Seasonal Variations of Selected Ornamental Plants as Biomonitors of Air Pollutants in Ondo State, Nigeria

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ABSTRACT: This objective of this paper was to evaluate the seasonal variations of fourteen (14) ornamental plants as biomonitors of air pollution in three urban areas of Ondo State, Nigeria. The study was carried out in three areas that were purposively selected in Ondo State which are Oduduwa Road, Oloko (traffic congested area), FUTA area (Less traffic congested area) and uncongested area in Elizade University as control. The ornamental plants namely *Roystonea regai, Convallaria majalis, Polyalthia longifolia, Ficus benjamina, Dieffebachia amoena, Colocasia esculent, Caesalpinia pulcherrima, Codyline fructicosa, Viburnumt tinus variegatum, Variegatum punctatum, Hibiscus rosa-sinensis, Tradescantia pallida, Codiaeum variegatum, Acalypha wilkesiana* were selected purposively and their ascorbic acid contents, pH, relative water contents, total chlorophyll contents and air pollution tolerance index were evaluated using standard methods. The biochemical parameters and APTI values of the ornamentals showed that they have less (APTI<17) tolerance indices during the dry and the wet seasons. Thus, they are more susceptible to air pollutants as biomonitors. At congested areas ornamentals had lesser APTI values at the sampling site than the control site with *Tradescantia pallida* having the highest (8.86) mean value while *Variegatum punctatum* had the lowest value of 6.81 during the wet season while *Codiaeum variegatum* with value 7.08 and the lowest for *Variegatum punctatum* with value 4.71. Conclusively, this study recommends that in addition with the aesthetic values of the ornamental plants, they can be useful as model bioindicators of air pollution in urban settings.

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The air component is an inestimable natural resource because man cannot survive without it. Among the seventeen issues to be harnessed critically based on the sustainable developmental goals (SDGs) is the air environment. Presently, air as a complex and dynamic natural gaseous system has been affected severely due to increase in the concentrations of particulate and gaseous pollutants released by human agents (Jalal *et al*., 2021). Unlike other types of pollution, air pollution is the most critical pollution. In Urban areas of most developing countries, poor urban development and landscaping affect air quality. Moreover, the

World Health Organization (WHO) reported that more than 80% of urban areas possessed levels of air pollution higher than the recommended limits. For low- and middle-income countries, the figure increased to 98 %. According to the World Health Organization (WHO), an estimated 7 million people were affected and killed with diseases related to indoor and outdoor air pollutants (WHO, 2019). In Nigeria, Onitsha, Kaduna, Aba and Umuahia and Lagos were listed among the 20 African cities with the worst quality of air in the world (Enete, 2012). Moreover, Health Effects Institutes (2020) revealed that the

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quality of air in Nigeria was described as one of the deadliest anywhere on earth with extreme pollution sources, such as fumes from electricity generating systems, vehicular emissions, and forest burning, among others. These pollutants are classified as either primary or secondary pollutants emanating from diverse anthropogenic sources. (Barrero *et al.*, 2015; Muniyasamy and Dada, 2021). However, vehicular emissions are classified as one of the major sources of air pollutants in urban areas (Kumar *et al.*, 2022). Motor vehicles emit carbon monoxide, nitrogen oxide, Sulphur dioxide, and other toxic substances such as total suspended particulate matter and Lead. Therefore, it is germane to consistently monitor the air quality of urban centers. Over the years, biological systems such as insects, animals, microbes are useful tools to monitor air quality. However, the use of plant species for environmental assessment of air pollution is effective (Oseni *et al.*, 2015; Wei, 2017). This is because plant provides multi-faceted benefits as biomonitors and bioindicators of pollutants. For example, the enormous leaf area of plant functions efficiently to absorb pollutants in the air and serves as a sink for air pollutant. Moreover, plants are responsible for the natural sequestration of carbon di oxide from the atmosphere to release oxygen. The mechanisms by which plants respond to pollution depend on specific factors such as habitat, leaf physical parameters, and weather conditions present in the area (Forcados, 2016). In a polluted environment, sensitive plants can act as bio-indicators of air pollution while the tolerant plants can act as sinks for various air pollutants. Plants growing along the roadsides get affected the most as they are the primary recipients of different air pollutants and show varied levels of tolerance and sensitivity. In the use of plants as agent of environmental monitoring, most researchers successfully used the biochemical responses along with the Biological Index known as Air pollution tolerance index (APTI) to measure the ability of plants to cope with air pollution stress. Air pollution tolerance index has been used to screen out plants based on their tolerance or sensitivity level to different air pollutants. However, there are scanty evidences on the use of ornamentals as biomonitors of pollutants. In this study, the tolerance and sensitivity of ornamental plants to air pollution around two major urbarn centres in Ondo State, South-West region of Nigeria namely Oloko Urban central Business area and Federal University of Technology Akure (FUTA), Akure were assessed. Oloko Urban central Business area is a usually congested with vehicular emissions because of it is one of the major access road to other neighbouring States around Ondo State while the access road to Federal University of Technology Akure (FUTA), Akure is usually congested with numerous vehicles from students, residents and staff of FUTA among others. Fourteen species of common ornamental plants namely *Roystonea regai, Convallaria majalis, Polyalthia longifolia, Ficus benjamina, Dieffebachia amoena, Colocasia esculent, Caesalpinia pulcherrima, Codyline fructicosa, Viburnumt tinus variegatum, Variegatum punctatum, Hibiscus rosa-sinensis, Tradescantia pallida, Codiaeum variegatum, Acalypha wilkesiana* cultured along the road sides of the study areas were monitored for six months consecutively during rainy and dry seasons for their tolerance and sensitivity traits with a view to suggesting model ornamentals for sustainable environmental landscaping and management. Over the years, non-ornamental floral diversity has been used to monitor air, thus, there is scanty report on the use of ornamental plants been used as biomonitors of air pollution. Hence, the objective of this paper was to evaluate the seasonal variations of fourteen selected ornamental plants as biomonitors of air pollutants in three selected urban areas of Ondo State, Nigeria.

MATERIALS AND METHODS

Description of the Study Area: The study areas are three roadsides named Oduduwa Road, Oloko Area, FUTA road, FUTA Area; and Elizade Campus. Oduduwa Road, Oloko Area, FUTA road, FUTA Area are within Akure city, Ondo state while Elizade Campus is within Ilara-Mokin town, Ondo State. Akure in Ondo state is on Latitude and longitude 7.25256, and 5.19312 while Elizade University campus is on Latitude and longitude 7.3665 and 5.1066 respectively. The population of people in Akure city is approximately 484,798. Elizade University Campus is the control site located in Elizade University, Ilara Mokin, Ondo State in the South-west region of Nigeria with human population of about 1,526. Two seasons are experienced in this area; the dry and rainy seasons which ranges from the month of November-March and April-October respectively.

FUTA road around FUTA Area; is among the major roads that leads to Federal University of Technology Akure while Oduduwa Road, Oloko Area links to some residential areas and local roads in the city and they are parts of the road leading from Akure to the outskirts of Ondo State which results to a lot of anthropogenic activities in the area. These areas experience a lot of vehicular traffic and exhaust fumes emanating from smaller and heavy-duty vehicles.

The control site (Elizade campus) is located in Elizade University, Ilara Mokin; an agrarian community in Ondo state. There is minimal movement of vehicle in area sampled within Elizade University.
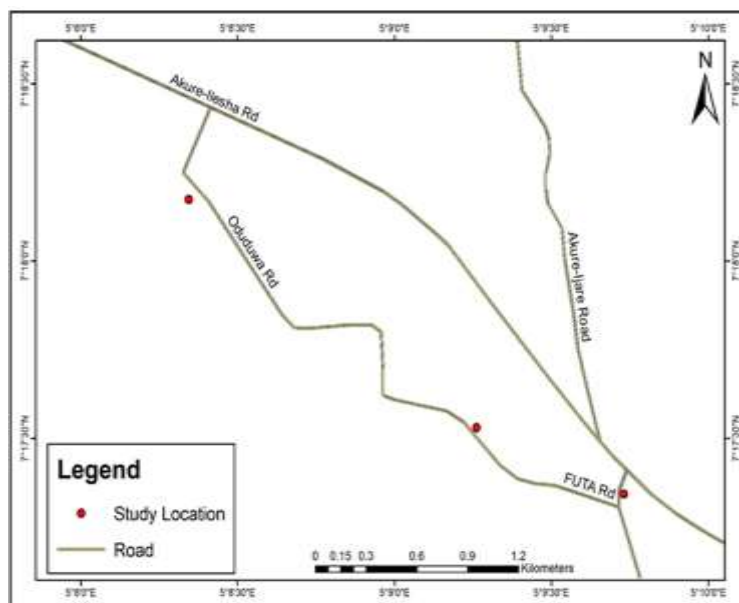
Fig 1: Map of Study Area

Collection of Samples: Sampling was done in the months of December to February (dry season) and April to June (rainy season). Samples of leaves of the test plants were purposively collected before noon between the hours of 8.30 a.m. and 11:00 a.m. Replicates of fresh leaves were harvested at the control sites. They were packed in well labeled sterile cellophane bags and hurriedly transported to an analytical laboratory for analysis.

Analysis of Leaf Samples for Biochemical parameters: Relative water contents, total chlorophyll contents, pH and ascorbic acid contents of leaf extracts were analyzed. The values obtained were used to compute the Air pollution tolerance index (APTI) values.

The Relative Water Contents (RWC): The Relative Water Content (RWC) was determined by weighing the fresh leaf samples of the test plants on a digital balance to obtain the fresh weight (FW).

Then, the fresh leaves were immersed in water overnight (8 hours), blotted dry with the aid of Whatman filter paper and reweighed to obtain the turgid weight (TW). They were finally oven dried for 8 hours at a temperature of 70^0C and re-weighed again to determine their dry weight (DW).

Using the formula described by Singh (1977) and Tanee *et al.* (2014), RWC was computed using the formula as stated equation 1:

$$RWC = \frac{\text{Fresh Weight (FW)} - \text{Dry Weight (DW)}}{\text{Turgied Weight (TW)} - \text{Dry Weight (DW)}} \quad (1)$$

Total Chlorophyll Content (TLC): Total Chlorophyll Content (TLC) was obtained according to the method of (APHA 1989) (Udeagbala *et al*., 2017). One gram of leaf was weighed and homogenized. Twenty milliliters of 80% acetone and 0.5g $CACO_3$ powder was added. The sample was then put in the refrigerator at 4^oC for four hours. The sample was then centrifuged at 5000 rpm for 5 minutes. The supernatant was transferred to 100 ml volumetric flask. It was then made up to mark with 80% acetone. The color absorbance of the solution was estimated by spectrophotometer using 645nm and 663nm wavelength against solvent. Acetone 80% was used as blank. Total Chlorophyll was calculated using equation 2.

$$TLC = \frac{0.1 \ (TCL) \times \ (\text{Leaf Dry Weight})}{\text{Weight of Wet leaves}} \quad (2)$$

Where TLC = Total Chlorophyll Content; Chl a = $12.7A_{663} - 2.69A_{645}$; Chl b = $22.9A_{645} - 4.68A_{663}$; A_{645} = Absorbance at wavelength of 645nm; $A_{663=}$ Absorbance at a wavelength of 663nm

Where chl a and chl b are chlorophyll. Hence, (SERAS, 1994), TLC is

$$TLC = \text{leaf (mg/ml)} = \text{Chlorophyll a} + \text{Chlorophyll b} \quad (3)$$

Determination of pH: Five grammes of homogenized sample was measured and transferred into a 10 ml conical flask. Ten milliliters of distilled water was added to mark and the extract filtered. Thereafter, pH meter was calibrated with buffer solutions of pH 4, 7

and 9. Then, the pH of the extract was determined using the calibrated pH meter.

Determination of Ascorbic Acid Contents: Ascorbic acid content (mg/g) was measured using the spectrophotometric method. A analytical balance was used to weigh 0.5 gramme each of fresh samples of leaves of the respective ornamental plants in a test tube. Five milliliters of oxalic-EDTA extracting solution was added for 24 hours. Standard ascorbic acids of 2.5 mls were pipetted into 25 mls volumetric flask. In the mixture, 2.5 mls of oxalic-EDTA were added as well as 2 mls of ammonium molybdate. One milliliter of 5 % H_2SO_4 were also added thereafter. To make up to 25 mls mark on the volumetric flask, distill water were also added. The solution was then allowed to stand for 15 minutes after which the absorbance at 760 nm was measured with the ultra violet spectrophotometer.

Determination of Air pollution tolerance index (APTI): Air Pollution Tolerance Index (APTI) was calculated using the standard method as described by Singh and Rao (1983). Thus:

$$APTI = \frac{AAC\ (TLC+pH)+RWC}{10} \quad (4)$$

Where; AAC = ascorbic acid content (mg/g); TLC = total chlorophyll (mg/g); pH = pH of leaf extract; RWC = relative water content of leaf (%)

Plate 1: *Ficus benjamina*
Source: Field Data, 2023

Plate 2: *Duranta repens*
Source: Field Data, 2023

Plate 3: *Colocasia esculenta*
Source: Field Data, 2023

Plate 4: *Cordyline fruticosa*
Source: Field Data, 2023

Plate 7: *Acalypha wilkesiana*
Source: Field Data, 2023

Plate 8: *Caesalpinia pulcherrima*
Source: Field Data, 2023

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Plate 9: *Codiaeum Variegatum Punctatum*
Source: Field Data, 2023

Plate 10: *Tradescantia pallida*
Source: Field Data, 2023

Plate 11: *Tradescantia pallida*
Source: Field Data, 2023

RESULTS AND DISCUSSION

pH of the Leaf Extracts of Ornamentals Cultivated around The Congested Area: The pH values of leaf extract of ornamental plants sampled at the Congested area (Oduduwa Road, Oloko area) is shown in Table 1. Here, *Ficus benjamina* has the highest (7.4± 0.01) pH value in dry season while *Roystonea regia* has the lowest value of 5.55± 0.02. For raining season, *Ficus benjamina* had the highest (6.78± 0.02) value while *Caesalpinia pulcherrima* had the lowest pH value of 5.87± 0.02 at the control site during dry season while *Ficus benjamina* had the highest pH value of 7.18± 0.01 and *Polyalthia lonifolia* had the lowest value of 5.65± 0.05. During raining season at the control area, *Ficus benjamina* has the highest value of 7.55± 0.02 and *Roystonea regia* has the lowest value of 5.97± 0.02. At the experimental site, the pH was reduced and moderately acidic during the dry season than the control site while for the raining season, the pH was moderately basic for the ornamentals harvested at the control site (Temmerman, 2001). However, *Convallaria majalis* was not found at the control site. pH plays very vital role in the modification of the toxicity of air pollution such as oxides of sulphur, nitrogen and carbon. It has been reported that plants with lower pH are more susceptible while those with pH of about 7 are more tolerant to pollution. In addition, high pH could increase the rate of production of ascorbic acid (Raji et al., 2021). This result corroborated with the study carried out by Akande et al. (2022). The reduced pH in the leaves of plants at the experimental sites could be attributed to the impacts of air pollutants. Thus, at the Oloko area with dense vehicular emission, *Ficus benjamina* acted as tolerant species while only *Viburnum tinus variegatum* acted as tolerant species in FUTA Area which was less polluted.

pH of the Leaf Extracts of Ornamentals Cultivated around The Less Congested Site (FUTA Road Sides) and Control Sites: The pH values of leaf extracts of ornamental plants sampled at Less Congested area (FUTA area) is shown in Table 2. In Table 2, the highest (6.23± 0.01) pH value was reported during dry season for *Codiaeum variegatum* with the lowest (5.00± 0.01) for *Acalypha wilkesiana* while for raining season *Variegatum punctatum* has the highest value of 6.36± 0.03 while lowest value of 5.02± 0.03 was reported in *Acalypha wilkesiana*. For the control in dry

season, *Viburnum tinus variegatum* had the highest value of 7.44± 0.01 and the lowest value of 5.00 lowest value of 5.02± 0.03 in *Acalypha wilkesiana*. For the ornamentals grown at the control site during raining season, *Viburnum tinus variegatum* had the highest (7.21) value and the lowest value of 5.15 was reported in *Acalypha wilkesiana*. This result revealed that *Acalypha wilkesiana* was sensitive to air pollutants released from the vehicular emissions. For *Viburnum tinus variegatum* (5.63 ± 0.01), *Tradescantia pallida* (5.90± 0.05) and *Acalypha wilkesiana* (5.00± 0.01),

the pH was reduced at the less congested site during the dry season than for the control site. Similarly, for the raining season, the pH was higher at the control site than at the less congested area. The raining season had higher pH values than the dry season except *that Variegatum punctatum* was not found at the control site. Therefore, *Viburnum tinus variegatum, Tradescantia pallida* and *Acalypha wilkesiana* were sensitive to the air pollutants (Falon, 2015; Dada, 2019)

Table 1: pH of the Leaf Extracts of Ornamentals Cultivated around the Congested Site (Oduduwa Road, Oloko Area) and Control Site

Selected Ornamental Plants	Dry season	Wet season	Control dry season	Control rainy season
Roystonea regia	5.55± 0.02	5.88± 0.00	6.03± 0.04	5.97± 0.02
Convallaria majalis	6.63± 0.05	6.39± 0.03	NIL	NIL
Polyalthia longifolia	5.65± 0.01	5.95± 0.00	5.65± 0.05	6.10± 0.01
Ficus benjamina	7.4± 0.01	6.78± 0.02	7.18± 0.01	7.55± 0.02
Duranta repens	5.73± 0.03	6.00± 0.03	5.85± 0.01	6.09± 0.00
Colocasia esculenta	6.00± 0.01	6.29± 0.03	6.3± 0.05	6.38± 0.00
Caesalpinia pulcherrima	5.8± 0.04	5.87± 0.02	6.04± 0.02	6.09± 0.01

Table 2: pH of leaf of Ornamentals Cultivated around The Less Congested and Control Sites

Names of Test Plants	Dry Season		Wet season	
Selected Ornamental Plants	Polluted	Control	Polluted	Control
Codyline fructicosa	5.63 ± 0.03	5.51± 0.05	6.03± 0.02	5.75± 0.02
Viburnum tinus variegatum	5.63 ± 0.01	7.44± 0.01	6.02± 0.01	7.21± 0.01
Variegatum punctatum	5.68± 0.04	NIL	6.36± 0.03	NIL
Hibiscus rosa-sinessis	6.15± 0.02	6.07± 0.02	6.05± 0.03	6.1± 0.01
Tradescantia allida	5.90± 0.05	6.00± 0.01	5.92± 0.02	6.47± 0.02
Codiaeum variegatum	6.23± 0.01	6.08± 0.01	6.22± 0.01	6.45± 0.04
Acalypha wilkesiana	5.00± 0.01	5.15± 0.04	5.02± 0.03	5.15± 0.02

Ascorbic Acid Contents (AACs) of Ornamentals Cultivated around The Less Congested and Control Areas: The Ascorbic acid contents of leaf extracts of ornamental plants sampled at Less Congested area and the control is shown in Figure 1. *Acalypha wilkesiana* had the highest AAC of 0.04 for dry season while *Variegatum punctatum* had the lowest AAC of 0.02 and for raining season *Codyline fructicosa* had the

highest AAC of 0.04 while *Variegatum punctatum, Hibiscus rosa-sinesis, Codiaeum variegatum* had their AAC of 0.02. For the control in dry season, all the ornamental had the same AACs. For the control of raining season, *Acalypha wilkesiana* has the highest value of 0.04 while the others are the same. Thus, *Variegatum punctatum* was not found at the control sites.
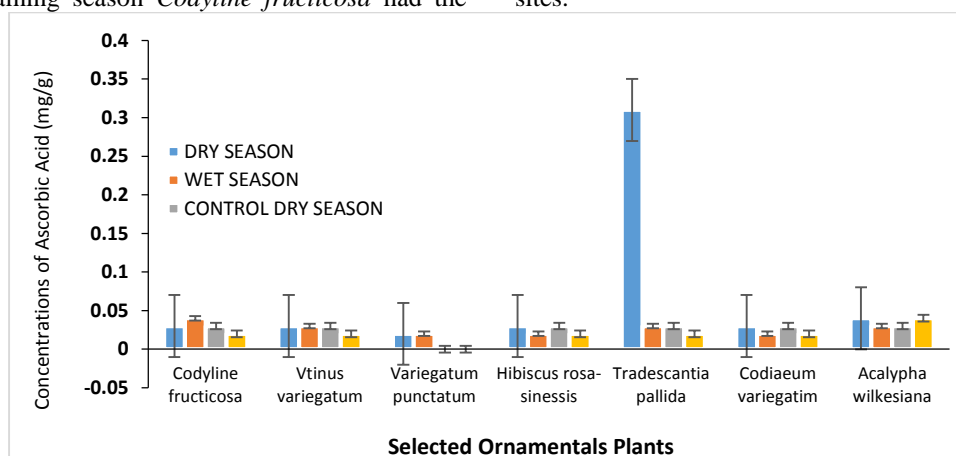

Fig 1: Ascorbic Acid Contents of the Ornamentals during Dry and Wet Seasons in Less Congested and Control Areas

Ascorbic Acid Contents (AACs) of Ornamentals Cultivated around the Congested and Control Areas:

The mean Ascorbic acid contents of leaf of ornamental plants sampled at congested area (Oloko area) is

shown in Figure 2. The highest (0.03) Ascorbic acid contents were reported in *Polyalthia longifolia, Colocasia esculenta, Caesalpinia pulcherrima*, for dry season while *Duranta repens, Ficus benjamina, Convallaria majalis, Roystonea regia*, had the reduced AAC of 0.02. For raining season, *Polyalthia longifolia*, *Caesalpinia pulcherrima, Ficus benjamina* had the highest values of 0.04 while *Colocasia esculent* had the lowest value of 0.02. Thus, *Polyalthia longifolia*, *Colocasia esculenta*, *Caesalpinia pulcherrima* are ornamentals suggested to have resilient traits against vehicular emission during dry

season. At the control site during dry season, all the ornamentals had the same values of AACs while for the control of raining season *Roystonea regia* had the highest value of 0.03 while the others are the same. According to Ram et al. (2015), the reducing power of Ascorbic acid is proportional to its concentrations. It also plays very significant role in light reaction during photosynthesis but when subjected to stress, it has the ability to replace water from light reaction II (Li, 2018). Therefore, reductions in the AACs in the study site during dry season than during raining season is an indication of air pollution stress (Liang, 2023b).
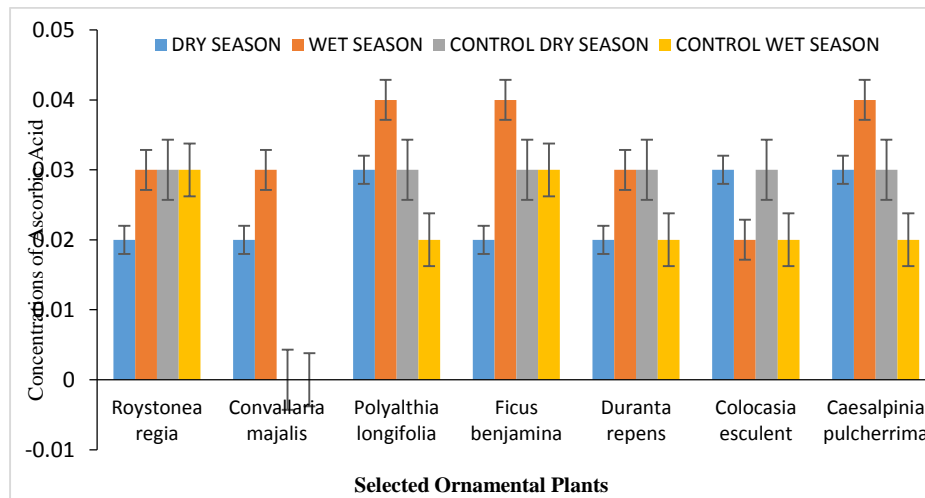

Fig 2: Ascorbic Acid Contents of Ornamentals Cultivated around the Congested and Control Areas
Relative Water Contents (RWCs)

Relative Water Contents of Ornamentals Cultivated around The Less Congested and Control Areas: The values of the Relative water content (RWC) of leaf extracts of ornamental plants sampled at the less congested (FUTA area) area is shown in Figure 2. Here, the Relative water content was the highest (75.11%) during dry season for *Tradescantia pallida* and at the lowest (46.72%) for *Variegatum punctatum*. During raining season, *Tradescantia pallida* had the highest Relative water content of 88.45% while *Variegatum punctatum* had the lowest value of 67.72%. For the control in dry season, *Codiaeum variegatum* had the highest (91.61%) value and the lowest value of 73.27% was reported in *Acalypha wilkesiana*. At raining season, the highest value of 94.05% was reported in *Codyline fructicosa* and the lowest value of 79.08% was reported in *Viburnum tinus variegatum*. However, *Variegatum punctatum* was not found at the control site. Across the plants, the relative water contents were reduced at the experimental site during the dry season than the control site while for the raining season the relative water contents was higher for the control site; except that *Acalypha wilkesiana,* and *Codyline fructicosa*

were not found at the control site. This result was in line with the outcome of the report of Kaur *et al.* (2021).

Relative water contents of Ornamentals Cultivated around the Congested and Control Areas: The RWCs of the leaf extracts of the ornamental plants sampled at the congested area (Oduduwa Road, Oloko area) is shown in Figure 3. The Relative water contents were higher during dry season at the experimental site for *Polyalthia longifolia* with value of 75.99% while for the raining season, *Convallaria majalis* had the highest RWC value of 81.13%. For the control in dry season, *Caesalpinia pulcherrima* had the highest RWC value of 90.23% and the lowest value of 56.50% was reported in *Dieffenbachia amoena*.

However, at the control during raining season, *Ficus benjamina* had the highest RWC (84.48%) and the lowest (62.86%) RWC was reported in P*olyalthia longifolia*. The RWCs were reduced at the control site during dry season across the ornamental plants. For the raining season, the RWCs were reduced at the sampling site than the ornamentals harvested as

control. In raining season, RWCs of ornamentals were at their peaks across all the ornamentals. Here, P*olyalthia longifolia* was observed to have the highest potentials to tolerate the impacts of vehicular emissions. The increased RWC in P*olyalthia*

longifolia may be an adaptive strategy devised against air pollutants released from the roadsides vehicular emissions (Ram *et al.,* 2015; Meng *et al.,* 2015; Akande et al., 2021).
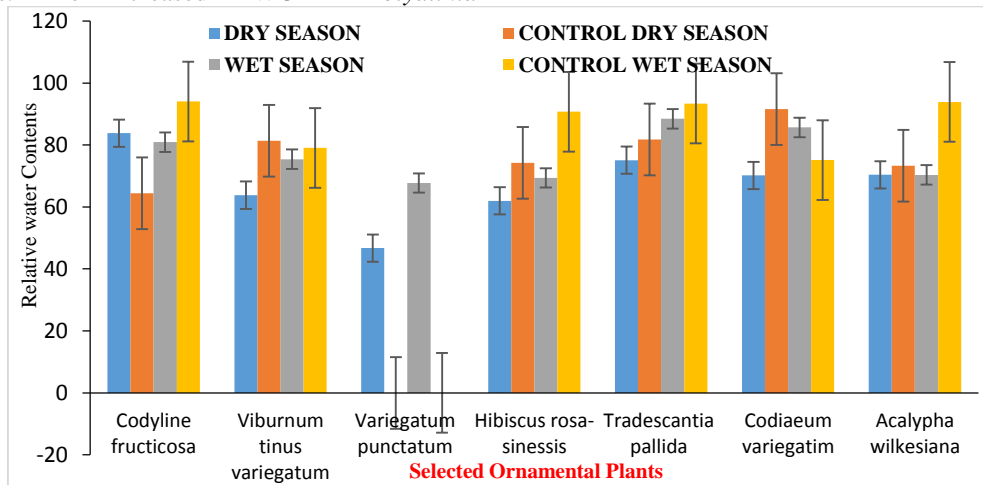

Fig 3: Relative Water Contents of Ornamentals Cultivated Around Less Congested and Control Areas
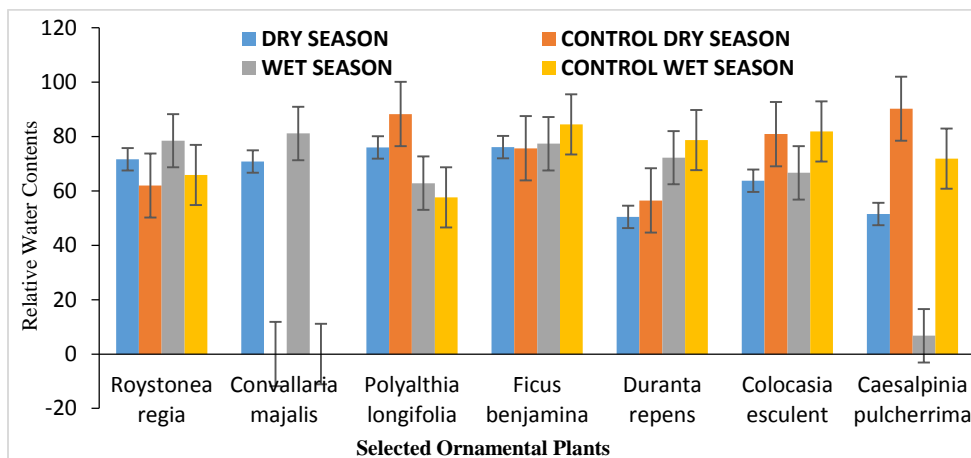

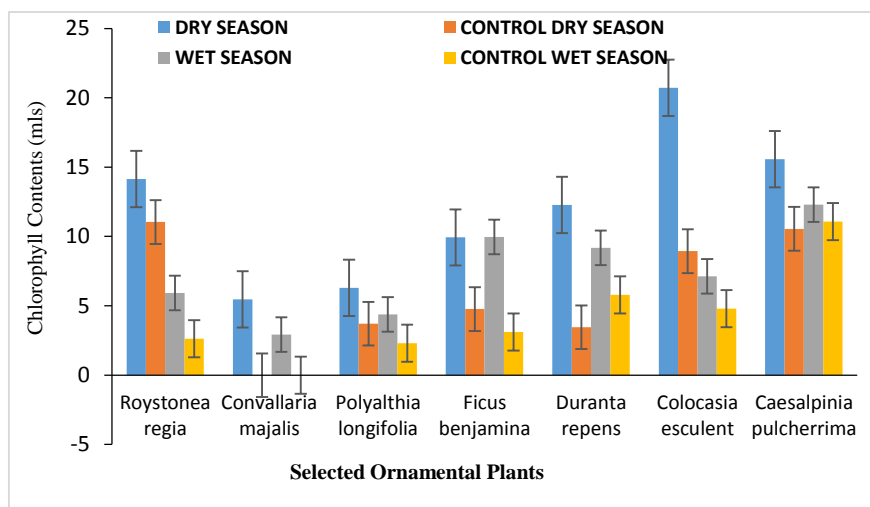**Fig 4:** Relative water contents of Ornamentals Cultivated around the Congested and Control Area

Fig 5: Total chlorophyll contents of Ornamentals Cultivated around the Congested and Control Sites

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Total chlorophyll content of Ornamentals Cultivated around the Congested Site and Control Area: Total Chlorophyll contents (TCCs) of leaf extracts of ornamental plants sampled at congested area (Oloko area) were shown in Figure 5. During dry season, the TCCs were highest at the congested road in *Roystonea regia* with value of 14.15 and at the lowest in *Convallaria Majalis* with value about 5.47. However, in raining season at sampling site, *Caesalpinia pulcherrima* had the highest value of 12.29 while *Convallaria majalis* had the lowest value of 2.92. For the control, in dry season, *Roystonea regia* had the highest value of 11.04 and the lowest value of 3.46 in *Duranta repens* while for the control of raining season, *Caesalpinia pulcherrima* had the highest value of 11.07 and the lowest value of 2.30 was reported in *Polyalthia longifolia*. For the raining seasons, at the control site, the TCCs of the ornamentals were higher than that of the control site with higher Chlorophyll contents reported at the raining season. This reported was similar to the report of Akande *et al*. (2021) while in some studies the TCCs were reduced.

Total chlorophyll contents of Ornamentals Cultivated at the Less Congested Site (FUTA Road Sides) and Control Sites: The Total chlorophyll contents of leaf extracts of ornamental plants sampled at the less congested area (FUTA area) as shown in Figure 6. In Figure 6, the TCC was the higher (8.92) during dry season for *Viburnum tinus variegatum* and reduced for *Codyline Fructicosa* with TCC of 3.30. During raining season, *Acalypha wilkesiana* had the highest value of 9.46 while *Hibiscus rosa-sinessis* had the lowest (2.70). For the control, in dry season, *Codyline fructicosa* had the highest TCCs of 14.02 and *Hibiscus rosa-sinessis* had the lowest TCC of 3.02. At the control site, *Codyline fructicosa* had the highest value of 9.22 and the lowest value of 1.61 was observed in *Tradescantia pallida* during raining season. The TCCs were higher during the dry season for *Tradescantia pallida, Hibiscus rosa-sinessis, viburnum tinus variegatum* than for those ornamentals at the control site with *Codyline fructicosa, Acalypha wilkesiana*, and *Codiaeum variegatim* having reduced TCCs. In the raining season, the TCCs were higher at the polluted sites except for *Hibiscus rosa-sinessis* while during the dry season at the polluted site higher TCCs were obtained than during the raining season except for *Codyline fructicosa,* and *Acalypha wilkesiana*. The reduction in the TCCs of the ornamentals during the dry season may be as a result of the effects of air pollutants (Yao, 2016; Dada, 2019).
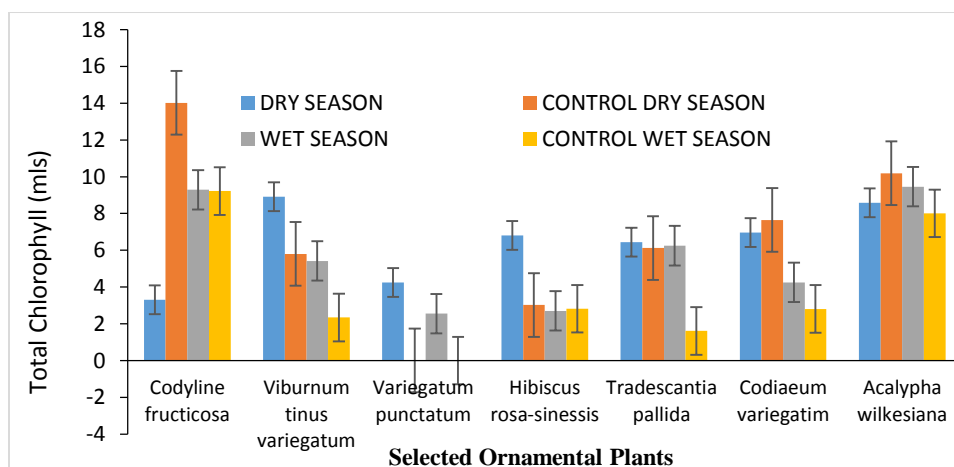

Fig 6: Total chlorophyll contents of Ornamentals Cultivated around the Less Congested Site and Control Sites

Air pollution tolerance Index of Ornamentals Cultivated around The Less Congested and Control Sites: The Air pollution tolerance indices values of leaf extract of ornamental plants sampled at Futa area is shown in Figure 7. The APTI value was the higher during dry season at the sampling site with *Codiaeum variegatum* having 7.08 APTI value. *Variegatum punctatum* had the lowest APTI value of 4.71. During the raining season, *Tradescantia pallida* had the highest mean APTI value of 8.86 while *Variegatum punctatum* had the lowest value of 6.81. For the control in dry season, *Codiaeum variegatum* has the

highest value of 9.18 and the lowest APTI value of 7.34 was reported in *Acalypha wilkesiana* while for at the control site, *Acalypha wilkesiana* had the highest APTI of 9.44 and the least APTI of 7.95 in *Viburnus tinus variegatum* during raining season. The APTI was reduced during the dry season at sampling site than at the control site. The APTI was reduced during the raining season at polluted site than the control site while during the raining season, higher APTI values were reported than the dry season except for the APTI value reported in *Acalypha wilkesiana*. Notably, *Variegatum punctatum* was not found at the control

site. In all the APTI determined, all the ornamentals are sensitive in displayed traits of sensitive plants. Thus, according to Perera (2017) and Udeagbala, T. (2017) these are good candidates for biomonitoring of

pollutants in the environment; although *Codiaeum variegatum* and *Acalypha wilkesiana* were the best candidate of all during the dry and wet seasons respectively.
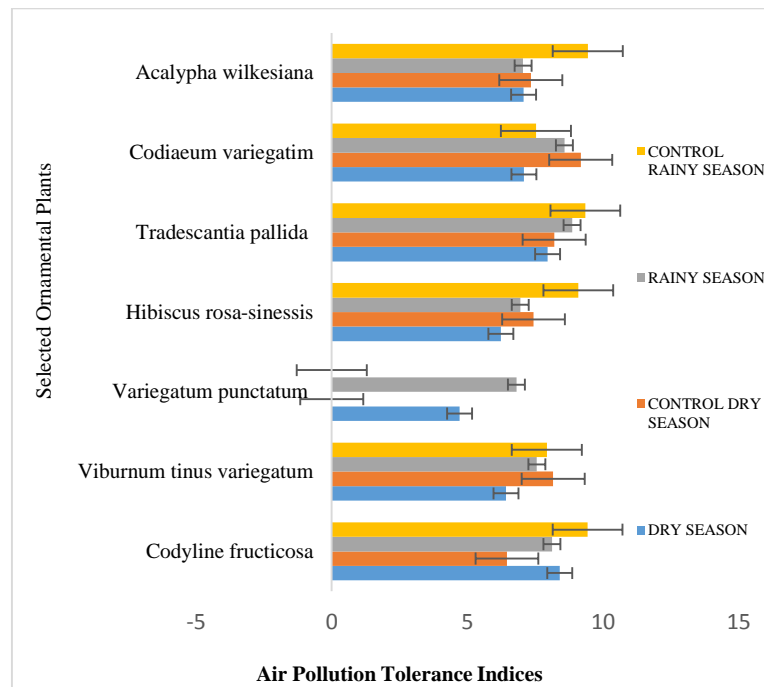

Fig 7: Air pollution tolerance Index of Ornamentals Cultivated around the Congested and Control Sites
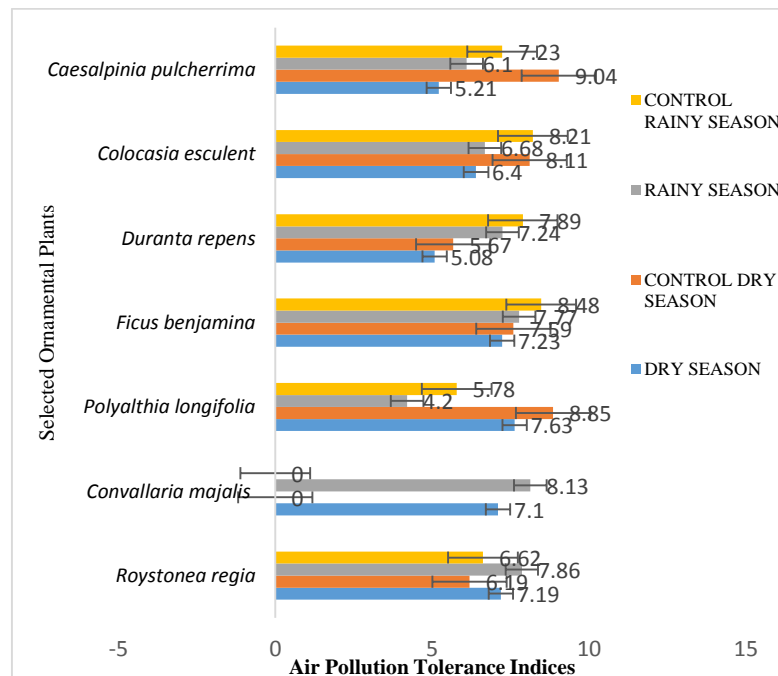

Fig 8: Air pollution tolerance Index of Ornamentals Cultivated around the Congested and Control Sites

Air pollution Tolerance Index of Ornamentals Cultivated around the Congested and Control Sites: Figure 8 revealed the APTI values of the ornamentals

cultivated around the congested areas in Oduduwa Road, Oloko Area. At the congested site, the APTI values evaluated during the dry season were within the

range for sensitive plants. However, *Polyalthia longifolia* had the highest APTI value of 7.56. Conversely, across all the flowers, the APTI values of ornamentals at the control site were higher than that of the congested site with *Polyalthia longifolia* having the highest values. The APTI values were within the range for sensitive plant species with *Convallaria Majalis* displayed APTI with highest value of 8.13 during the raining season. According to Singh et al. (2022), this may be attributed to the influence of seasonal changes and that of the effects of the air pollutants released at the congested site.

Thus, the APTI of the ornamentals were in this trend: *Polyalthia longifolia>Ficus benjamina> Roystonea regai> Convallaria majalis,> Colocasia esculent>Caesalpinia pulcherrim> Duranta repens>Dieffebachia amoena* during the dry season at the congested area. However, during wet season, the APTI values were in this trend: *Convallaria majalis,> Roystonea regai>Ficus benjamina> Duranta repens> Colocasia esculent>Caesalpinia pulcherrim*. This sorted trend may be due to the influence of seasonal changes and impacts of the air pollutants (Aguinaga et al. 2022). For the dry season, *Polyalthia longifolia* can be suggested as a model candidate for biomonitoring of air quality during dry season while *Convallaria majalis* could be identified as model candidate for the same purpose in wet season (Agrawal, 2005; Raji et al., 2021)

Conclusion: The use of plant species to bio-monitor the air quality of the environment is a sustainable environmentally-friendly technique that is feasible because of the sessile nature of plant species. In this study, tropical ornamentals were examined for their potentials as bio-monitors of air pollution using their Air Pollution Tolerant Indices (APTI) as well as the metabolites released after exposure to air pollutants. Consequently, in addition to their aesthetic values, all the ornamentals were identified as promising candidates that are sensitive in nature for biomonitoring of air pollutants from vehicular emissions. Thus, the studied ornamentals could be used to monitor air pollution trends in the environment.

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