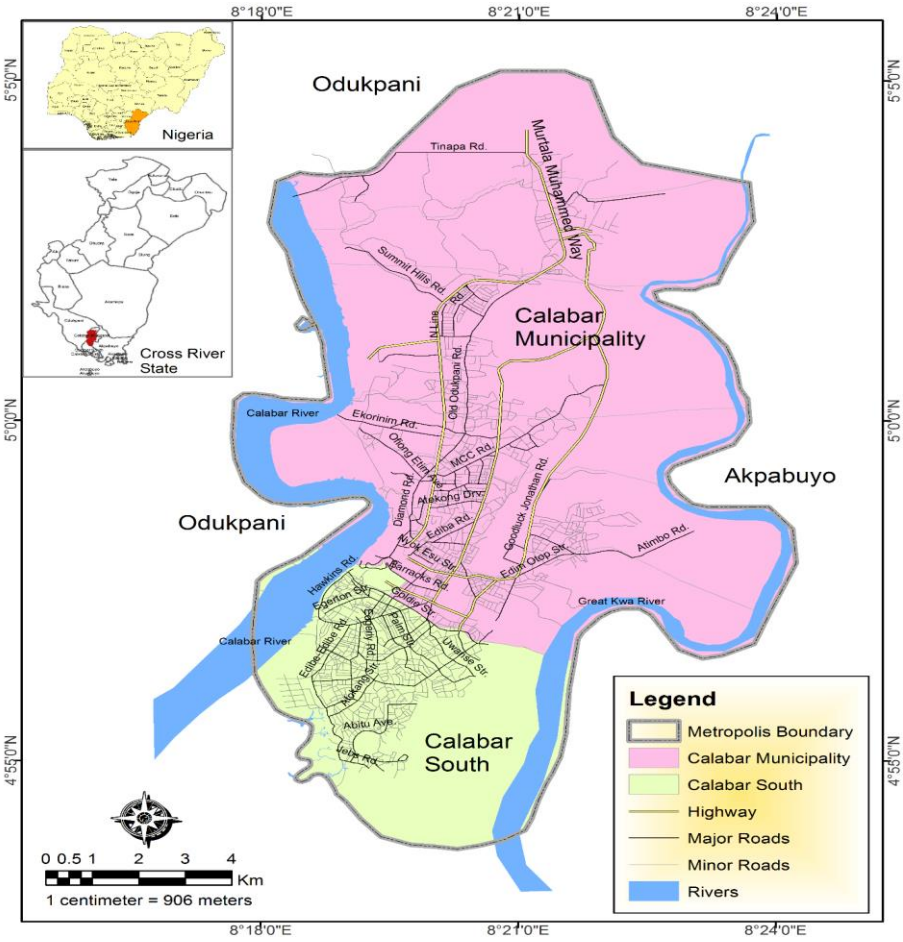


Fig. 1: Map Showing Calabar Metropolis (Calabar Municipality and Calabar South Local Government Area)

Source: Office of the Cross River State Surveyor General, 2025

and allowed to stabilize for 5 minutes; then it was left to take readings for 8hours at each sampling point during peak activity. Distance from the oven was measured using a meter tape. Sampling was performed under routine working conditions to capture occupational exposure associated with flour handling, dough preparation, and baking operations. The same instrument and general procedures were used across all six bakeries. Sampling was done between April and June 2026. The readings obtained at the three points were recorded as the raw field data, after which the mean values for each parameter were calculated for each bakery.

Data Presentation and Analysis

The point-level readings showed variation across bakeries and operational points (Table 2). At B1, $PM_{2.5}$ declined from 100 µg/m³ at PT1 to 19 µg/m³ at PT3, and PM_{10} declined from 142 to 27 µg/m³. CO_2, HCHO, and VOC readings also tended to be higher at PT1 than PT3 in several bakeries, although this pattern was not uniform for every parameter or site. The point-level readings were used to calculate arithmetic means and standard deviations for each bakery (Table 3). One-way ANOVA statistics were calculated from the three point-level observations per bakery and are reported as exploratory comparisons. Statistical significance was set at $p < 0.05$.

Table 2: Recorded point values for Air Pollutants and Environmental Parameters across Six Bakeries

Bakery	Point	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	CO (-110-	Temp. C)	HCHO (mg/m³)	VOCs (mg/m³)	RH (%)
B1	PT1	100	142	1264	36	0.232	1.527	57
B1	PT2	38	54	1185	33	0.210	1.397	61
B1	PT3	19	27	850	27	0.084	0.411	62
B2	PT1	19	23	693	39	0.039	0.161	61
B2	PT2	18	22	538	38	0.033	0.142	60
B2	PT3	19	22	420	37	0.004	0.005	57
B3	PT1	18	23	694	37	0.037	0.161	61
B3	PT2	16	21	539	36	0.034	0.141	60
B3	PT3	14	20	415	35	0.004	0.005	57
B4	PT1	19	26	941	37	0.152	0.825	61
B4	PT2	14	20	602	36	0.015	0.071	61
B4	PT3	14	20	429	36	0.020	0.111	58
B5	PT1	14	20	1232	39	0.726	1.759	60
B5	PT2	15	21	1079	38	0.155	0.845	60
B5	PT3	14	20	640	36	0.050	0.201	61
B6	PT1	18	25	940	37	0.151	0.824	60
B6	PT2	15	20	602	36	0.016	0.071	61
B6	PT3	14	20	428	34	0.020	0.111	58

Source: Field Survey, 2026

Table 3: Bakery-level descriptive statistics

Bakery	$PM_{2.5}$ mean ± SD	PM_{10} mean ± SD	CO_2 mean ± SD	Temp. mean ± SD	HCHO mean ± SD	VOCs mean ± SD	RH mean ± SD
B1	52.33 ± 42.36	74.33 ± 60.14	1099.67 ± 219.80	32.00 ± 4.58	0.175 ± 0.080	1.112 ± 0.610	60.00 ± 2.65
B2	18.67 ± 0.58	22.33 ± 0.58	550.33 ± 136.92	38.00 ± 1.00	0.025 ± 0.019	0.103 ± 0.085	59.33 ± 2.08
B3	16.00 ± 2.00	21.33 ± 1.53	549.33 ± 139.79	36.00 ± 1.00	0.025 ± 0.018	0.102 ± 0.085	59.33 ± 2.08
B4	15.67 ± 2.89	22.00 ± 3.46	657.33 ± 260.45	36.33 ± 0.58	0.062 ± 0.078	0.336 ± 0.424	60.00 ± 1.73
B5	14.33 ± 0.58	20.33 ± 0.58	983.67 ± 307.30	37.67 ± 1.53	0.310 ± 0.364	0.935 ± 0.783	60.33 ± 0.58
B6	15.67 ± 2.08	21.67 ± 2.89	656.67 ± 260.34	35.67 ± 1.53	0.062 ± 0.077	0.335 ± 0.423	59.67 ± 1.53

Note: Mean ± sample standard deviation across the three operational points within each bakery

Table 4: Exploratory comparisons among bakeries

Parameter	F-value	p-value	Original nominal interpretation
$PM_{2.5}$	2.198	0.122	Not statistically significant
PM_{10}	2.300	0.110	Not statistically significant
CO_2	3.119	0.049	Nominally significant
Temperature	2.955	0.058	Not statistically significant
HCHO	1.507	0.259	Not statistically significant
VOCs	2.470	0.093	Not statistically significant
Relative humidity	0.138	0.980	Not statistically significant

N.B: The exploratory ANOVA returned $p = 0.049$ for CO_2 and p-values above 0.05 for the other parameters.

Table 5: Mean Values of Parameters across the six bakeries in Comparison with NESREA Standards

Bakery	$PM_{2.5}$ mean	PM_{10} mean	CO_2 mean	Temp. mean	HCHO mean	VOCs mean	RH mean
B1	52.33	74.33	1099.67	32.00	0.175	1.112	60.00
B2	18.67	22.33	550.33	38.00	0.025	0.103	59.33
B3	16.00	21.33	549.33	36.00	0.025	0.102	59.33
B4	15.67	22.00	657.33	36.33	0.062	0.336	60.00
B5	14.33	20.33	983.67	37.67	0.310	0.935	60.33
B6	15.67	21.67	656.67	35.67	0.062	0.335	59.67
NESREA (2021)	Unregulated	20µg/m^3(8hrs)	Unregulated	20°- 25°	<30 µg/m^3(0.030mg/m^3)	<200 µg/m^3(0.200mg/m^3) 8hr	40 – 70%(8hrs)
WHO (2021)	15 (24hr)	45 (24hr)	Unregulated	Unregulated	0.1mg/m^3(30mins)	Unregulated	Unregulated

Source: Field survey, 2026

The comparison in Table 5 revealed differences in air quality among the six selected wood-fired bakeries. Bakery B1 recorded the highest mean concentrations of PM_{10} (74.33 µg/m³) and VOCs (1.112 mg/m³), while B5 had the highest mean formaldehyde concentration (HCHO) of 0.310 mg/m³. Compared with the NESREA mean values, all six bakeries exceeded the PM_{10} benchmark of 20 µg/m³, while B1, B4, B5, and B6 exceeded the reference values for formaldehyde and VOCs. These results suggest that workers in the affected bakeries may be exposed to higher levels of airborne pollutants during baking activities. Prolonged exposure to such pollutants may contribute to breathing difficulties, irritation of the eyes and respiratory tract, and other health problems, depending on the pollutant, concentration, and duration of exposure. The differences among bakeries may be related to variations in fuel burning, oven operation, ventilation, and the movement of smoke within the working areas.

The mean temperatures ranged from 32.00°C in B1 to 38.00°C in B2, exceeding the NESREA (2021) reference range of 20–25.5°C in all six bakeries. These elevated temperatures suggest that workers may experience considerable heat discomfort, particularly during prolonged baking activities. Relative humidity, however, ranged from 59.33% to 60.33%, remaining within the specified reference range of 40–70%. Although the humidity values were within this range, they do not eliminate the possible effects of high temperatures and airborne pollutants on workers. Overall, the findings indicate that air quality and heat conditions in the selected bakeries deserve attention. However, these findings indicate potential health concerns rather than confirmed health effects, as the study did not directly assess workers' health outcomes.

Discussion of Findings

The present study demonstrates considerable variation in air quality conditions across the six bakeries. The highest concentrations of $PM_{2.5}$ (52.33 ± 42.36 µg/m³) and PM_{10} (74.33 ± 60.14 µg/m³) were recorded in B1, suggesting greater particulate generation or less effective ventilation at this site. This finding is consistent with evidence by Odunlami (2021) from bakery environments showing that production activities, particularly flour handling, mixing, and related processes, can generate substantial airborne particulate matter. Oko-Ose and Oko-Ose (2024) reported significantly higher particulate concentrations among bakery workers than control workers in a South-South Nigerian institutional setting.

Similarly, Pocock et al., (2023) identified flour handling and surface dusting activities as important sources of inhalable flour dust and emphasized the importance of engineering controls in commercial bakeries. The $PM_{2.5}$ concentrations in the present study were above the WHO (2021) guideline value of 15 µg/m³ in five of the six bakeries, while B1 was also above the corresponding PM_{10} NESREA guideline of 20 µg/m³ 8hour averaging periods. The findings indicate potentially important particulate exposure in the bakery environment. WHO (2021) emphasizes that exposure to $PM_{2.5}$ and PM_{10} is associated with adverse health effects and recommends reducing exposure to the lowest achievable concentrations. A 2026 study in

Côte d'Ivoire found substantially elevated $PM_{2.5}$ concentrations in bakery production areas and reported an association between production area exposure and respiratory symptoms and impaired lung function (Konan et al., 2026).

CO_2 concentrations ranged from 549.33 ppm in B3 to 1099.67 ppm in B1, with a statistically significant difference among bakeries ($F = 3.119$, $p = 0.049$). The relatively elevated CO_2 concentration in B1, together with its high particulate and VOC concentrations, may indicate differences in ventilation effectiveness and pollutant generation between facilities. Formaldehyde concentrations were highest in B5 (0.310 ± 0.364 mg/m³) and B1 (0.175 ± 0.080 mg/m³). These values are above the WHO indoor air guideline of 0.1 mg/m³ for a 30-minute averaging period. VOC concentrations were likewise elevated in B1 (1.112 ± 0.610 mg/m³) and B5 (0.935 ± 0.783 mg/m³). The simultaneous elevation of VOCs and formaldehyde at these sites may reflect differences in combustion, heating, fuel use, building materials, cleaning products, or ventilation. Similar variability in HCHO and VOC concentrations has been documented in occupational indoor environments, demonstrating that workplace activities can substantially influence pollutant concentrations.

Overall, the findings indicate that particulate matter represents the most prominent air quality concern in the surveyed bakeries, particularly at B1, while B1 and B5 also showed comparatively elevated gaseous pollutants. The absence of statistically significant differences for most parameters does not necessarily indicate absence of occupational concern, particularly because the small number of measurements per bakery limits statistical power. The results therefore support the need for improved ventilation, effective dust control practices, appropriate cleaning procedures, and routine monitoring of indoor air quality in bakery workplaces.

Potential implications for Human Health

The findings indicate potential occupational health concerns for bakery workers, particularly from exposure to particulate matter and gaseous pollutants. The elevated $PM_{2.5}$ and PM_{10} concentrations observed in some bakeries, especially B1, may increase workers' exposure to airborne particles capable of penetrating the respiratory system, potentially contributing to respiratory irritation and longer-term respiratory and cardiovascular effects (WHO, 2021). A recent study in Abidjan, Cote d'Ivoire, highlighted that bakery workers, exposed to high concentration of fine particulates exhibited significant respiratory symptoms and impaired lung function (Konan et al., 2026). Similarly, research on brick kiln workers, who are exposed to intense biomass combustion smoke, found that 95% of employees had impaired lung function with 15% showing restrictive patterns (Jamwal et. al, 2025). While bakery exposures are generally lower in intensity than brick kilns, the chronic, daily nature of baking shifts suggests a cumulative risk of chronic bronchitis and accelerated lung function decline (Adem et. al., 2024).

The relatively high concentrations of formaldehyde and VOCs in B1 and B5 may also contribute to eye, nose, and throat irritation, headaches, and other respiratory symptoms with repeated exposure. The elevated CO_2 concentrations, particularly in B1, may indicate inadequate ventilation, which can promote the accumulation of indoor contaminants and reduce overall indoor-air quality. Although most parameters did not differ significantly among bakeries, the observed pollutant levels highlight the importance of adequate ventilation, dust-control measures, appropriate personal protective equipment, and regular indoor-air-quality monitoring to reduce occupational exposure.

Conclusion

The study demonstrates that bakery operations in the selected bakeries in Calabar metropolis contribute to measurable variations in ambient air quality within their immediate surroundings. The concentrations of $PM_{2.5}$, PM_{10}, CO_2, HCHO and VOCs varied across the sampling locations, with several of the highest values generally recorded at the sampling point closest to the bakeries. This pattern suggests that emissions associated with bakery activities and fuel combustion may influence air quality within the immediate bakery vicinity. Although the magnitude of variation differed among the bakeries and not all parameters showed statistically significant differences, the presence of particulate matter and gaseous pollutants highlights a potential exposure concern for bakery workers and people regularly present around

these facilities. The findings therefore underscore the need for improved emission control, adequate ventilation and routine air-quality monitoring around bakeries, particularly those using combustion-based ovens.

Recommendations

Based on the findings from the study, the following recommendations are made:

1. Bakery operators should provide adequate ventilation and maintain ovens and combustion systems properly to reduce the accumulation and dispersion of air pollutants.
2. Bakery workers should be provided with appropriate personal protective equipment, particularly respiratory protection, and trained on measures for reducing exposure to pollutants.
3. Relevant environmental and public-health authorities should conduct periodic air quality assessments and routine inspections of bakeries to ensure compliance with applicable environmental and occupational health standards.

Limitations: Short duration measurements from a small number of sites cannot establish long term exposure or prove that measured pollutants caused illness.

Ethical Consideration: Permission to conduct air quality measurements was obtained from the managers of the selected bakeries before data collection. The purpose and procedures of the study were explained. Bakery identities were protected using codes (B1–B6) to maintain confidentiality. Measurements were conducted with minimal disruption to routine baking activities and with due consideration for workplace safety. Data were recorded and analyzed objectively, and the findings were reported accurately without manipulation. The researcher also complied with applicable institutional requirements for research ethics review and approval.

REFERENCES

Adem, R., Kayhan, M. & Topal, E. (2024). Determination of the Prevalence of Asthma and Asthma Symptoms in Bakery Workers in Malatya. Annals of Medical Research, 0,1. https://doi.org/10.5455/annalsmedres.2024.08.170

Atsa, J. W. U., Abang, R. I., & Abang, D. A (2025). Assessment of Waste Disposal Practices Among Business Operators in Calabar, Nigeria. *Gombe Journal of Geography and Environmental Studies* (GOJGES) 4(3),139-151. e-ISSN: 2714-321X. p-ISSN: 2714-32. http://www.gojgesjournal.com

Jamwal, L., Sharma, R. & Kaushal, S.(2025). Prevalence of Respiratory Symptoms Among Brick Kiln Workers in Baddi (Himachal Pradesh) & Kalka (Haryana). Archives of Environmental and Occupational Health. https://doi/abs/10.1080/19338244.2025.2605087

Konan, L.L., Essis, E.M.L., Cherif, I.S., Yavo, W., & Tiembre, I. (2026). Respiratory Symptoms and Lung Function Impairment Among Bakery Employees Exposed to Flour Dust in Abidjan, Côte d'Ivoire. Scientific reports. https://doi.org/10.1038/s41598-026-6029-6

National Environmental Standards and Regulation Enforcement Agency (2021). National Environmental (Air Quality Control) Regulations,2021. Schedule IV/XI Federal Republic of Nigeria.

Obiezi, S. C., Ejiogu, C. C., & Verla, E. N. (2023). Assessment and characterization of indoor and outdoor air quality of selected facilities in a university environment using different fuel sources. *Global Research in Environment and Sustainability, 1*(9), 53–71.

Odunlami, O., Emekekwue, C., Elehinaje, F., Fajobi, M. & Abioye, O. (2021). Assessment of Carbon Monoxide Emission Levels on the Floor of Some Selected Bakeries in Southwestern Nigeria. Proceedings of The World Congress on Engineering. WCE 2021, July 7-9. London, U.K. ISBN:978-988-14049-2-3

Oko-Ose, J. N., & Oko-Ose, O. H. (2024). Analysis of particulate matter and respiratory symptoms of bakery workers in a tertiary educational institution in South-South Nigeria. *GPH-International Journal of Biological & Medicine Science*, *7*(10), 1–9. https://doi.org/10.5281/zenodo.14050050

Pili, S., Muru, A., Lachowicz, J. I., Milia, S., Pedrazzi, T., De Palma, G., Campagna, M., & Lecca, L.I. (2026). Occupational Exposure to Ultrafine Particles (Ufps) in Pizzerias: Personal Monitoring and Comparison of Oven Technologies, Environments, 13 (7), 403. https://doi.org/10.3390/environments13070403

Pocock, D., Hall, S., Bennett, S., Darnton, L., & Molloy, M. (2023). Laboratory study of the effectiveness of substituting traditional wheat flour with low-dust flour and use of different sieve designs as controls to reduce exposure to inhalable flour dust in commercial bakeries. Annals of Work Exposures and Health, 67(9), 1081–1087. (OUP Academic)

Sakwe, A., & Gbeinzi, E. (2023). Investigation of particulate matter (PM_{10} & $PM_{2.5}$) and gaseous pollutants (CO_2 & CO) in houses using kerosene cooking stoves & wood fire in Attisa 3, Bayelsa State, Nigeria. *NIPES Journal of Science and Technology Research, 5*(2). https://doi.org/10.5281/zenodo.8014409

World Health Organization (2015). WHO Residential Heating with Wood and Coal: Health Impacts and Policy Options in Europe and North America. Copenhagen, Denmark, 2015

World Health Organization. (2021). WHO global air quality guidelines: Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Geneva: WHO. (World Health Organization) https://www.who.int/publicatios/i/item/9789240034228