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Determination of Air Quality Levels in Selected Markets in Owerri Metropolis and its Environs Imo State, Nigeria

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Abstract:- The air quality levels of Ihiagwa, Ekeonunwa, and Amakohia main markets were assessed. The objectives of this research were to examine those activities that affect air quality, identify the gases emitted, measure the concentration, and suggest ways to minimize them. The study was carried out within three days and readings were taken morning, afternoon, and evening in each market. The concentrations of the gases emitted in the study area were measured using a haze dust particulate monitor, the Crowcon gas man monitor, GPS, and MRU AMPRO2000 gas monitor. The parameters determined were Carbon monoxide (CO), Ammonia (NH_3), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), particulate matter (PM_{10}), hydrogen sulfide (H_2S), and Methane (CH_4). The values of the data generated were compared with the acceptable limits given by the Federal Ministry of Environment. The result obtained shows that the mean concentration of Carbon monoxide (CO), varied from 0.00-28.80 (7.09±0.60)ppm. Ammonia (NH_3) mean concentration ranges from 0.00-25.00(1.96±0.40)ppm while nitrogen dioxide (NO_2)mean levels varied from 0.02-0.41(0.17±0.01)ppm. The average values for sulfur dioxide (SO_2) were between 0.02-0.83(0.26±0.01) ppm while hydrogen sulfide (H_2S) average values were from 0.00-2.81(0.38±0.040)ppm. The particulate matter (PM_{10}) average concentration was 3.48-36.00(18.9±0.69)mg/m^3. The mean concentration of flammable gas methane (CH_4) was 0.00-1.50(0.23±0.04)LEL%. It was found that PM_{10}, NO_2, and SO_2 all exceeded the limit given by the Federal Ministry of Environment. This study, therefore, recommends continuous monitoring of the ambient air quality of the market to know the evolution of the concentration levels of these gases for the protection of lives and properties within the surrounding communities.

Keywords:- *Air Quality, Gas Concentration, Particulate Matter, and Flammable Gas.*

I. INTRODUCTION

In recent years, there has been a tremendous increase in solid waste generation, resulting to the heaps of refuse along major streets, farmlands, market places, and roads in most cities of Nigeria, and other developing countries. One of the basic and necessary requirements for our well-being human, health and the environment is clean air.

Air pollution is the introduction of chemicals, particulate matter or biological materials that cause harm and discomfort to humans and other living organisms (Bhatia, 2009). The most common air pollutants in the urban environment include: sulphur dioxide (SO_2); oxides of nitrogen (NO_x), such as nitrogen oxide (NO) and nitrogen dioxide (NO_2); carbon monoxide (CO); volatile organic compounds (VOCs); ozone (O_3); suspended particulate matter (SPM) also called particulates; and lead (Pb) (Lutgens and Edward, 2000). Air pollutant can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made agricultural residues (Akanni, 2010; Komolafe, Adegboyega, Anifowose, Akinluyi and Awoniran 2014).

The increasing population in urban and some rural areas has actually heightened the pressure on its facilities and environment as well as those of markets. Consequent upon the volume of activities taking place daily especially in leading food stuff markets like Ihiagwa, Amakohia, Ekeonunwa, much refuse is generated. The refuse dumps remain part of the surroundings of sellers for a long time, decomposing with strong stench, blocking the roads and preventing ease of movement in and out of the market. In many nations of the world today, people, industries and local governments have polluted rivers, streams, and lakes through dumping of waste materials (Ogunbameru and Rotimi, 2006). Consequently, the dumping of refuse on the land leads to environmental pollution in form of air, water and land pollution. This is because land pollution in form of refuse and sewage produces offensive odour and an ugly sight. This affects the oxygen from the air and perhaps accounts for one reason why air pollution according to the

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European Public Health Alliance (EPHA, 2009) is one of the most common forms of pollution throughout the world.

Urban and rural markets, usually the major work place of the teeming urban poor, suffer from the problem of environmental pollution which results from dumping of sewage, dirt and animal dung. It is often devoid of virtually appreciable social amenities. In Nigeria, these markets are huge production centers; however, many are unkempt, foul-smelling, fly breeding, rat –infested and rife with health hazards. Now these issues have become more alarming for the greater proportion of the poor including traders, hawkers, and buyers in the markets including women and their hapless children. This is especially so, in the case of Ihiagwa, Ekeonunwa and Amakohia markets and therefore call for attention. Lack of adequate management of refuse dump which has contributed to the increasing pollution of the environment is still a clog in the wheel of environmental development in Imo state. The consequences of which are evident in stench and offensive smell, dirtiness of the environment and disease infestation. Also most of the air pollution takes place due to the incomplete burning of fossil fuels. Gasoline are mostly used in these market places on daily basis to carry out various activities like grinding of grain, use of generators to produce electricity, etc. Most of these Market places uses open burning of garbage as a waste disposal method. Open burning of garbage is much more harmful to our health and the environment than one may think. These pollute the air people breathe and adversely affect their health. It is against this back drop that the study seeks to examine the phenomenon of air quality levels in Ihiagwa, Amakohia and Ekeonunwa markets in Nigeria.

II. STUDY AREA

The study locations are Ihiagwa Market, Amakohia Market and Ekeonunwa Market all in Imo State. Like every other part of the state, the study locations share similar attributes.

Owerri lies within Latitude $5^0$5'N and Longitude $7^0$03'E. Owerri municipal is bounded on the North by Amakohia, on the North-East by Uratta, on the East by Egbu, on the South-East by Naze, on the South by Nekede, and on the North-West by Irete. The project sites (reading collection spots) (1.) Ohaji/Egbema LGA (2.) Owerri Municipal (3.) Owerri North and (4.) Owerri West.

Imo State lies within the humid tropics and is generally characterized by warm temperatures year-round; and also fluctuates a little during any given month or year. Although more fluctuation occurs in daily temperature than in monthly or yearly temperature. The mean minimum temperature is 23.5°C and the means maximum temperature is 32.1°C (Fidelis, 2014). Two seasons, wet and dry were observed in the year. The rainy seasons begin in April and last till October. The State experiences climate variations following rainfall variability. Imo State has two geological regions namely a coastal plain and a plateau portion.

Tropical rainforest is the dominant vegetation in the state, although its density has drastically reduced due to anthropogenic activities such as urbanization, deforestation and agricultural activities. Some other parts consist of Guinea savannah due to poor environmental management and pollution (Onweremadu and Peter, 2016). Owerri has a mean annual rainfall of about 2,250-2,500mm, the mean temperature is 25-27$_0$C and a relative humidity is 80%. The predominant soil in this part of the country is deep-well drained sandy soil (Onu, 2011).

The population of the state is about 3, 927, 563 with male, 1, 976, 471 and female 1, 951, 092 as reported by National Bureau of Statistics (NBS, 2017) cited by Fidelis (2014). With only 10% of the population residing in larger towns and the capital, agriculture is the main economic activity of the inhabitants of the State, engaging 74% of the populace. Around 10% of residents of Owerri are engaged in wage employment and 27% are self-employed in non-agricultural areas such as trading, while the remaining fraction are farmers who also engage in diverse activities including petty trading in rural and semi-urban areas. Owerri town and its environs have had a transition in land use over time (i.e. land use changes with time), which on average have demonstrated much vegetation cover in the 1980s and early 1990s transiting to a modest increase in housing and agriculture in the late 1990s and early 2000s and thereafter to massive urbanization that has continued to present day.

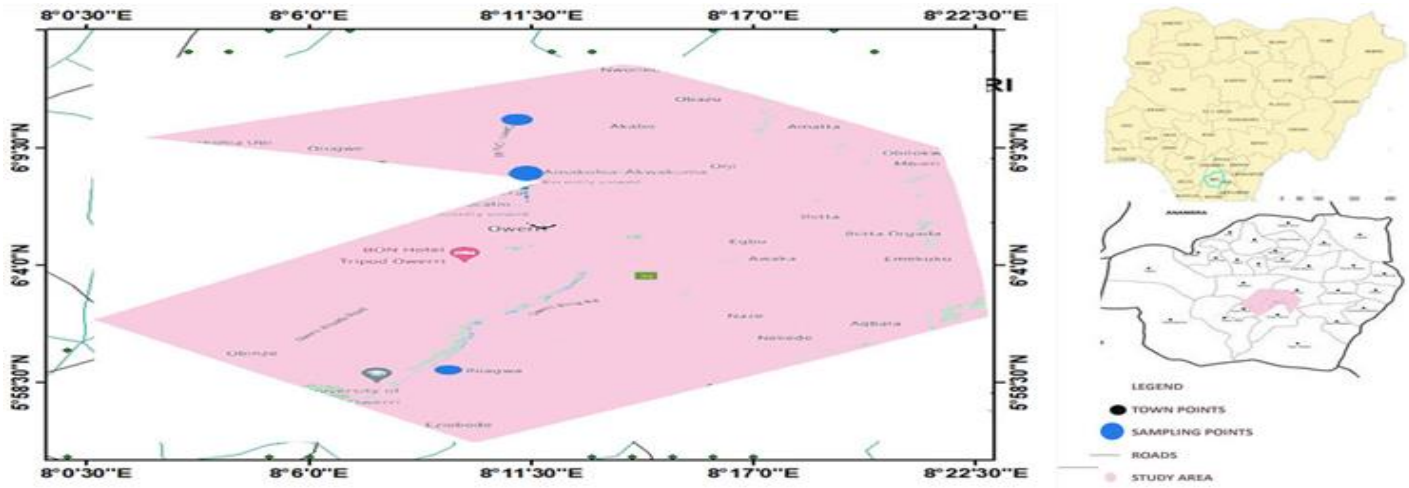

Fig 1 Showing Map of the Study Area.

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III. METHODOLOGY

➢ *Sample Collection and Measurement*

The study areas were visited before data collection commenced, in order to get accurate result, the following were done; observing the activities carried out in the area, observing the waste generation processes, observing the procedures used for dumping of refuse and get acquainted with it. During this period, operations on and around the market areas such as vehicular movements, abattoir and other activities were closely monitored.

Readings were taken in the morning, afternoon and evening within three (3) days in each market. In each of the market, concentrations of parameters were taken in the morning, afternoon and night. Four (4) points were mapped out to represent the points sampled; the readings were taken randomly at a distance of approximately every 140m (0m-140m, 140m-280m etc.) on and around the sites in the direction of the prevailing wind. The wind speed and wind direction were measured using a wind vane and a digital anemometer, the dew points and relative humidity were also measured. This monitoring process is called meteorological monitoring. It is important to monitor meteorological conditions at the air quality monitoring site. Since weather is a significant factor which influences air contaminant concentrations.

The ambient atmospheric conditions were determined by measuring the concentration levels of gases emitted on and around the market with the aid of a sensitive crowcon gasman monitor. Gases monitored include: carbon monoxide (CO), Ammonia (NH_3), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), particulate matter (PM_{10}), hydrogen sulphide (H_2S) and Methane (CH_4). All measurements were made at and near the study area at distances in the direction of the prevailing wind, at abattoirs, points of vehicular movements, parks around the market etc. The concentration levels of the gaseous parameters were recorded in a field work notebook.

The major materials and equipment used in conducting the field exercises are: Air quality monitoring meter, Writing pad/pen, field notebook, anemometer, pyranometer and GPS 60cx. The field exercise includes the identification of the point's location of the respective monitoring stations.

Table 1 Showing the Parameters and Instruments Used in Data Collection

S/N	Parameter	Instrument and measurement method
1	Wind speed and wind direction	Digital anemometer and wind gauge
2	Dew point, relative humidity, and air temperature	MRS AMPRO2000 gas monitor
3	CO, NH_3, NO_2, SO_2, N_2S, CH_4	Gas man monitor
4	PM10	Haze dust particulate monitor

Data generated from all analysis were subjected to descriptive statistics, ANOVA, Correlations, analysis of variance and means where significant ($p \leq 0.05$) using Duncan multiple range test.

IV. RESULT

Table 2 The Mean Concentration of the Parameters

Levels/concentration Parameters	Minimum	Maximum	Mean	STD error	FMEnv STD
Air Temperature (℃)	31.20	39.80	33.93	0.19	
Wind speed (m/s)	0.60	6.20	2.47	0.11	
Dew point (℃)	27.00	35.70	29.99	0.18	
CO (ppm)	0.00	28.80	7.09	0.6	10.0
NH_3 (ppm)	0.00	25.00	1.96	0.40	
NO_2 (ppm)	0.02	0.41	0.17	0.01	0.06
SO_2 (ppm)	0.01	0.83	0.26	0.01	0.01
PM_{10} (mg/m^3)	3.48	36.00	18.91	0.69	0.25
H_2S (ppm)	0.00	2.81	0.38	0.04	10.0
CH_4 (LEL%)	0.00	1.50	0.23	0.04	5.0
RH (%)	73.90	79.90	76.72	0.21	

STD Error: Standard Error, FMEnv STD: Federal Ministry of Environmental Standard, CO: Carbon monoxide, NH_3: Ammonia, NO_2:Nitrogen dioxide, SO_2: Sulphur dioxide, PM_{10}: Particulate Matter, H_2S: Hydrogen Sulphide, CH_4: Methane, RH: Relative Humidity

The descriptive statistics of the air quality parameters show that Mean air temperature, wind speed, and dew point varied from 31.20-39.80(33.93±0.19)ºC, 0.60-6.20(2.47±0.11)m/s and 27.00-35.70(29.99±0.18)ºC respectively. Concentration of carbon monoxide varied from 0.00-28.80(7.09±0.60)ppm, Ammonia varied from 0.00-25.00(1.96±0.40)ppm and Nitrogen dioxide varied from 0.02-0.41(0.17±0.01)ppm. Levels of Sulphur dioxide, Particulate matter, Hydrogen Sulfide, Methane, and Relative humidity varied from 0.02-0.83(0.26±0.01)ppm, 3.48-36.00(18.9±0.69)mg/m^3, 0.00-2.81(0.38±0.040)ppm, 0.00-1.50(0.23±0.04)LEL% and 73.90-79.90(76.72±0.21) respectively.

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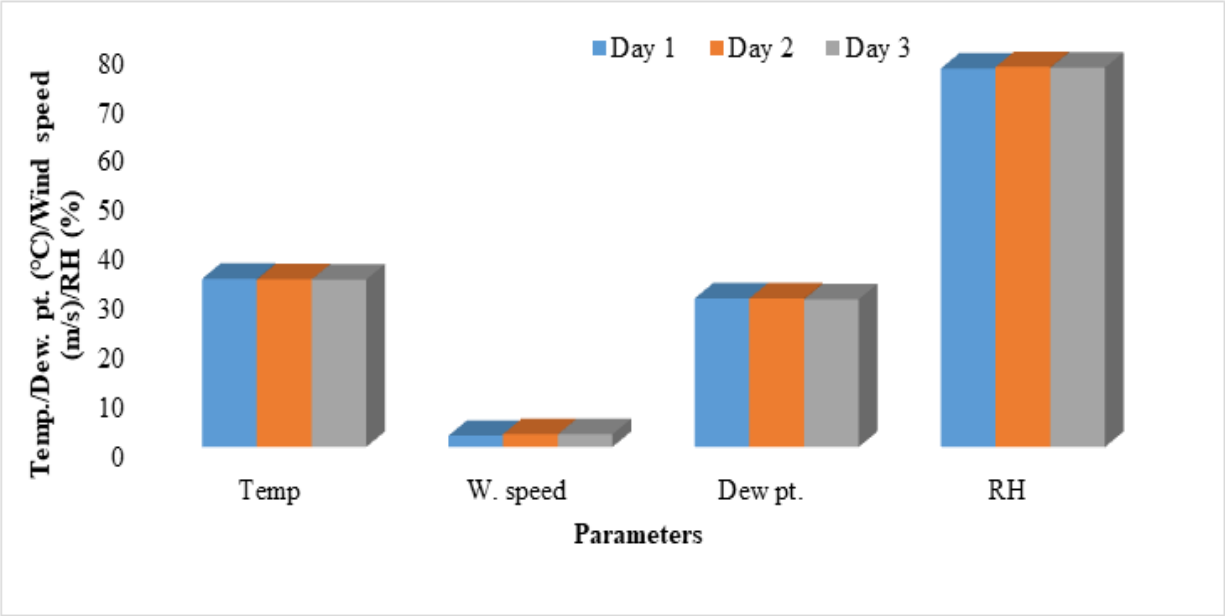

Fig 2 Variations in Daily Mean Air Temperature, Wind Speed, Dew Point and Relative Humidity Around Markets in Owerri

Figure 2. above showed a very high level of Relative Humidity in the days of the fieldwork, this was followed by Temperature and Dew point, while Wind speed had the least concentration level.

Variation in mean daily concentration of Carbon monoxide, Ammonia, Hydrogen sulphide and Sulphur dioxide in Day 1 were 6.92± 1.08ppm, 1.79±0.70ppm, 0.34±0.08ppm and 0.14±0.13ppm. On Day 2, their mean concentration were 7.16±1.05ppm, 2.03±0.70ppm, 0.39±0.07ppm and 0.27±0.22ppm. On Day 3, they were 7.19±1.01ppm, 2.07±0.68ppm, 0.40±0.08ppm and 0.28±0.03ppm respectively.

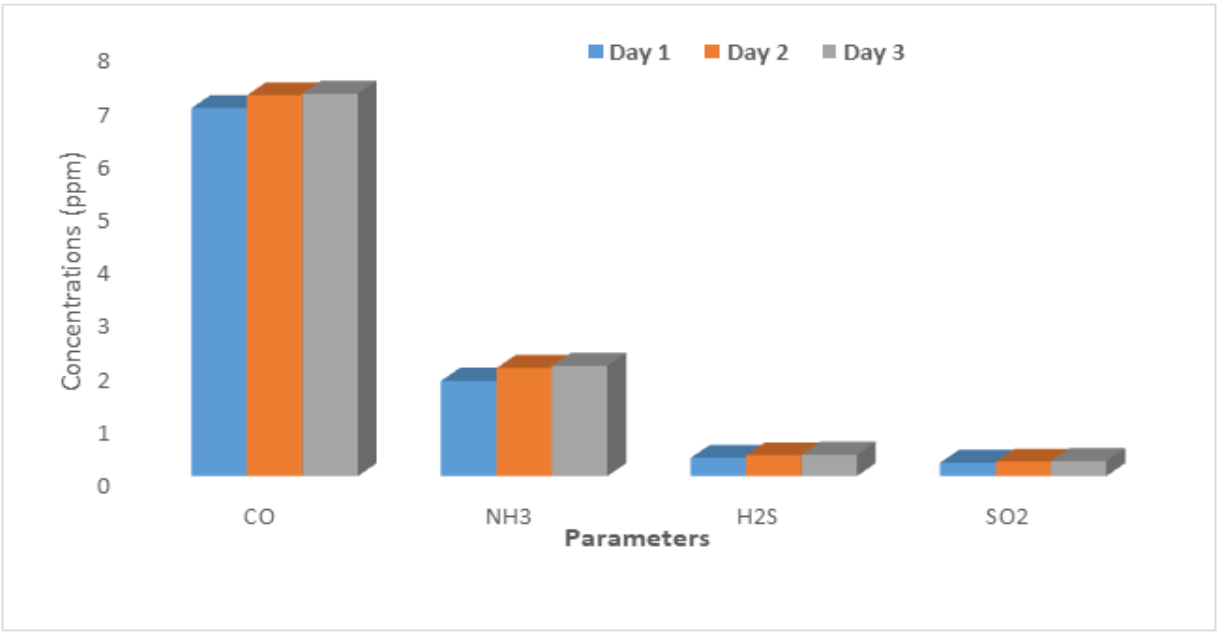

Fig 3 Variations in Daily Mean Concentrations of Carbon Monoxide, Ammonia, Hydrogen Sulphide and Sulphur Dioxide Around Markets in Owerri

Figure 3. revealed that there were very high levels of CO followed by NH_3, H_2S from day 1 to day 3 around the markets in Owerri, while SO_2 had the least concentration level. The daily mean concentration of variation for Nitrogen oxide, Particulate matter and Methane in Day1were 0.19±0.02ppm, 18.98±1.23mg/$m^{3,}$ 0.23±o.o7LEL%. On Day 2, their mean concentration were 0.19±0.01ppm, 18.90±1,18mg/$m^{3,}$, 0.23±0.07LEL%.On Day 3, they were 2.07±0.68ppm, 18.86±1.21mg/$m^{3,}$ 0.23± 0.07LEL% respectively.

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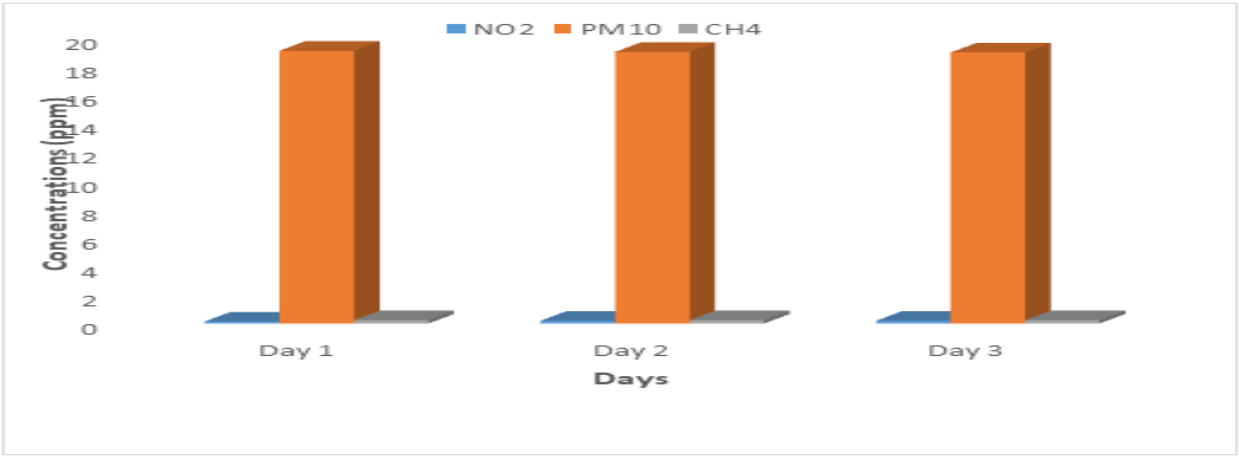

Fig 4 Variations in Daily Mean Concentrations of Nitrogen (IV) Oxide, Particulate Matter and Methane Around Markets in Owerri

Figure 4. Above it can be seen that PM_{10} was predominant throughout the 3days, with NO_2 and CH_4 almost at the same level. The very high level of PM_{10} around the Markets can be attributed to the season (dry) of the year, as well as human traffic as always the case in Markets located within urban settlement.

Table 3 Mean Separation in the Ambient Air Quality Parameters Using Duncan Multiple Range Test (P<0.05)

Parameter	Day 1	Day 2	Day 3
Air Temperature ^oC	34.03^a	33.89^a	33.87^a
Wind Speed, m/s	2.26^a	2.59^a	2.55^a
Dew Point, ^oC	30.04^a	30.05^a	29.87^a
CO (ppm)	6.92^a	7.16^a	7.19^a
NH_3 (ppm)	1.79^a	2.03^a	2.07^a
NO_2 (ppm)	0.14^a	0.19^b	0.19^b
SO_2 (ppm)	0.25^a	0.27^a	0.28^a
PM_{10} (mg/m^3)	18.98^a	18.90^a	18.86^a
H_2S (ppm)	0.34^a	0.39^a	0.40^b
CH_4, LEL%	0.23^a	0.23^a	0.23^a
Relative Humidity	76.58^a	76.87^a	76.74^a

Values with the same superscript along same row are not significantly different at $p<0.05$.

The one-way analysis of variance revealed that the concentration of Nitrogen dioxide varied significantly across the sampling days (significant value of NO_2 equals 0.018) at $p<0.05$. A post-hoc mean separation using Duncan Multiple Range test (DMRT) revealed that the observed difference in NO_2 was between Day 1 and other Days.

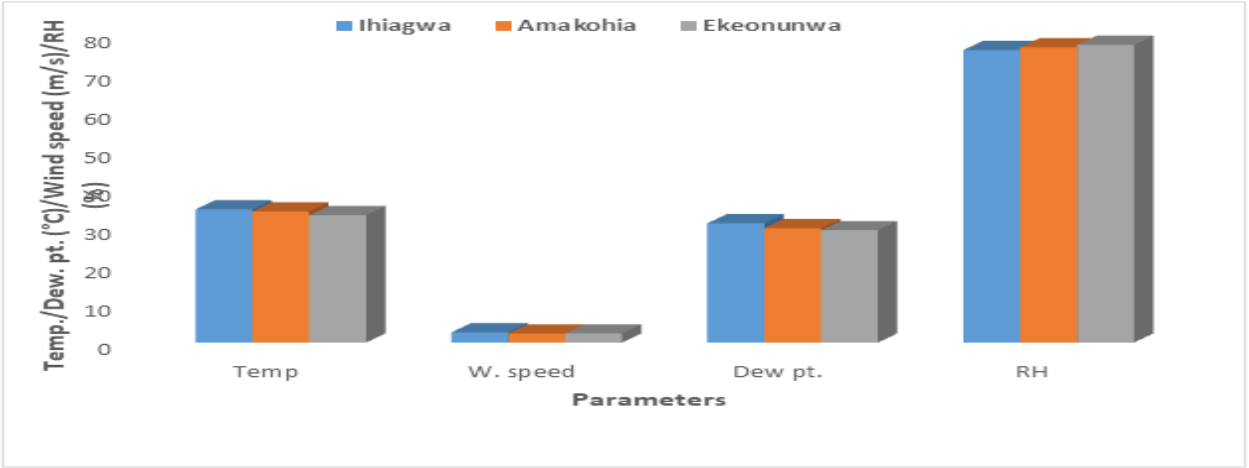

Fig 5 Variations in Mean Air Temperature, Wind Speed, Dew Point and Relative Humidity Around Three Market Locations in Owerri

ISSN No:-2456-2165

Figure 5. Above revealed that Relative humidity had almost the same level in the three markets sampled, but slightly higher in Ekeonunwa market, followed by Temperature, which was slightly higher in Ihiagwa market, then followed by Dew point; while Wind speed had the least concentration.

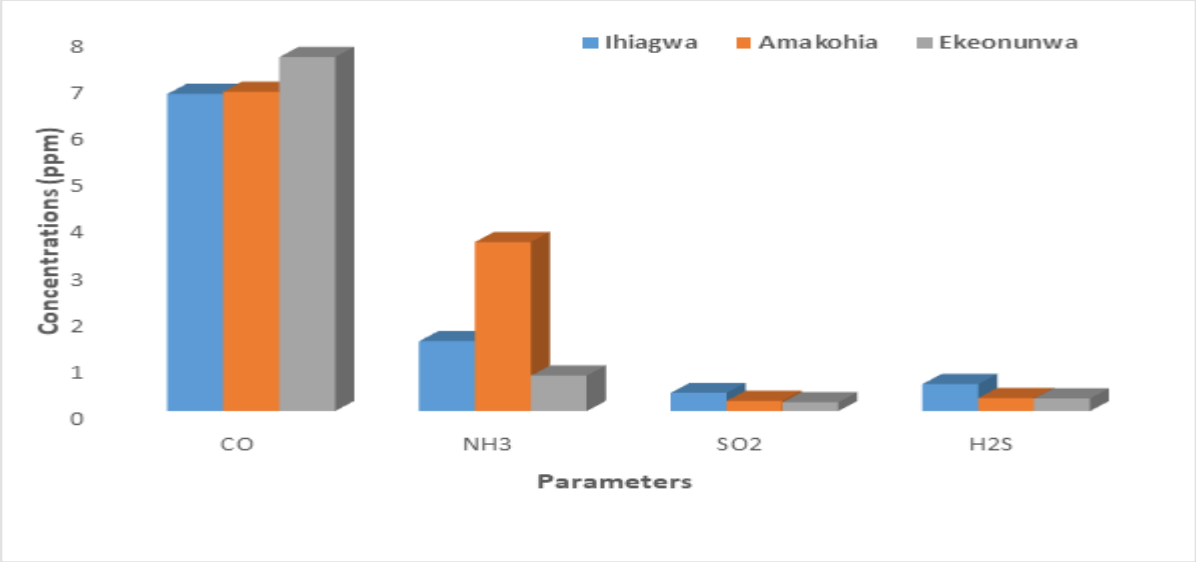

Fig 6 Variations in Mean Concentrations of CO, NH3, SO2, and H2S Around the Three Market Locations in Owerri

Variation in mean daily concentration of Carbon monoxide, Ammonia, Hydrogen sulphide and Sulphur dioxide in Location 1 were 6.81±1.02ppm, 1.50± .0.15ppm, 0.39±0.02ppm and 0.58±0.12ppm. On Location 2, their mean concentration were 6.86±0.75ppm, 3.63±1.13ppm, 0.22±0.22ppm and 0.28±0.03ppm. On Location 3, they were 7.60±1.30ppm, 0.76±0.09ppm, 0.19±0.15ppm and 0.27±0.03ppm respectively. Figure 5. Revealed that CO concentration was higher in all the three markets, with Ekeonunwa market recording the highest level. The levels of CO in the sampled markets were all within the tolerable limit of FMEnv. Comparing the level of NH_3 in the three sampled points, NH_3 was higher Amakohia market, followed by Ihiagwa market, Ekeonunwa had the least concentration of NH_3.

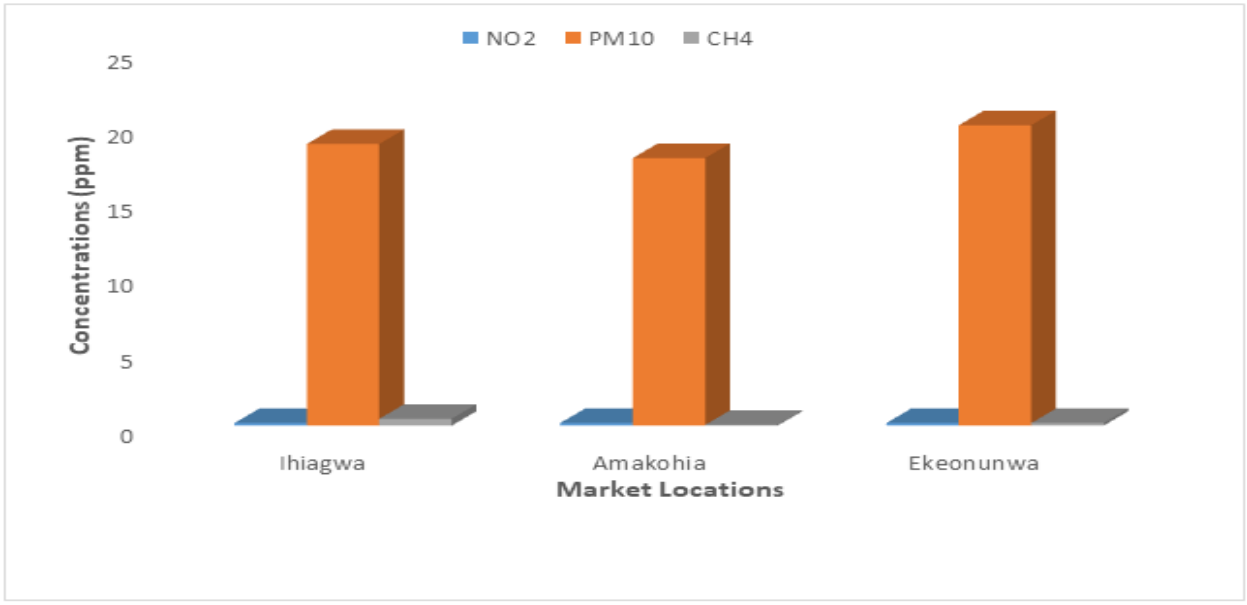

Fig 7 Variations in Mean Concentrations of Nitrogen (IV) Oxide, Particulate Matter and Methane Around Three Market Locations in Owerri

The mean concentration of variation for Nitrogen oxide, Particulate matter and Methane in Location 1 were 0.17±0.01ppm, 18.81±1.03mg/m^3 and 0.46±0.08LEL%. On Location 2, their mean concentration were 0.18±0.01ppm, 17.87±1.24mg/m^3 and 0.05±0.03LEL%..On Location 3, they were 0.17±0.08ppm, 20.06±1.30mg/m^3 and 0.17±0.07LEL%. respectively.

ISSN No:-2456-2165

Table 4 Mean Separation in the Ambient Air Quality Parameters Using Duncan Multiple Range Test (P<0.05)

Parameter	Market locations Ihiagwa	Amakohia	Ekeonunwa
Air Temperature (°C)	34.63^{b}	34.06^{b}	33.10^{a}
Wind Speed (m/s)	2.67^{a}	2.35^{a}	2.38^{a}
Dew Point (°C)	31.01^{b}	29.75^{a}	29.20^{a}
CO (ppm)	6.81^{a}	6.86^{a}	7.60^{a}
NH_3 (ppm)	1.50^{a}	3.63^{b}	0.76^{a}
NO_2 (ppm)	0.17^{a}	0.18^{a}	0.17^{a}
SO_2 (ppm)	0.39^{b}	0.22^{a}	0.17^{a}
PM_{10} (mg/m^3)	18.81^{a}	17.87^{a}	20.06^{a}
H_2S (ppm)	0.58^{b}	0.28^{a}	0.27^{b}
CH_4, LEL%	0.46^{b}	0.05^{a}	0.17^{a}
Relative Humidity	76.04^{a}	76.76^{ab}	77.38^{b}

Values with the same superscript along same row are not significantly different at $p<0.05$.

The one-way analysis of variance revealed that the concentration of Air temperature, Dew points, NH_3, SO_2, H_2S, CH_4 and Relative Humidity varied significantly across the Market locations (significant value of Air temperature, Dew points, NH_3, SO_2, H_2S, CH_4 and Relative Humidity equals 0.003, 0.000, 0.008, 0.000, 0.004, 0.000 and 0.036) at $p<0.05$ (Appendix 2). A post-hoc mean separation using Duncan Multiple Range test (DMRT) revealed that the observed difference in Air temperature was between Ekeonunwa Market and other Markets, in Dew points was between Ihiagwa Market and Other Markets, in NH_3 was between Amakohia Market and other Markets, in $SO_2$was between Ihiagwa Market and other Markets, in H_2S was between Ihiagwa Market and other Markets, in CH_4 was between Ihiagwa Markets and other Markets and in Relative Humidity was between Ihiagwa Market and other Markets.

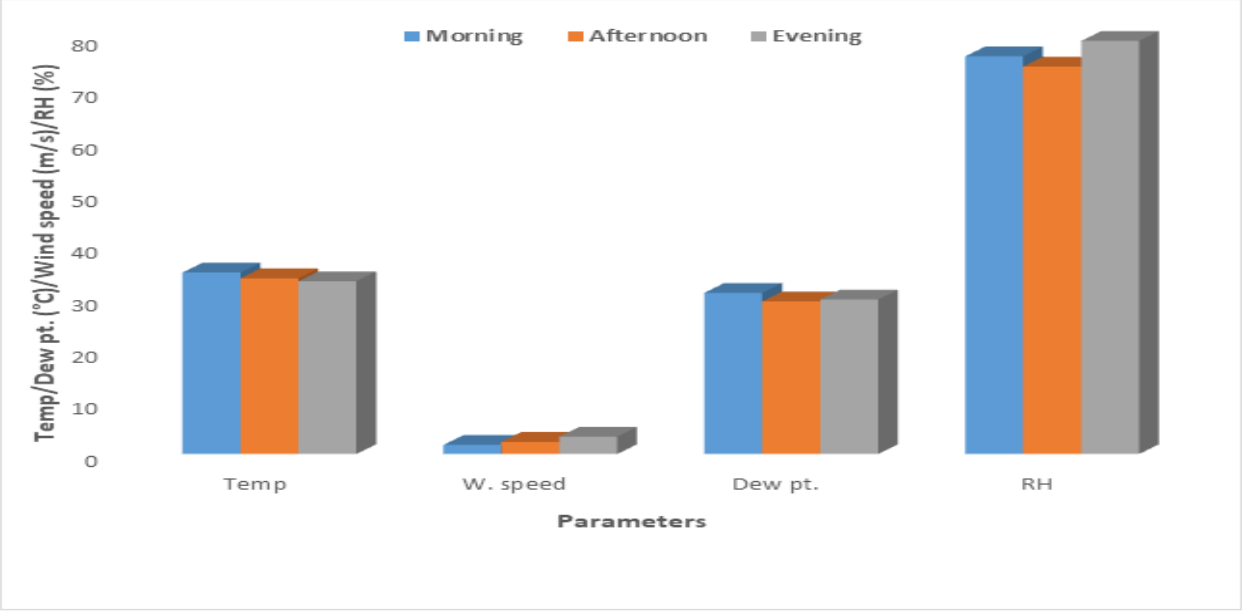

Fig 8 Variations in Mean Air Temperature, Wind Speed, Dew Point and Relative Humidity Around Markets During the Day's Periods in Owerri

Variations were observed in the ambient air quality parameters measured in the sampling period.

On Period 1 of the sampling period, the mean Air temperature, wind speed, Dew point and relative humidity were 34.85±0.44℃, 1.74±0.87m/s, 30.96±0.40℃ and 76.40±0.24% respectively. On Period 2, their respective mean value were 33.75±0.18℃, 2.33±0,16m/s, 29.32±0.18℃ and 74.43±0.06%.

However, on Period 3, they were 33.19±0.25℃, 3.33±0.24m/s, 29.68±0.24℃ and 79.36±0.06%respectively.

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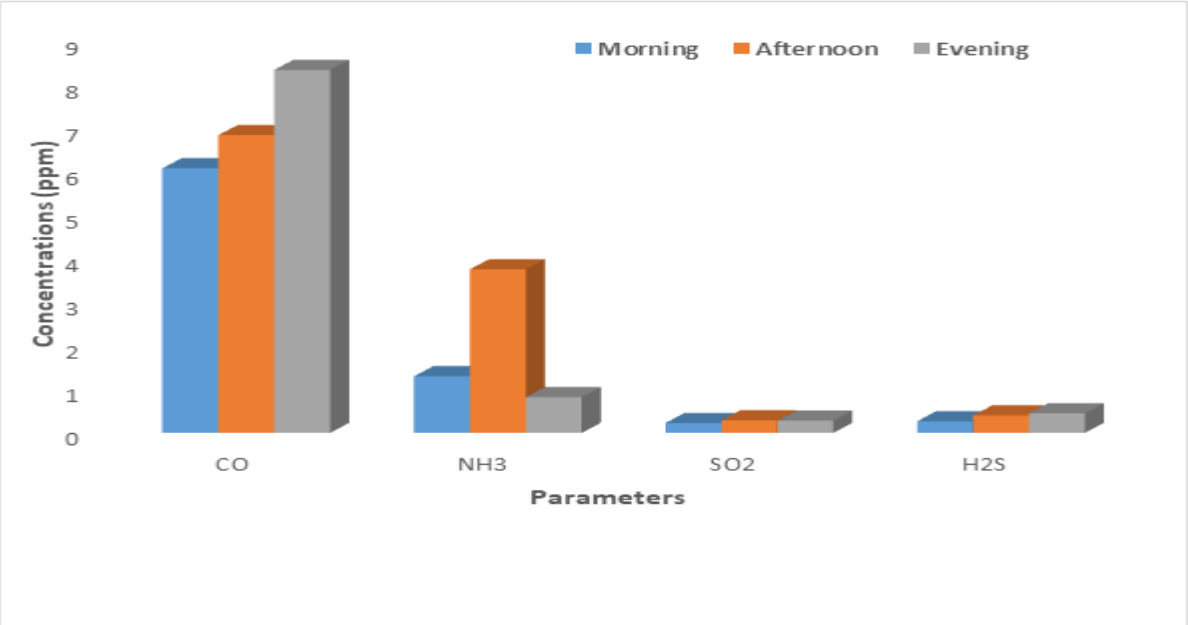

Fig 9 Variations in Mean Concentrations of Carbon Monoxide, Ammonia, Sulphur Dioxide and Hydrogen Sulphide Around Markets During the Day's Periods in Owerri

Variation in mean daily concentration of Carbon monoxide, Ammonia, Hydrogen sulphide and Sulphur dioxide in Period 1 were 6.08±0.70ppm, 1.30±0.51ppm, 0.23±0.01ppm and 0.27±0.20ppm.. On Period 2, their mean concentration were 6.84±0.72ppm, 3.76±1.13ppm, 0.29±0.02ppm and 0.40±0.06ppm. On Period 3, they were 8.34±1.50ppm, 0.82±0.18ppm, 0.28±0.03ppm and 0.45±0.12ppm. Figure 8. Showed that there was a high level of CO in the evening followed by afternoon and then morning. NH_3 was relatively higher in the afternoon compared to morning and evening. Levels of SO_2 were insignificantly indifferent, as well as H_2S which showed a slight difference in the evening and afternoon.

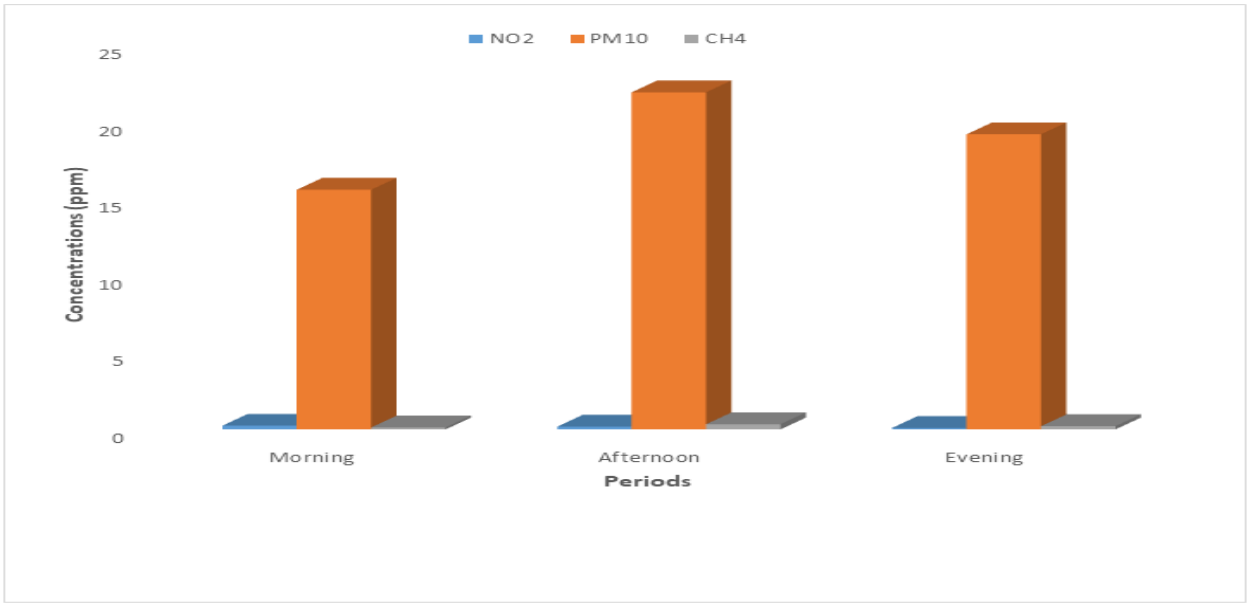

Fig 10 Variations in Mean Concentrations of Nitrogen Dioxide, Particulate Matter and Methane Around Markets During the Day's Periods in Owerri

The daily mean concentration of variation for Nitrogen oxide, Particulate matter and Methane in Period 1 were 0.24±0.01ppm, 15.59±1.03mg/m^3 and 0.13±0.70LEL%. On Period 2, their mean concentration were 0.18±0.01ppm, 21.94±0.73mg/m^3 and 0.34±0.73LEL%. On Period 3, they were 0.10±0.01ppm, 19.20±1.48mg/m^3 and 0.21±0.06LEL% respectively.

ISSN No:-2456-2165

Table 5 Mean Separation in the Ambient Air Quality Parameters Using Duncan Multiple Range Test (P<0.05)

Parameter	Morning	Afternoon	Evening
Air Temperature, ℃	34.83^{b}	33.75^{a}	33.19^{a}
Wind Speed, m/s	1.74^{a}	2.33^{a}	3.33^{c}
Dew Point, ^{o}C	30.96^{b}	29.32^{a}	29.68^{a}
CO,ppm	6.08^{a}	6.84^{a}	8.34^{a}
NH_3 ppm	1.30^{a}	3.76^{b}	0.82^{a}
NO_2, ppm	0.24^{c}	0.18^{b}	0.10^{a}
SO_2, ppm	0.23^{a}	0.29^{a}	0.28^{a}
PM_{10}, mg/m^3	15.59^{a}	21.94^{b}	19.20^{b}
H_2S, ppm	0.27^{a}	0.40^{a}	0.45^{a}
CH_4, LEL%	0.13^{a}	0.34^{b}	0.21
Relative Humidity	76.40^{b}	74.43^{a}	79.36^{c}

Values with the same superscript along same row are not significantly different at p<0.05.

The one-way analysis of variance revealed that the concentration of Air temperature, Wind speed, Dew point, NH_3, NO_2, PM_{10}, and Relative Humidity varied significantly across the Market locations (significant value of Air temperature, Wind speed, Dew point, NH_3, NO_2, PM_{10}, and Relative Humidity equals 0.000, 0.000, 0.004, 0.000, 0.001 and 0.001) at p<0.05 (Appendix 2). A post-hoc mean separation using Duncan Multiple Range test (DMRT) revealed that the observed Air temperature varied in the Morning period while wind speed varied in the Morning, Afternoon and Evening. Dew point was in the Morning period, NH_3 varied in the Afternoon, in NO_2 was Morning, Afternoon and Evening periods, in $PM_{10}$was in the Morning period, while in Relative Humidity varied in the Morning, Afternoon and Evening periods.

Table 6 Pearson's Correlation Matrix Between the Ambient Air Quality Parameters

	AIR TEMPERATURE	WIND SPEED	DUE POINT	CO	NH_3	NO_2	SO_2	PM_{10}	H_2S	CH_4	RH
AIRs TEMPERATURE											
WIND SPEED	0.278**										
DUE POINT	0.780**	0.053									
CO	0.137	0.061	0.132								
NH_3	0.050	0.048	0.005	0.049							
NO_2	0.124	0.255**	0.053	0.117	0.246*						
SO_2	0.219	0.313**	0.330**	0.299**	0.281**	0.026					
PM_{10}	0.084	0.207*	0.099	0.759**	0.089	0.039	0.442**				
H_2S	0.208	0.001	0.079	0.324**	0.043	0.008	0.422**	0.327**			
CH_4	0.024	0.133	0.018	0.200*	0.103	0.087	0.467**	0.303**	0.296**		
RH	0.316**	0.386**	0.111	0.093	0.308**	0.327**	0.127	0.061	0.009	0.079	

∗= significant at p<0.05, ∗∗= significant at p<0.01

V. DISCUSSION

The levels of Nitrogen dioxide varied from 0.02-0.41ppm with a mean concentration of 0.17±0.01ppm. The Federal ministry of Environment recommended standard for NO_2 is between 0.04-0.06ppm. The variations in daily mean for across sampling days were as follows: on Day 1, the mean level of NO_2 was 0.19±0.02ppm, on Day 2, it was 0.19±0.01ppm and on Day 3, it was 2.07±0.68ppm. There was a significant difference for NO_2 equals (0.018 at p<0.05) across the sampling days. A post-hoc mean separation using Duncan Multiple Range test indicated that the observed difference was between Day 1 and other Days.

The spatial variation of NO_2 across sampling locations were: in Ihiagwa Market, NO_2 mean concentrations was 0.17±0.01ppm, while in Amakohia Market it was 0.18±0.01ppm and Ekeonunwa Market was 0.17±0.08ppm. Also, there was no significant difference (p<0.05) in NO_2 concentration across sampling locations. Variations in average values of NO_2 across sampling periods were as follows: in the Morning period, the level of NO_2 was 0.24±0.01ppm, in the Afternoon, it was 0.18±0.01ppm and in the Evening it was 0.10±0.01ppm. There was a significant difference in NO_2 equals 0.000 at (p<0.05) across sampling periods. Comparing the levels of NO_2 with FME standard shows that NO_2 exceeds the recommended

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value. This is as a result of burning fossil fuels which includes: vehicular movements in market places, power plants, industrial emissions and off road constructions. The main health effect of nitrogen dioxide is on the respiratory system. The World Health Organization (WHO) reports on six major air pollutants, namely particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. Exposure to air pollutants can affect human health in various ways, leading to an increase in mortality and morbidity (WHO, 2005).

The descriptive statistics of levels of sulphur dioxide varied from 0.02-8.83ppm with a mean concentration of (0.26±0.01) ppm. The Federal ministry of Environment recommended standard for SO_2 is 0.01ppm. The variations in mean daily for across sampling days were as follows: on Day 1, the mean levels of SO_2 was 0.14±0.13ppm, on Day 2, it was 0.27±0.22ppm and on Day 3, it was 0.28±0.03ppm. There were no significant differences ($p<0.05$) in SO_2 across the sampling days. The spatial variation of SO_2 across sampling locations were: in Ihiagwa Market, SO_2 mean concentrations was 0.58±0.12ppm, while in Amakohia Market it was 0.28±0.03ppm and Ekeonunwa Market was 0.27±0.03ppm. Also, there were significant difference ($p<0.05$) in SO_2 (0.000) across sampling locations. Using DMRT mean separation technique, it was observed that the difference in location of SO_2 was between Ihiagwa Market and Other Markets. Variations in average values for SO_2 across sampling periods were as follows: in the Morning, the level of SO_2 was 0.27±0.20ppm, in the Afternoon, it was between 0.40±0.06ppm and in the Evening it was between 0.45±0.12ppm. There were no significant differences ($p<0.05$) in SO_2 across sampling periods. Comparing the levels of SO_2 with FME standard shows that SO_2 exceeds the required value. This may be as a result of fumes from generators, stoves, gas cookers, dryers and smoke from tobacco. Clean air is very important for human survival, as any alteration in the natural and normal constituents of air may have adverse effects on the living systems of the environment, especially on humans. Anjaneyulu (2005) defined air pollution as the presence of toxic chemicals or compounds (including those of biological origin) in the air, at levels that pose a health risk. This finding is in agreement with Simwela *et al.* (2018).

The descriptive statistics of levels of Particulate Matter varied from 3.48-36.00mg/m^3 with a mean concentration of 18.9±0.69mg/m^3. The Federal ministry of Environment recommended standard for $PM_{10}$is 0.25mg/m^3. The variations in daily mean concentration across sampling days were as follows: Day 1, the mean levels of PM_{10} was 18.98±1.23mg/m^3, Day 2, it was 18.90±1.18mg/m^3 and Day 3, it was 18.86±1.21mg/m^3. There were no significant differences ($p<0.05$) in PM_{10} across sampling days. The spatial variation of PM_{10} across sampling locations were: in Ihiagwa Market, mean PM_{10} concentrations was 18.81±1.03mg/m^3, while in Amakohia Market it was 17.87±1.24mg/m^3 and Ekeonunwa Market was 20.06±1.30mg/m^3. Also, there were no significant differences ($p<0.05$) in PM_{10} across sampling locations. Variations in average values of PM_{10} across sampling periods were as follows: in the Morning, the level of PM_{10} was 15.59±1.03mg/m^3, in the Afternoon, it was 21.94±0.73mg/m^3 and in the Evening it was between 19.20±1.48mg/m^3. There were significant differences ($p<0.05$) in PM_{10} (0.001) across sampling periods. A post-hoc mean separation method using DMRT revealed that the observed difference was in the morning and other periods. Comparing the mean values of PM_{10} against the Federal Ministry of Environment Standard indicates that the levels of PM_{10} exceeds its recommended standard as a result of burning of waste, most particles form in the atmosphere as a result of complex reaction of chemicals such as SO_2 and NO which are pollutants emitted from power plant, vehicular movements, etc. This agrees with the study by Omenikolo *et al.* (2017) that the increase in the number of authorised vehicles in Owerri has extensively given rise to the vehicular emissions in the State. Pollution from mobile sources is exacerbated by inefficient vehicles, disorganized road networks, traffic congestion, and fuel adulteration (Hopkins *et al*., 2009; Osuji *et al.,* 2009; Assamoi *et al*., 2010).

VI. CONCLUSION AND RECOMMENDATIONS

It can be concluded that Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2) and Particulate Matter (PM_{10}) all exceeded the recommended standard by Federal Ministry of Environment (FMEnv), thereby posing health and Environmental risk to people living around the market areas and Imo state in general, this mean that these gases are hazardous. The research also revealed the presence of gases such as methane, hydrogen sulfide and ammonia in traced quantities, and which are gases expected to be present due to the activities carried out in the market, the concentration of these gases are safe and can accommodate human beings without causing harm to health and vegetation.

➢ *Recommendations*

Generally, this research could serve as a vital tool to assist in monitoring concentration of Air pollutants. Based on the above findings, this research work makes the following recommendations:

- This study therefore recommends continuous monitoring of the ambient air quality of the market to know the evolution of the concentration levels of these gases for the protection of lives and properties within the surrounding communities.
- State and local government should actively disseminate health warning so that communities can better protect themselves from air pollution.
- The market place is a very important place which means the activities carried out in the area cannot be prohibited. Therefore, it is highly recommended that members of the local population and traders of the market should be provided with masks to avoid inhalation of pollutant gases.
- It is highly recommended that there should be proper waste disposal method in the disposal of waste, on or around the market area.

REFRENCES

[1]. Akanni, C.O. (2010). Spatial and seasonal analysis of traffic-related pollutant concentrations in Lagos Metropolis, Nigeria. *African Journal of Agricultural Research*, 5: 1264-1272.

[2]. Anderson C.L.(2003) Community Health St. Louis C-V Mosby Company.

[3]. Bhatia, S.C. (2009). *Environmental pollution and control in chemical process industries*. Khanna publishers. 163pp.

[4]. Dede, E.B. (2006). "Realizing effective Medical Waste Management from Cradle to Gravel in Nigeria." Paper presented at the Fourth Annual National Conference of the Senate on the Environment Port Harcourt, Rivers State, Nigeria, p.28.

[5]. Enger, E.D., and Smith, B.F. (2004). Environmental Science: A study of Interrelationships, New-York: Mc Graw-Hill companies Inc. (pp. 280-304).

[6]. FAO (2000) Corporate Document Repository, Land Cover Classification System. http://www.fao.org/docrep/003/x0596e/x0596e01e.htm

[7]. Fawa, H. (2005). Environmental implication of indiscriminate waste disposal: A case study of Ringim Town, Jigawa state. Being a project submitted to the Nasarawa State University, Nasarawa state.

[8]. Garg, S. K., Garg, R. and Garg, R. (2006), Environmental Science and Ecological Studies Delhi, Khanna Publishers Hyderabad India.

[9]. Gaurlay, Y. A. (2012). Waste Generation and Management Techniques. *Contemporary Issues in Environmental Studies*, pp. 112 – 115.

[10]. Ioannis manisalidis, Elisavet stavropoulou, Agathangelos Stavropoulos, Eugenia Bezirtzolou (2020). Environmental health and Exposome: *Environmental and health impact of Air pollution.* Vol 8. Front. Public Health 8:14. doi: 10.3389/fpubh.2020.00014

[11]. Jemide (2009). Solid waste collection and disposal: Tudun Wada, Kaduna as a case study. Being a project submitted to the Nigerian Defence Academy, Kaduna. National Waste and Recycling Association, (2013) "History of solid waste management".

[12]. Washington, DC.

[13]. Ladan, S. (2013), Examining Air Pollution and Control Measure in Urban Centers of Nigeria, research india publications, vol 4, pp. 621-628.

[14]. Lutgens, F.K., and Edward, J. T. (2000). *The Atmosphere: An Introduction to Meteorology*. 8th ed. Prentice Hall, New Jersey. 512pp.

[15]. Microsoft Encarta Online Encyclopedia. 2009.

[16]. Milter, R. V. (2008). *Environmental Health*, London: Biddles Ltd, Guildford and King's Lynn.

[17]. National academic press (US) 2002, Air quality measurement technique and application, Washington (DC): national academic press (US); 2002. Vol 7.

[18]. Nwankwo, I.M. (1998) Domestic waste Management problems in Abuja Municipal Council, a project submitted to the Ahmadu Bello University, Zaria, and Kaduna state.

[19]. Ogunbameru, K. and Rotimi, W. 2006. *Man and His Social Environment: A Textbook of Sociology*, Spectrum Books Limited, Ibadan, Nigeria.

[20]. Ogundele B.O. and Olubode O.O. (2007) Waste Generation and Management Practices of Industrial Establishments as Correlates of Health Stats of People of Ibadan; Nigeria. Nigerian School Health Journal 19(1) 9-18

[21]. Okeke, P.N. (2015) An Assessment of Two Decades of Land Use Changes in Owerri

[22]. Olanipekun J.A, Oyeniyi P. and Konwea P.E. (2007).Assessment of Solid Waste Management Techniques in EkitiState Urban Area.NigerianSchool Health Journal 19(2) 75-82

[23]. Oluwade P. A. (2009). *A guide to tropical environmental health and Engineering*, Lagos. A publication of Nigerian Istitute of Social and economic Research.

[24]. Park K. (2007). Park's Textbook of Preventive and Social Medicine India; Banarsida Bhanot Publishers.

[25]. Simmens, D. L. (2001). *Protecting the Environmental workers*, Bombay: Society for the study of Environmental Studies Publications.

[26]. Stover RH. (accessed July 1, 2019). Flooding of soil for disease control. In:Mulder D, editor. Chapter 3. Developments in Agricultural andManaged Forest Ecology. Elsevier (1979). p. 19–28. Available online at: http://www.sciencedirect.com/science/article/pii/B9780444416926500094 doi: 10.1016/B978-0-444-41692-6.50009-4.

[27]. U.S. Environmental Protection Agency, (2012) Office of Air Quality Planning and Standards, *Air Trends*. Compiled annually, and available at http://www.epa.gov/airtrends/.

[28]. United States Environmental Protection Agency. (2011). http:// www.usepa.org.Retrived on 08/08/2012.

[29]. Wikipedia.com (2006): Waste Management.

[30]. Akimoto, H. (2003). Global Air Quality and Pollution. *Science*, *302*(5651), 1716–1719. https://doi.org/10.1126/science.1092666

[31]. Amegah, K. A., & Agyei-mensah, S. (2016). Urban air pollution in Sub-Saharan Africa : Time for action *. *Environmental Pollution*, 1–6. https://doi.org/10.1016/j.envpol.2016.09.042

[32]. Anjaneyulu, Y. (2005). *Introduction to Environmental Science*. Hyderabad: BS Publications Hyderabad India.

[33]. Assamoi EM, Liousse C (2010). A new inventory for two-wheel vehicle emissions in West Africa for 2002. Atmos. Environ. 44, 3985-3996.

[34]. At market places. https://www.aqi.in/blog/here-are-the-10-main-causes-of-air-pollution/

[35]. Calderon-Garciduenas L, Azzarelli B, Acuna H, et al. Air pollution and brain damage. Toxicol Pathol. (2002) 30:373–89. doi: 10.1080/01926230252929954

[36]. Deepshikha Deb. (2019). 10 Main Causes of Air Pollution. https://www.aqi.in/blog/here-are-the-10-main-causes-of-air-pollution/
[37]. E.U. Onweremadu and K.D. Peter, 2016. Pedogenesis of Soils of Two Tropical Microclimates in Owerri Area Southeastern Nigeria. *International Journal of Soil Science, 11: 14-18.***DOI:** 10.3923/ijss.2016.14.18
[38]. Fibrinogen) in myocardial infarction survivors. Environ Health Perspect. (2007) 115:1072–80. doi: 10.1289/ehp.10021
[39]. Fidelis Chinazor Okorie (2014). Analysis of 30 years rainfall variability in Imo State of southeastern Nigeria. Hydrological Sciences and Water Security: Past, Present and Future. Pp 131-132.
[40]. Front. Public Health 8:14. doi: 10.3389/fpubh.2020.00014
[41]. Fullerton, D. G., Bruce, N., & Gordon, S. B. (2008). Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *102*(9), 843–851. https://doi.org/10.1016/j.trstmh.2008.05.028
[42]. Garg, S. K., Garg, R., & Garg, R. (2006). *Environmental Science and Ecological Studies*. Delhi: Khanna Publishers Hyderabad India.
[43]. Hopkins JR, Evans MJ, Lee JD, Lewis AC, Marsham JH, McQuaid JB, Parker DJ, Stewart DJ, Reeves CE, Purvis RM (2009). Direct estimates of emissions from the megacity of Lagos. Atmos. Chem. Phys. 9, 8471-8477. http://dx.doi.org/10.5194/acp-9-8471-2009.
[44]. Kloog I, Ridgway B, Koutrakis P, Coull BA, Schwartz JD. Long- and short-term exposure to PM2.5 and mortality using novel exposure models, Epidemiology. (2013) 24:555–61. doi: 10.1097/EDE.0b013e318294beaa
[45]. Kurt OK, Zhang J, Pinkerton KE. Pulmonary health effects of air pollution. Curr Opin Pulm Med. (2016) 22:138–43. doi: 10.1097/MCP.0000000000000248
[46]. Macmillan Nigeria Secondang Atlas. (2006). Macmillan publishers limited. 1st edition Ibandan p 22-27.
[47]. Manisalidis I, Stavropoulou E, Stavropoulos A and Bezirtzoglou E (2020) Environmental and Health Impacts of Air Pollution: A Review.
[48]. Nakano T, Otsuki T. [Environmental air pollutants and the risk of cancer]. (Japanese). Gan To Kagaku Ryoho. (2013) 40:1441–5.
[49]. Omenikolo, A. I., Uduma, C. I., Chinekeokwu, T., & Abara, J. C. (2017). Assessment of air pollution generated by transport in
[50]. Owerri, South East, Nigeria. *Merit Research Journal of Environmental Science and Toxicology* ., *5*(1), 9–17.
[51]. Osuji L.C, Ogali R.E and Usen M.U (2009). Effect of petroleum condensate/gasoline mixture on automotive engines. Helv. Chim. Acta 92, 328e334.PwC (Pricewaterhouse Coopers), http://www.pwc .com/en_GX/gx/world
[52]. Ramanathan, V., Crutzen, P. J., Kiehl, J. T., & Rosenfeld, D. (2001). Atmosphere: Aerosols, climate, and the hydrological cycle. *Science*, *294*(5549), 2119–2124. https://doi.org/10.1126/science.1064034
[53]. Rückerl R, Greven S, Ljungman P, Aalto P, Antoniades C, Bellander T, et al. Air pollution and inflammation (interleukin-6, C-reactive protein,
[54]. Simwela, A., Xu, B., Mekondjo, S. S., & Morie, S. (2018). Air Quality Concerns In Africa: A Literature Review. *International Journal of Scientific and Research Publications (IJSRP)*, *8*(5). https://doi.org/10.29322/ijsrp.8.5.2018.p7776
[55]. World Health Organisation. (2005). *Air quality guidelines : Global update 2005*. Copenhagen.
[56]. World Health Organisation. (2014). *Methods for burden of disease attributable to ambient air pollution for the year 2012*.
[57]. World Health Organisation. (2016). *Ambient Air Pollution: A global assessment of exposure and burden of disease* (Vol. 3). Retrieved on 25th August, 2017.