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SURVEY OF AUTOMOBILE EXHAUST TOLERANT PLANT SPECIES IN KANO METROPOLITAN

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ABSTRACT
A survey of trees and shrubs exposed to automobile exhaust along Zungero, Dan Agundi and Zaria Roads which are among the major roads in Kano metropolis was conducted in 2021. A green area with natural vegetation (Botanic Garden of Plant Biology Department of Bayero University, Kano) was selected as a control environment. Concentration of air pollutants such as SO_2***,*** CO_2***,*** H_2S***,*** PM_{10}***, and*** NH_3 ***were detected in the study sites using portable gas sensor manufactured by Crown Detection Instrument Ltd. Oxon OX14DY England while plant survey was carried out using quadrat sampling of 600 x 600m size. The results showed that the concentrations of the air pollutants released in the automobile emission exceeds maximum limits recommended by World Health Organization (WHO) in all the three sites to support biotic health and reproduction. Analysis on plant survey has revealed Azadirachta indica, Calotropis procera, Ficus polita, Albizia labbeck (all exotic species) to be the most abundant and tolerant specie to air pollution. Comparison between the three polluted areas and control (unpolluted) sites also revealed that more plant species were encountered in control site which implies that the automobile exhaust influenced plant diversity.***
Keywords: Plant diversity, Automobile emission, Roadsides

INTRODUCTION

Global advancement in industrialization, urbanization as well as economic growth is generally associated with increased demand for energy particularly from fossil fuels, which results in increased emission of toxic gases and other substances to the environment (Kalandadze, 2003; Uaboi-Egbenni *et al*., 2009). A variety of pollutants are released by vehicles during different operations such as carbon monoxide (CO), nitrogen oxides (NO_2), sulphur dioxide (SO_2), ammonia (NH_3), methane (CH_4), non-methane volatile organic compounds (NMVOCs), particulate matter and toxic heavy metals (Chouhan *et al*., 2012). Among the toxic metals extracted from polluted air and regarded as key contaminants are lead (Pb), cadmium (Cd), manganese (Mn), molybdenum (Mo), copper (Cu), antimony (Sb), zinc (Zn), arsenic (As), platinum (Pt), palladium (Pd), and rhodium (Rh) (Enete, 2013; Khalid *et al*., 2018). The pollutants are responsible for the bad air quality because of the suspension of particulate matter in the air. In addition, roadside soil, dust and vegetation have become an important sink of these pollutants. Govindaraju *et al*. (2012) reported that if the quality of air is disturbed, ecosystems will also be affected and biotic health and reproduction are greatly disturbed.

In the last three decades, the world has experienced unprecedented emission of pollutants and one of the prime concern for today's world is changes in the gaseous composition of earth's atmosphere (Chouhan *et al*., 2012) and Ogunrotimi and Adereti (2017) have reported increasing level of air pollution burden in several urban cities of Nigeria that has become a great challenge to air quality management. In addition, a study by Mondal *et al*. (2011) revealed that urban canopy pollution resulting from urbanization is one of the microclimatic problems faced in many urban centers, to which Kano metropolis cannot be an exception. Over the last few decades, interest in the study of the ecological characteristics of the edges associated with roads has increased (Sing, 1997).

Floristic surveys are helpful in proper identification of plant-wealth for their utilization on a scientific and systematic basis (Rahul *et al.*, 2015). Floristic data are a basic tool for evaluating and monitoring biodiversity.

The identification of local plants along with the description of an area is very important, because it can indicate specific species of the local area and their occurrence, growing season, species hardness, distinct and new species as well as the effect of climate. In line with these trends, this study is aimed at determining the concentrations of air pollutants in Kano metropolis and some plant species which tolerate such pollutants for exploitation towards biomonitoring of urban pollution using plants.

MATERIALS AND METHODS

The study was conducted within Kano Metropolis located at the central western part of Kano State (latitude 11°59'59.57 – 12°002'39.57N and longitudes 8°33'19.69 – 8°31'59.69E). It lies in the northern central boundary of Nigeria and is located some 840km away from the edge of the Sahara desert and 1,140km from the Atlantic Ocean (Sani *et al*., 2020). Its metropolis population is the second largest in Nigeria after Lagos. The Kano Urban area covers 137sq.km and comprises six Local Government Areas (LGAs) - Kano Municipal, Fagge, Dala, Gwale, Tarauni and Nassarawa.

Three sites situated along busy roads originating from the city center covering three LGAs were selected as polluted and another unpolluted site was selected as the control. The polluted sites were Zungeru Road (Site A) Located at latitude 12.02°81'20 and longitude 8.52°33'04, Dan Agundi (Site B) and Zaria Road (Site C) located at latitude 11.98°61'72 and longitude 8.53°42'98 while Botanic Garden of Plant Biology, Bayero University, Kano located (Site D) at latitude 11.97°77'36 and longitude 8.47°85'56 was the control site.

Concentrations of the gaseous pollutants (PM_{10}, CO, H_2S, SO_2, NO_2, CO_2 and NH_3) were determined using portable mobile gas sensors BH, 4S. The **s**urvey conducted in all the four study sites was carried out using 60 x 60m quadrat and population characteristics of the plant species were determined and converted to per hectare.

Data were collected by directly counting plant species in the sample quadrat. Quantitative data of plant species population were determined using the following formulae (Haruna *et al*., 2018):

$$\text{Frequency} = \frac{\text{Number of quadrat in which the species occurred}}{\text{Total number of quadrat studied}} X\ 100$$

$$\text{Density} = \frac{\text{Total number of individuals of a species in all the quadrat}}{\text{Total number of quadrat studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all the quadrant}}{\text{Total number of quadrats in which the species occurred}}$$

$$\text{Relative Density} = \frac{\text{Number of individual of the species}}{\text{Number of individual of all the species}}$$

RESULTS AND DISCUSSION

The concentrations of CO_2, H_2S, NO_2 and SO_2 are presented in Table 1. The results revealed higher concentration of CO_2 in site A with the value 781.42ppm when compared to site C which recorded 771.14ppm. Site B has recorded 765.42ppm and least concentration (21.57ppm) was recorded in site D. Concentration of NO_2 observed in site A and C was high (0.27ppm) when compared to 0.19ppm in site B. At the control site (site D), 0ppm NO_2 was observed. With respect to the concentrations of SO_2, Site A and B recorded highest concentration of 0.26 and 0.21ppm respectively while site C with the value 0.17ppm and site D with the least value 0.01ppm. Highest concentration of PM_{10} was observed in site B with 287.43ug/m^3, site C with 241.00ug/m^3, site A with the value of 159.71ug/m^3 and site D with the least value 5.57ug/m3. Highest concentration of NH_3 was also observed in site C and B (14.29ppm and 13.8ppm respectively). Site A however, had 11.07ppm and the least value (0.86ppm) was recorded in site D.

It is therefore, indicated that the average concentrations of CO_2 are statistically and significantly similar in site A, B and C but different from Site D. Average concentration of PM_{10} and SO_2 are statistically different in all the sites studied. The results showed that, there has been increasing level of NO_2,SO_4, NH_3 in site A, B and C when compared to the finding of Ochu *et al*. (2012) who worked on the same Sites in Kano metropolitan but the concentration of H_2S does not however, change. The changes in the gases concentration may be attributed to the increase in the number of vehicles which can increase the emission of these gases. According to Chouhan *et al*. (2012), the significant positive correlation indicates that the emission sources are somewhat similar that is, vehicular exhaust generated by the traffic density affects the concentration of pollutants and mild relationship between traffic and gaseous pollutants could be due to the fact that vehicles manufactured after 1989 were all equipped with a catalyst which emit 8 to 12 times less CO_2 and 3 to 6 times less NO_2, depending on the catalyst type used (Singh, 1997), and the conventional technology of the vehicles (Chouhan *et al*., 2012). Abdullahi *et al*. (2020) also reported similar finding in the concentration of CO_2 in Kumbotso and Kano municipal which are the same local government area with site B and site C studied in the current research.

For determination of plant density, individual plants species encountered in the study sites (Tables 2 – 4) were belong to 21 families and higher density of plant was observed in site D and these results could be attributed to the fact that human population growth, urbanization and vehicular influx have in a relative way led to the high emission from automobiles which subsequently play a role in plant population abundance.

Azdirachta indica, Calotropis procera, Monoom longifolia, Ficus polita, Albizia lebbeck, Terminalia mantally, Delonix regia and *mangifera indica* were the most encountered plant species in the study sites and Rahul *et al*. (2015) has reported that these plant species are of ecological relevance serving as keystone species and their removal leads to extinction cascade, thus perturbing the urban ecosystem. *Azadirachta indica*, *Calotropis procera*, *Ficus polita* and *Monoon longifolium*, *Albizia lebbeck* were observed in the three roadside sites to have highest occurrence while *Ceiba pentadra*, *Carica papaya*, *delonix regia* and *Parkia clappertoniana* have relatively recorded least occurrence. While abundance and distribution of individual species are measurable indicators of plant diversity (Uaboi-Egbenni *et al*., 2009), their investigation on the street trees can be important steps toward biodiversity conservation within the urban setting.

Table 1: Air quality index in four study areas of Kano Metropolis (ppm/ug/m^3) in March, 2021

Parameter	PM_{10}	NO_2	NH_3	SO_2	CO_2	H_2S	TEMP	HUM
ZGR	159.71^c	0.27^a	11.07^b	0.26^a	781.42^a	1.16^b	33.31^a	15.14^a
ZRR	241.00^b	0.27^a	14.29^a	0.17^c	771.14^a	1.36^b	34.47^a	15.57^a
DD	287.43^a	0.19^b	13.81^a	0.21^b	765.42^a	1.87^a	35.29^a	14.00^a
BUK OLD	5.57^d	0.00^c	0.86^c	0.01^d	21.57^b	0.27^c	34.62^a	18.42^a
LSD(5%)	29.27	0.03	1.69	0.03	54.80	0.28	NS	NS

Means along column with different superscripts are significantly different at 95% using LSD. ZGR = Zungeru Road, ZRR = Zaria Road, DD = Dan'agundi Road, BUK OLD = Bayero University, Kano Old Campus, LSD = Least Significant Difference.

Table 2: Population indices of plant species along Zungero Road, Kano Metropolis in March, 2021

S/No	Scientific Names	Common Name	Family Name	Density	Frequency	Abundance	R/Density
1	*Senna simea*	Cassod tree	Fabaceae	15.00	100.00	3.00	5.42
2	*Azadirachta indica*	Neem	Malieceae	83.33	100.00	16.66	30.12
3	*Albizia lebeck*	Fry wood	Fabaceae	5.00	66.67	1.50	1.80
4	*Ficus polita*	Fig	Moraceae	10.00	100.00	2.00	3.61
5	*Terminalia catappa*	Umbrella	Combretaceae	8.33	66.67	2.50	3.01
6	*Syzygium guineensis*	syzygium	Mrytaceae	3.33	66.67	1.00	1.20
7	*Mangifera indica*	Mango	Anarcadiaceae	8.33	100.00	1.66	3.01
8	*Roystonea regia*	Royal palm	Arecaceae	13.33	100.00	2.66	4.81
9	*Monoom longofolium*	Masquerade	Annonaceae	33.33	100.00	6.66	12.24
10	*Khaya senegalensis*	Mahogany	Meliaceae	5.00	66.67	1.50	1.80
11	*Bougaivillea spectabolis*	*Bougaivillea*	Nyctaginaceae	3.33	33.33	2.00	1.20
12	*Termilalia mentaly*	Terminalia	Combretaceae	3.33	33.33	2.00	1.20
13	*Casuarina equisetifolia*	Casuarina	Casuarinaceae	3.33	66.67	1.00	1.20
14	*Eucalyptus camaldulensis*	Eucalyptos	Myrtaceae	3.33	33.33	2.00	1.20
15	*Calotropis procera*	Sodom apple	Apocynaceae	38.33	100.00	7.66	13.85
16	*Moringa oleifera*	Moringa	Moringaceae	3.33	33.33	2.00	1.20
17	*Adansonia digitata*	Baobab	Malvaceae	5.00	66.67	1.00	1.80
18	*Parkia clappertoniana*	Parkia	Fabaceae	3.33	66.67	1.00	1.20
19	*Ficus thinoongii*	Stranger fig	Moraceae	10.00	100.00	2.00	3.61
20	*Gmelina aborea*	Gmelina	Lamiaceae	5.00	66.67	1.50	1.80
21	*Citrus aurentifolia*	Bitter Lemon	Rutaceae	3.33	33.33	2.00	1.20
22	*Psidium guajava*	Guava	Mrytaceae	3.33	66.67	1.00	1.20
23	*Ceiba pentadra*	Kapok tree	Malvaceae	3.33	33.33	2.00	1.20
24	*Carica papaya*	pawpaw	Caricaceae	3.33	66.67	2.00	1.20

R/Density = Relative density

Table 3: Population indices of plant species along Dan'agundi Road, Kano Metropolis in March, 2021

S/No	Scientific Names	Common Name	Family Name	Density	Frequency	Abundance	R/Density
1	*Cassia simea*	Cassod Tree	Fabaceae	5.00	66.67	1.50	2.40
2	*Azadirachta indica*	Neem	Malieceae	45.00	100.00	9.00	21.61
3	*Albizia lebeck*	Albizia	Fabaceae	8.33	100.00	1.66	4.00
4	*Ficus polita*	Leave	Moraceae	25.00	100.00	5.00	12.00
5	*Terminalia catappa*	Umbrella	Combretaceae	8.33	66.67	2.50	4.00
6	*Syzygium guineensis*	Syzygium	Mrytaceae	6.66	66.67	2.00	3.20
7	*Mangifera indica*	Mango	Anarcadiaceae	11.66	66.67	3.50	5.60
8	*Roystonea regia*	Royal Pan	Arecaceae	3.33	33.33	2.00	1.60
9	*Monoom longofolium*	Masqurate	Annonaceae	16.66	100.00	3.33	8.00
10	*Khaya senegalensis*	Mahogany	Meliaceae	1.66	33.33	1.00	0.80
11	*Terminalia mentaly*	Mantally	Combretaceae	15.00	66.67	4.50	7.20
12	*Casuarinaequisetifolia*	Casuarina	Casuarinaceae	6.66	66.67	2.00	3.20
13	*Eucalyptus camaldulensis*	Eucalyptos	Mrytaceae	6.66	100.00	1.33	3.20
14	*Calotropis procera*	Sodom Apple	Apocynaceae	11.66	33.33	2.33	5.60
15	*Moringa oleifera*	Moringa	Moringaceae	3.33	66.67	1.00	1.60
16	*Ficus thinoongii*	Stranger Fig	Moraceae	15.00	66.67	4.50	7.20
17	*Gmelina aborea*	Gmelina	Lamiaceae	5.00	66.67	1.50	2.40
18	*Dalbergia sisso*	Makarho	Fabaceae	8.33	33.33	5.00	4.00
19	*Delonix regia*	Flamboyant	Fabaceae	3.33	33.33	1.00	1.60
20	*Ficus platyphylla*	Ficus	Moraceae	1.66	33.33	1.00	0.80

R/Density = Relative Density

Table 4: Population indices of plant species along Zaria Road, Kano Metropolis in March, 2021

S/No	Scientific Names	Common Name	Family Name	Density	Frequency	Abundance	R/Density
1	*Cassia simea*	Cassod tree	Fabaceae	10.00	33.33	6.00	0.24
2	*Azadirachta indica*	Neem	Malieceae	80.00	100.00	16.00	1.88
3	*Albizia lebeck*	Albizia	Fabaceae	43.33	100.00	8.66	1.02
4	*Ficus polita*		Moraceae	46.66	66.33	9.33	1.10
5	*Terminalia catappa*	umbrella	Combretaceae	13.33	66.33	4.00	0.31
6	*Syzygium guineensis*	Syzygium	Mrytaceae	23.33	100.00	4.66	0.55
7	*Mangifera indica*	mango	Anarcadiaceae	11.66	100.00	2.33	0.27
8	*Dalbergia sisso*	Dalbergia	Arecaceae	1.66	33.33	1.00	0.04
9	*Monoom longofolium*	masquerade	Annonaceae	36.66	100.00	7.33	0.86
10	*Khaya senegalensis*	Mahogany	Meliaceae	3.33	66.33	1.00	0.08
11	*Ceiba pentadra*	Silk cotton tree	Nyctaginaceae	3.33	33.33	1.00	0.08
12	*Termilalia mentaly*	Mentaly	Combretaceae	41.66	100.00	8.33	0.98
13	*Casuarina equisetifolia*	Casuarina	Casuarinaceae	5.00	33.33	3.00	0.12
14	*Eucalyptus camaldulensis*	Eucalyptos	Mrytaceae	35.00	66.33	10.50	0.82
15	*Calotropis procera*	Sodomapple	Apocynaceae	10.00	66.33	3.00	0.24
16	*Ficus platyphylla*	Ficus	Moringaceae	1.66	33.33	1.00	0.04
17	*Adansonia digitata*	baobab	Malvaceae	1.66	33.33	1.00	0.04
18	*Ficus thinoongii*	Heart fig leaves	Moraceae	1.66	33.33	1.00	0.04
19	*Delonix regia*	flamboyant	Fabaceae	26.66	66.33	5.33	0.63
20	*Roystonea regia*	Royal fan	Arecaceae	25.00	100.00	5.00	0.59
21	*Gmelina aborea*	Gmelina	Lamiaceae	10.00	33.33	6.00	0.24
22	*Tamarindus indica*	Tamarind	Fabaceae	80.00	100.00	16.00	1.88

R/Density = Relative Density

Table 4: Population indices of plant species in Bayero University, Kano Old Campus in March, 2021

S/No	Scientific Names	Common Name	Local Name	Density	Frequency	Abundance	R/Density
1	*Azadirachta indica*	Neem	Malieceae	10.00	100.00	10.00	4.13
2	*Albizia lebeck*	Fry wood	Fabaceae	25.00	100.00	25.00	10.33
3	*Ficus polita*	Stranger fig	Moraceae	1.00	100.00	1.00	1.24
4	*Terminalia catappa*	Umbrella	Combretaceae	3.00	66.67	4.50	1.24
5	*Syzygium guineensis*	Syzygium	Mrytaceae	14.00	100.00	14.00	5.79
6	*Mangifera indica*	Mango	Anarcadiaceae	23.00	100.00	23.00	9.50
7	*F. platephylla*	Ficus	Moraceae	2.00	100.00	2.00	0.83
8	*Monoom longofolium*	masqurand	Annonaceae	20.00	100.00	20.00	8.26
9	*Khaya senegalensis*	mahogany	Meliaceae	7.00	100.00	7.00	2.89
10	*Ziziphus spina-christy*	Thorny jujube		1.00	66.67	1.50	0.41
11	*Termilania mentaly*	mentali	Combretaceae	34.00	100.00	34.00	14.05
12	*Casuarina equisetifolia*	casuarina	Casuarinaceae	1.00	66.67	1.50	1.24
13	*Eucalyptuscamaldulensis*	River gum tree	Mrytaceae	10.00	100.00	10.00	4.13
14	*Calotropis procera*	Sodom apple	Apocynaceae	2.00	66.67	3.00	0.83
	Anacadiumoscidentally	cashew	Anacardiaceae	3.00	100.00	3.00	1.24
16	*Punica granatum*	pomegranate	Lythraceae	2.00	100.00	2.00	0.83
17	*Ficus thinoongii*	Thoningi	Moraceae	1.00	66.67	1.50	0.41
18	*Delonix regia*	flamboyant	Fabaceae	20.00	100.00	20.00	8.26
19	*Thuja plicata*	thuja	Cupressoideae	3.00	100.00	3.00	0.41
20	*Ficus syncomorus*	Syncamore	Moraceae	1.00	66.67	1.50	0.41
21	*leucenia leucosophyla*	leuceaenia	Fabaceae	3.00	66.67	4.50	1.24
22	*plumeria rubra*	Red jasmine	Plumeria	2.00	66.67	3.00	0.83
23	*ficus thinoonji*	Stranger fig	Moraceae	1.00	66.67	1.50	0.41
24	*citrus aurentifolia*	Lemon	Rutaceae	4.00	100.00	4.00	1.65
25	*acacia nilotica*	Arabic gumtree	Fabaceae	2.00	66.67	3.00	0.83
26	*Maerua angolensis*	Maerua	Capparaeae	1.00	66.67	1.50	0.41
27	*vitex doniana*	Black plum	Lamiaceae	2.00	100.00	2.00	0.83
28	*Sclerocaryo birrea*			1.00	66.67	1.50	1.24
29	*Delbagia sisso*	Delbagia	Fabaceae	1.00	66.67	1.50	1.24
30	*Casuarina equisetifolia*	Casuarina	Casuarinaceae	1.00	66.67	1.50	1.24
31	*Ficus polita*	Heart leaved fig	Moraceae	1.00	100.00	1.00	1.24

R/Density = Relative Density

CONCLUSION

Based on air quality assessment, the results indicated that P_{10}, $S0_2$ and NO_2 exceeded the limit recommended by WHO air quality guideline and this implies that automobile emission in Kano metropolitan is not within the safe limit. The results of the quantitative survey of plant species along major roads of Kano metropolis have only revealed plant species belonging to 26 families. Higher abundance of *Azadirachta indica, Calotropis procera, Ficus polita* and *Albizia labbeck* was observed. The study also revealed that more plant were encountered in Bayero University, Kano which is the control site and this alludes the influence of the pollutants released in the automobile emission on the diversity of plant species and hence, the need to decline anthropogenic stress in the sites.

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