

## ASSESSMENT OF AIR POLLUTION TOLERANCE INDEX (APTI) OF URBAN TREE SPECIES FOR SUSTAINABLE GREEN INFRASTRUCTURE

\*Japheth, D.H.<sup>1</sup>; Dawaki, S. A.<sup>2</sup>; Levi, I.G.<sup>1</sup>; Muktar, M.<sup>2</sup> and Aminu, H.<sup>2</sup>

<sup>1</sup>Department of Forestry and Wildlife Technology, Federal University of Technology Owerri, Nigeria; <sup>2</sup>Department of Forestry Technology, Audu Bako College of Agriculture, Dambatta, Kano State, Nigeria

Corresponding: [daujaphson@gmail.com](mailto:daujaphson@gmail.com)

**ABSTRACT:** Vegetation in most cities has been exposed to a variety of pollution arising from increased traffic, population, industrial activities and increased human population. Air pollution is a significant environmental issue that affects human well-being. This problem is particularly acute in some areas of the Owerri metropolis. This study aims to assess the biochemical parameters (total chlorophyll, ascorbic acid, pH and relative water content) and air pollution tolerance index (APTI). Four dominant tree species (*Elaeis guineensis* (oil palm), *Casuarina equisetifolia* (whistling pine), *Acacia auriculiformis* (earpod), and *Polyalthia longifolia* (false asoke)) along selected major roadsides in Owerri Municipal, Imo state, Nigeria were purposively sampled. The tree species were collected through purposive sampling of major roads with high traffic. The dominant tree species' leaf samples were located, gathered, and transported to the lab for biochemical evaluation. Moisture content, pi ascorbic acid content, chlorophyll content, and APTI are among the parameters that were examined. From the results, *Elaeis guineensis* had the highest moisture content (73.3%), followed by *Acacia auriculiformis* (62.8%) and *Casuarina equisetifolia* (64.5%). The highest APTI was found in *Elaeis guineensis* (16.4), indicating its superior tolerance to air pollution. *Elaeis guineensis* showed the highest values for chlorophyll (25.3) and ascorbic acid content (2.9), while *Acacia auriculiformis* recorded the highest pH value (6.0). Statistically significant differences (p-value = 0.000) were observed across all biochemical parameters, with *Elaeis guineensis* emerging as the most suitable tree species for arboricultural and air quality improvement purposes in the study area.

[Japheth, D.H.; Dawaki, S. A.; Levi, I.G.; Muktar, M. and Aminu, H. **ASSESSMENT OF AIR POLLUTION TOLERANCE INDEX (APTI) OF URBAN TREE SPECIES FOR SUSTAINABLE GREEN INFRASTRUCTURE.** *Nat Sci* 2025,23(6):9-17]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). <http://www.sciencepub.net/nature> 02. doi:[10.7537/marsnsj230625.02](https://doi.org/10.7537/marsnsj230625.02)

**Keywords:** Air Quality; Environmental; Management; Resilience; Urban Forestry; Urban Greening

### INTRODUCTION

Different physical and chemical methods have been considered and employed to help ameliorate air quality, however, this has been continuously challenged by the exorbitant costs of setting up and maintaining these systems. While the biological method, commonly known as greening projects in urban areas, mitigates the effects of air pollution (Baro *et al.*, 2015), as plants play an important role in the ecological balance, particularly in the cycling of nutrients and exchange of gases (Cieslik *et al.*, 2009). Plants provide innumerable benefits to mankind, such as provision of shade, aesthetics, habitats and acting as scavengers of air pollutants. Also, absorbing pollutants and regulating the urban atmospheric environment (Sia Su *et al.*, 2018).

The response of plants to air pollution can be determined by measuring the air pollution tolerance index (APTI) (Esfahani *et al.*, 2013). APTI is an index used for biological monitoring and assessing bio-indicator species (Abdu *et al.*, 2024). It is a process that assesses the response of plants' biochemical and physiological systems (Rasool *et al.*, 2025). Also, it describes the inherent quality of plants to tolerate air

pollution (Shrestha *et al.*, 2021). APTI is based on four biochemical parameters (chlorophyll content, leaf extract pH, relative water content and ascorbic acid) in leaf samples (Lohe *et al.*, 2015). APTI determination provides a reliable method for screening large numbers of plants for susceptibility to air pollution (Lohe *et al.*, 2015).

Air pollution is one of the environmental issues that cannot be ignored, and inhaling pollutants for a long time causes damage to human health (Xu *et al.*, 2022). Air pollution has become a serious environmental stress to man, plants and their environment due to the increase in industrialization and urbanization during the last few decades (Manisalidis *et al.*, 2020). Air pollution remains a major problem that affects the well-being of people. The particulate and gaseous pollutants, alone and in combination, cause serious setbacks to the overall physiology of plants and human health (Das and Prasad, 2012). Vegetation in most cities has been exposed to a variety of pollution due to increased traffic, population, industrial activities and increased human population.

One of the most pressing concerns is the high volume of vehicular traffic, which serves as a major

contributor to greenhouse gas emissions, primarily carbon dioxide (CO<sub>2</sub>) and methane, in the Owerri metropolis. These emissions not only degrade air quality but also heighten the area's vulnerability to the adverse effects of climate change. The environmental challenges confronting Owerri Municipal are increasingly pronounced, particularly in certain areas of the metropolis.

Owerri is facing a lot of environmental issues, especially air and water pollution, alongside inadequate waste management systems. Air pollution is a critical concern in the city, arising from multiple sources, including exhaust fumes from vehicles, emissions from industrial activities, and the open burning of waste. Water pollution exacerbates environmental stress, commonly due to the discharge of untreated wastewater generated by residential and commercial sources, as well as from agricultural runoff containing pesticides and fertilizers.

Waste management remains inefficient, with no robust or organized system for the collection and proper disposal of refuse. Despite the growing environmental pressures, there is a paucity of research focusing on the air pollution tolerance capacity of plant species within the study area. This knowledge gap revealed the need for further scientific findings for urban greening and environmental management efforts. Hence, this finding aims to assess the rate of air pollution absorbed by plants in selected areas within the Owerri municipal local government area of Imo state, Nigeria.

## MATERIALS AND METHODS

### The Study Area

The study was carried out in the Owerri Municipal of Imo State, Nigeria. Owerri Municipal is located within latitudes 5° 24' 1" N and 5° 35' 1" N, longitude 6° 56' 1" E and 7° 08' 1" E. The study area is a densely populated urban area, with a population of over 127,213 at the 2006 census. It is home to many important institutions and a major commercial center. It is also a major transportation hub, with many roads and railways.

The topography of Owerri Municipal is generally flat, with a gentle slope to the south (Odoh *et al.*, 2024). The average elevation is about 100 meters above sea level. The highest point in the LGA is the Owerri Hills, which have an elevation of about 200 meters above sea level. The climate of Owerri Municipal is tropical, with hot and humid weather throughout the year. The average temperature is about 27 degrees Celsius. The hottest months are March and April, when temperatures reach 35 degrees Celsius. The coolest months are July and August, when temperatures can drop as low as 20 degrees Celsius. Owerri Municipal has a bimodal rainfall pattern with distinct rainy and dry seasons. The first rainy season lasts from April to July and from

September to November. The first dry season lasts from December to February, and the second lasts from August to September. The average annual rainfall is about 2,000 millimeters. The study area is drained by many rivers and streams (Imo River, Nworie River, and the Otamiri River).

### Data Collection and Analysis

Data was collected along major roads with high traffic of vehicles, high human population, and high rate of air pollution. Four dominant tree species were identified. Three replicates of matured fresh leaves of each of the selected individual dominant tree species were randomly plucked from each species within the major roads. The major roads were purposively sampled based on high vehicular traffic in the study area.

Leaf samples were collected manually from the bottom of the tree's canopy, about 6–8 feet above the ground, in the morning from selected areas. The leaves were carefully selected and inspected to ensure they were free from visible fungal infections or diseases (Zahid *et al.*, 2023). The leaf samples were packed into a polythene bag to minimize the loss of moisture content (Kwak *et al.*, 2019). The collected leaf samples were well labelled for easy identification and immediately taken to the laboratory for analysis of various biochemical parameters, such as ascorbic acid, total chlorophyll, leaf extract pH and relative water content.

The ascorbic acid concentration (mg/g dry weight) was calculated by following the method explained by Keller and Schwager (Keller and Schwager, 1977) while using 2,6-dichlorophenol indophenol (DCPIP). Total chlorophyll content (mg/g) was calculated following the procedure of Singh *et al.* (1991). Relative water content was measured by following the procedure of Sivakumaran and Hall (1978). Leaf pH determination was done by adding 50 ml of distilled water to homogenize 5.0 g of the leaf sample to determine the pH of the suspension, which was then determined by using a digital pH meter.

The biochemical parameters were used to determine APTI (Gbeminiyi *et al.*, 2018). The APTI was determined using the four biochemical parameters in the formula given by Singh and Rao (1983) as described by Ogunrotimi *et al.* (2017) and Sharma *et al.* (2020) as thus:

$$APTI = \frac{A(T + P) + R}{10}$$

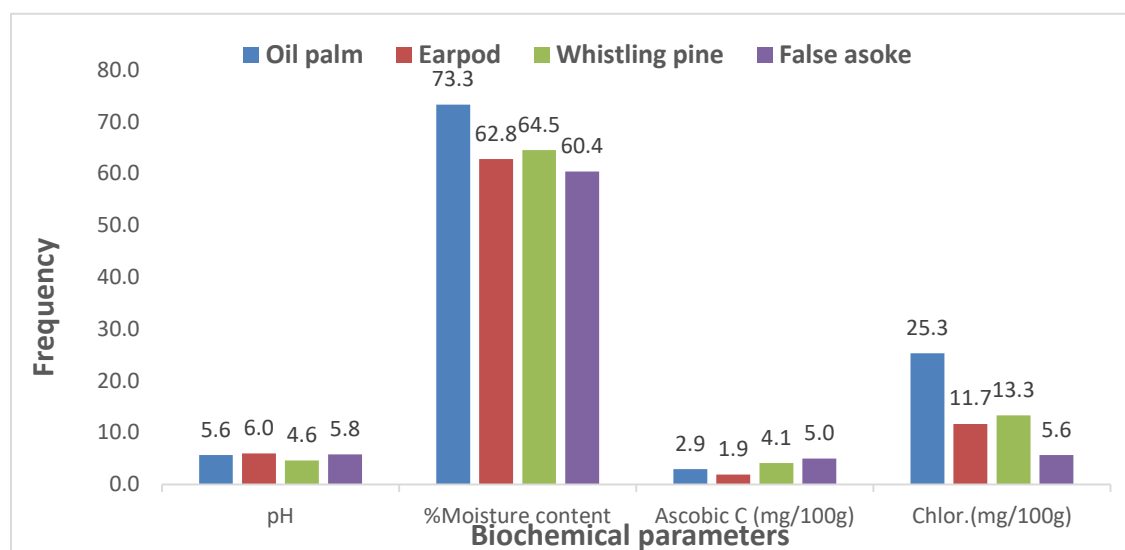
A is Ascorbic acid content (mg/g); T is Total chlorophyll content (mg/g); P is pH of leaf extract, and R is Relative water content of leaf (%).

Data obtained from the study area were subjected to descriptive statistics (mean and standard deviation) and inferential statistics- one-way Analysis of Variance (ANOVA). Means were separated using the Tukey test at a  $P < 0.05$  level of significance. Pearson's correlation was performed to examine the association between the Air pollution tolerance index (APTI) and each studied biochemical parameter. Statistical analyses were carried out using Excel (MS Excel 2013 version) and R-Statistics Package (R-version 3.1.0).

## RESULTS

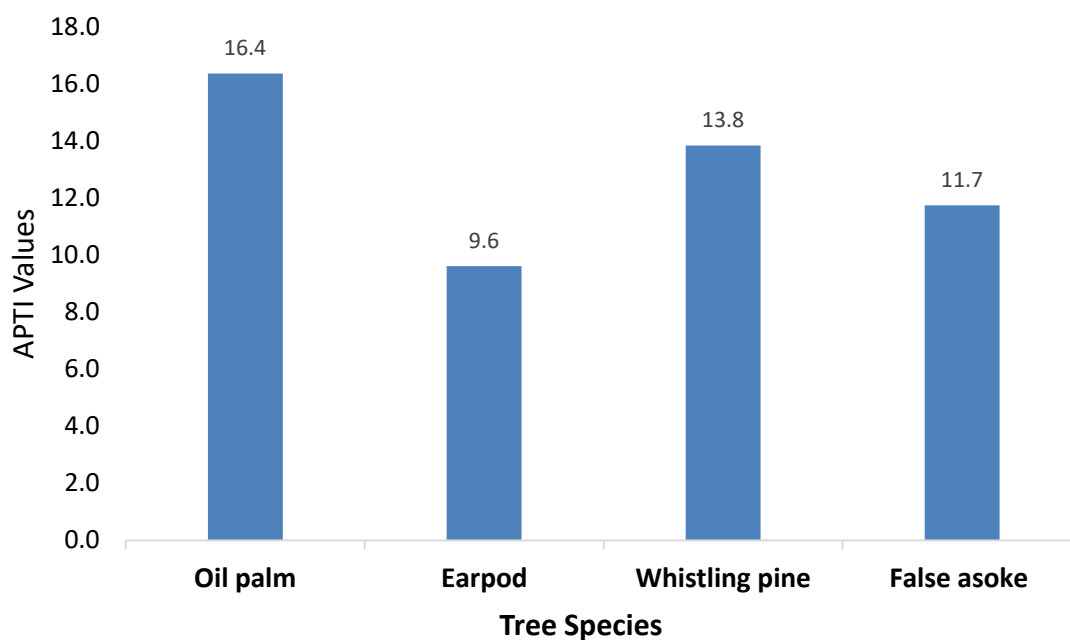
### Chlorophyll, Ascorbic acid content, Leaf extract and Relative water content in abundant Plant Species in the area.

The Biochemical parameters of the dominant tree species in the study area are shown in Figure 1. The result revealed that *Elaeis guineensis* (Palm tree) had the highest moisture content of (73.3%), followed by *Casuarina equisetifolia* (whistling pine) (64.5%), *Acacia auriculiformis* (Earpod) (62.8%); while the least value was (60.4%) from *Polyalthia longifolia* (Asoke). More details of the results for dominant species and frequency in the study area are shown in Figure 1.



**Figure 1: Biochemical Parameters of the Dominant Tree Species in the Study Area**

Figure 2 shows the average air pollution tolerance index (APTI) of four dominant tree species (oil palm - *Elaeis guineensis*), earpod - *Acacia auriculiformis*, whistling pine - *Casuarina equisetifolia*, and false asoke - *Polyalthia longifolia*) in the study area. The tree species with the highest APTI is the oil palm, with an APTI of 16.4. This is followed by the whistling pine (13.8), the false asoke (11.7), and the earpod (9.6). This result suggests that all four tree species are somewhat tolerant of air pollution. However, the oil palm is the most tolerant of air pollution, and the earpod is the least tolerant of air pollution.



**Figure 2: Air Pollution Tolerance Index (APTI) of Dominant Tree Species in the Study Area**

Table 1 presents summary statistics of biochemical parameters of the dominant tree species in the study area. Based on the result of this finding, the highest mean pH of the tree species was obtained as 6.0 from *Acacia auriculiformis*, followed by 5.8 from *Polyalthia longifolia*, 5.6 (*Elaeis guineensis*); while the lowest pH was recorded as 4.6 under *Casuarina equisetifolia*. *Acacia auriculiformis* had a minimum and maximum value of 5.9 and 6.0, *Polyalthia longifolia* had 5.8 and 5.9, and *Elaeis guineensis* had 5.5 and 5.7. The lowest value of 4.6 was recorded from *Casuarina equisetifolia*.

Based on the moisture content, the highest mean was obtained as 73.3 from *Elaeis guineensis*, followed by 64.5 from *Casuarina equisetifolia*, 62.8 from *Acacia auriculiformis*, while the lowest mean was 60.4 from *Polyalthia longifolia*. The minimum and maximum values of 73.1 and 753.5 from *Elaeis guineensis*, followed by 62.9 and 62.7 from *Acacia auriculiformis*, 64.5 and 64.4 from *Casuarina equisetifolia*, while the lowest values were recorded as 60.4 and 60.4 from *Polyalthia longifolia*. Based on the ascorbic acid, the highest mean was obtained as 5.0 from *Polyalthia longifolia*, followed by 4.1 from *Casuarina equisetifolia* and 2.9 from *Elaeis guineensis*, while the least was recorded as 1.9 from *Acacia auriculiformis*. The minimum and maximum values of 5.0 and 5.0 from *Polyalthia longifolia* were recorded, followed by 4.1 and 4.1 from *Casuarina equisetifolia* and 2.9 and 2.9 from *Elaeis guineensis*, while the lowest value was recorded as 1.9 and 1.9 from *Acacia auriculiformis*.

Based on the chlorophyll, the highest mean value was recorded as 25.3 from *Elaeis guineensis*, followed by 13.3 from *Casuarina equisetifolia* and 11.7 from *Acacia auriculiformis*, while the lowest mean value was recorded as 5.6 from *Polyalthia longifolia*. The minimum and maximum values of 25.3 and 25.3 from *Elaeis guineensis* were recorded, followed by 13.3 and 13.3 from *Casuarina equisetifolia*, 11.7 and 11.7 from *Acacia auriculiformis*, while the least value was recorded as 5.6 and 5.6 from *Polyalthia longifolia*.

**Table 1: Summary Statistics of Biochemical Parameters of the Dominant Tree Species in the Study Area**

| Variables               | Species | <i>Elaeis guineensis</i> | <i>Acacia auriculiformis</i> | <i>Casuarina equisetifolia</i> | <i>Polyalthia longifolia</i> |
|-------------------------|---------|--------------------------|------------------------------|--------------------------------|------------------------------|
| pH                      | N       | 3.0                      | 3.0                          | 3.0                            | 3.0                          |
|                         | Mean    | 5.6                      | 6.0                          | 4.6                            | 5.8                          |
|                         | Min     | 5.5                      | 5.9                          | 4.6                            | 5.8                          |
|                         | Max     | 5.7                      | 6.0                          | 4.6                            | 5.9                          |
| Moisture content        | N       | 3.0                      | 3.0                          | 3.0                            | 3.0                          |
|                         | Mean    | 73.3                     | 62.8                         | 64.5                           | 60.4                         |
|                         | Min     | 73.1                     | 62.7                         | 64.4                           | 60.4                         |
|                         | Max     | 73.5                     | 62.9                         | 64.5                           | 60.4                         |
| Ascorbic acid (mg/100g) | Ng      | 3.0                      | 3.0                          | 3.0                            | 3.0                          |
|                         | Mean    | 2.9                      | 1.9                          | 4.1                            | 5.0                          |
|                         | Min     | 2.9                      | 1.9                          | 4.1                            | 5.0                          |
|                         | Max     | 2.9                      | 1.9                          | 4.1                            | 5.0                          |
| Chlorophyll (mg/100g)   | N       | 3.0                      | 3.0                          | 3.0                            | 3.0                          |
|                         | Mean    | 25.3                     | 11.7                         | 13.3                           | 5.6                          |
|                         | Min     | 25.3                     | 11.7                         | 13.3                           | 5.6                          |
|                         | Max     | 25.3                     | 11.7                         | 13.3                           | 5.6                          |

### Air Pollution Tolerance Index (APTI) and Comparison of the biochemical parameters of dominant tree species in the study area

The comparative result on biochemical parameters of the dominant tree species in the study area is presented in Table 2. The result showed there was a significant difference between the tree species at the 0.05 level. pH values of the tree species were presented as follows  $6.0 \pm 0.1$  (*Acacia auriculiformis*), *Polyalthia longifolia* had  $5.8 \pm 0.0$ , *Elaeis guineensis*, had  $5.6 \pm 0.1$  while *Casuarina equisetifolia* had  $4.6 \pm 0.0$ . The APTI of *Elaeis guineensis*, *Casuarina equisetifolia*, *Polyalthia longifolia*, and *Acacia auriculiformis* were recorded as  $16.37 \pm 0.09$ ,  $13.83 \pm 0.4$ ,  $11.74 \pm 0.3$  and  $9.61 \pm 0.4$ , respectively. Details of biochemical parameters are shown in Table 2.

**Table 2: Comparative Results on Biochemical Parameters of Dominant Tree Species in the Study Area**

| Tree species             | pH              | MC               | AA              | Chlorophyll      | APTI               |
|--------------------------|-----------------|------------------|-----------------|------------------|--------------------|
| <i>E. guineensis</i>     | $5.6 \pm 0.1^b$ | $73.3 \pm 0.2^a$ | $2.9 \pm 0.0^c$ | $25.3 \pm 0.0^a$ | $16.37 \pm 0.09^a$ |
| <i>A. auriculiformis</i> | $6.0 \pm 0.1^a$ | $62.8 \pm 0.1^c$ | $1.9 \pm 0.0^d$ | $11.7 \pm 0.0^c$ | $9.61 \pm 0.4^d$   |
| <i>C. equisetifolia</i>  | $4.6 \pm 0.0^c$ | $64.5 \pm 0.1^b$ | $4.1 \pm 0.0^b$ | $13.3 \pm 0.0^b$ | $13.83 \pm 0.4^b$  |
| <i>P. longifolia</i>     | $5.8 \pm 0.0^a$ | $60.4 \pm 0.0^d$ | $5.0 \pm 0.0^a$ | $5.6 \pm 0.0^d$  | $11.74 \pm 0.3^c$  |
| <b>p-value</b>           | <b>0.000</b>    | <b>0.000</b>     | <b>0.000</b>    | <b>0.000</b>     | <b>0.000</b>       |

Table 3 presents comparative results of various biochemical parameters for four dominant tree species in the study area. These parameters include pH, Moisture Content (MC), Ascorbic Acid (AA) content, Chlorophyll content, and the Arboriculture Performance Index (APTI). The p-value for pH is 0.000, indicating that there is a significant difference in pH levels among these tree species. *A. auriculiformis* has the highest pH level, while *C. equisetifolia* has

the lowest. pH levels can influence nutrient availability and soil chemistry, which can affect the overall health and growth of these tree species. The p-value for MC is 0.000, indicating a significant difference in moisture content among these tree species. *E. guineensis* appears to have the highest moisture content, which may indicate its preference for moister soil conditions, while *A. auriculiformis* prefers drier conditions.

The p-value for AA content is 0.000, indicating a significant difference in AA content among these tree species. *E. guineensis* exhibits the highest AA content, indicating possesses greater antioxidant capacity than the other species. The p-value for chlorophyll content is 0.000, indicating a significant difference in chlorophyll content among these tree species. *E. guineensis* exhibits the highest chlorophyll content, indicating that it may have better photosynthetic capabilities compared to the other species. The p-value for APTI is 0.000, indicating a significant difference in APTI among these tree species. *E. guineensis* has the highest APTI, indicating the most suitable tree species for greening project purpose in the study area, considering the combined assessment of the analyzed parameters.

**Table 3: Pearson Correlation between APTI and Bio-parameters of Tree Species in the Study Area**

| Variables           | Species | pH    | Moisture content | Ascorbic acid (Cmg/100g) | Chlorophyll (mg/100g) | APTI |
|---------------------|---------|-------|------------------|--------------------------|-----------------------|------|
| Species             | 1.00    | -     | -                | -                        | -                     | -    |
| pH                  | -0.17   | 1.00  | -                | -                        | -                     | -    |
| Moisture content    | -0.85** | -0.09 | 1.00             | -                        | -                     | -    |
| Ascorbic (Cmg/100g) | 0.80**  | -0.36 | -0.37            | 1.00                     | -                     | -    |
| Chlor. (mg/100g)    | -0.90** | -0.11 | 0.99**           | -0.47                    | 1.00                  | -    |
| APTI                | -0.43   | -0.42 | 0.84**           | 0.18                     | 0.78**                | 1.00 |

\*\* Correlation is significant at the 0.01 level (2-tailed).

## DISCUSSION

The assessment of biochemical parameters and APTI for the dominant tree species within the study area revealed that *Elaeis guineensis* recorded the highest moisture content (73.3%), indicating a strong affinity for environments with elevated soil moisture. This finding aligns with the Osman *et al.* (2024) report, who reported that *E. guineensis* thrives in tropical climates characterized by substantial and consistent rainfall. In contrast, *Polyalthia longifolia* exhibited the lowest moisture content (60.4%), contradicting the report of Ojewuyi *et al.* (2014) who reported that *P. longifolia* contained 7.9% moisture in young leaves and 8.70% in mature leaves. Air pollutants increase cell permeability, which causes water and dissolved nutrients to be lost, and early leaf senescence occurs as a result (Kuddus *et al.*, 2011; Barjoe *et al.*, 2023). In terms of biochemical properties, *P. longifolia* showed the highest ascorbic acid (AA) concentration (5.0%), indicating a robust antioxidant capacity. This result aligns with the findings of Jothy *et al.* (2012), who reported high AA levels in the species, indicating its potential role in mitigating oxidative stress, particularly in urban settings. However, *Acacia auriculiformis* exhibited the lowest AA content (1.9%), indicating a comparatively lower capacity for counteracting oxidative stress. This is in line with the work of Shreshtha *et al.* (2017), who reported reduced AA concentrations in *Alternanthera sessilis* and *Amaranthus viridis* leaf extracts. Zahid *et al.* (2023) in their study reported that *Melia azedarach* exhibited the

highest ascorbic acid concentration, 0.06035 mg/g (5.98%), among the tree species sampled from residential areas, while *Eucalyptus* recorded the lowest value, 0.0593 mg/g (5.93%), within the same land-use type. *Mangifera indica* and *Dalbergia sissoo* showed the lowest concentrations of AA, each with a value of 0.0598 mg/g (5.98%) (Zahid *et al.*, 2023). The low ascorbic acid in different plant species resulted in sensitivity to air pollution (Zahid *et al.*, 2023), consistent with Verma *et al.*'s (2023) findings that ascorbic acid acts as a natural detoxifier, mitigating the adverse effects of air pollution on plant tissues.

Leaf pH measurements further clarified the ecological preferences of the studied species. *A. auriculiformis* was associated with the highest soil pH value (6.0), indicating a preference for slightly alkaline conditions. This result aligns with the findings of Raj *et al.* (2018), who reported the species' adaptability to a broad range of soil pH levels. *Casuarina equisetifolia* exhibited the lowest soil pH (4.6), indicating its suitability for acidic soils. Plants with higher concentrations of ascorbic acid and higher pH are more resilient to air pollution than those with lower concentrations (Bhadauria *et al.*, 2021; Zahid *et al.*, 2023). pH results indicated that *Casuarina equisetifolia* in traffic areas is more tolerant. This result is in line with the report of Gupta *et al.* (2022) and Gautam *et al.* (2020), who reported that low pH showed good correlation with sensitivity, which reduces photosynthesis.

The analysis of chlorophyll content revealed that *E. guineensis* had the highest concentration (25.3%),

reflecting enhanced photosynthetic efficiency. This result concurs with the study by Li *et al.* (2019), which revealed the species' superior photosynthetic performance under tropical environmental conditions. By contrast, *P. longifolia* had the lowest chlorophyll content (5.6%), potentially indicating a reduced potential to maintain optimal photosynthetic activity under environmental stress. This observation is consistent with Fernandez *et al.* (2021), who associated lower chlorophyll levels with decreased stress adaptability in tree species. Chlorophyll synthesis or degradation is linked with the concentration of sulfur dioxide (SO<sub>2</sub>) (Timilsina *et al.*, 2021). Agbaire and Esiefarienrhe (2009) reported that exposure to sulfur dioxide leads to a reduction in chlorophyll content across various plant species. Kuddus *et al.* (2011) observed a general decline in chlorophyll levels under pollution-induced stress conditions. Acebron *et al.* (2023) identified *Azadirachta indica* as the most tolerant species among 13 samples collected from roadside environments, attributing its resilience to the highest recorded chlorophyll content, a parameter closely associated with plant productivity.

The APTI values indicate species suitability for urban planting. *E. guineensis*, with the highest APTI score (16.4), emerged as the most resilient and suitable species for urban greening within the study area. *A. auriculiformis* had the lowest APTI value (9.6), faced limitations in adapting to urban conditions (Bharti *et al.*, 2018). This observation aligns with the report of Liang and Wang (2019), who reported reduced urban adaptability in *Acacia* species due to their sensitivity to environmental stressors. The findings of this study implies that plant responses to air pollution vary across different geographical areas and differ within the same locality due to influencing factors such as plant age, physiological and metabolic functions, and the concentration of specific air pollutants (chlorofluorocarbons, nitrogen oxides, and carbon monoxide) (Zahid *et al.*, 2023). Therefore, species exhibiting lower values of the Air Pollution Tolerance Index (APTI) are generally more susceptible to pollution, whereas those with higher APTI values demonstrate greater tolerance (Satpute and Bhalerao, 2017). The APTI thus serves as an important metric for evaluating and identifying plant species capable of withstanding polluted environments (Bharti *et al.*, 2018).

## CONCLUSION

Based on this study, there is significant variation in the biochemical characteristics and air pollution tolerance of the dominant tree species in the study area. *Elaeis guineensis* (oil palm) emerged as the most efficient species, with the highest moisture content, chlorophyll, ascorbic acid, and APTI, indicating its

suitability for improving urban air quality and environmental health. The significant differences in pH, moisture content, ascorbic acid, chlorophyll, and APTI among the tree species in the study area show the importance of selecting appropriate species for urban forestry and pollution control initiatives. To maintain a healthy urban environment, it is recommended to diversify tree species, prioritize native varieties, and implement strong greening policies. Regular tree management, integration of green spaces into planning, community involvement, and continuous air quality monitoring are also essential for long-term success.

## REFERENCE

1. Abdu, B., Bature, M., Lamutanni, D., and Sadiq, S. (2024). Use of leaves as bio-indicator to assess air pollution tolerance index (APTI) and elemental concentration of heavy metals at Katsina Central Market grinding area, Katsina State-Nigeria. *International Journal of Scientific Research in Science and Technology*, 11, 679-688. doi: 10.32628/IJSRST24113238.
2. Acebron K, Salvatori N, Alberti G, Muller O, Peressotti A, Rascher U, Matsubara S (2023) Elucidating the photosynthetic responses in chlorophyll-deficient soybean (*Glycine max*, L.) leaf. *J Photochem Photobiol* 13:100152. <https://doi.org/10.1016/j.jpap.2022.100152>
3. Agbaire P, and Esiefarienrhe E (2009). Air pollution tolerance indices (apti) of some plants around Otorogun gas plant in Delta State, Nigeria. *J Appl Sci Environ Manag*. <https://doi.org/10.4314/jasem.v13i1.55251>
4. Barjoe SS, Malverdi E, Kouhkan M, Alipourfard I, Rouhani A, Farokhi H, Khaledi A (2023) Health assessment of industrial ecosystems of Isfahan (Iran) using phytomonitoring: Chemometric, micromorphology, phytoremediation, air pollution tolerance and anticipated performance indices. *Urban Clim* 48:101394. <https://doi.org/10.1016/j.uclim.2022.101394>
5. Baró, F., Haase, D., Gómez-Baggethun, E., & Frantzeskaki, N. (2015). Mismatches between ecosystem services supply and demand in urban areas: A quantitative assessment in five European cities. *Ecological Indicators*, 55, 146-158. <https://doi.org/10.1016/j.ecolind.2015.03.013>.
6. Bhadauria S, Dixit A, Singh D (2022) Estimation of air pollution tolerance and anticipated performance index of roadside plants along the national highway in a tropical urban city. *Environ Monit Assess* 194(11):808. <https://doi.org/10.1007/s10661-022-10483-0>

7. Bharti, S. K., Trivedi, A., and Kumar, N. (2018). Air pollution tolerance index of plants growing near an industrial site. *Urban Climate*, 24, 820-829. <https://doi.org/10.1016/j.uclim.2017.10.007>
8. Cieslik, S., Omasa, K., and Paoletti, E. (2009). Why and how terrestrial plants exchange gases with air. *Plant Biology*, 11, 24-34. <https://doi.org/10.1111/j.1438-8677.2009.00262.x>
9. Das S, Sarkar A (2022) Utilization of mango plants (*Mangifera indica* L.) as in situ bio-monitoring tool against vehicular air pollution along National and State Highways: a case study from Malda district, West Bengal, India. *J Biol Today's World* 11(3):1-4. <https://doi.org/10.35248/2322-3308-11.3.004>
10. Das, S. and Prasad, P.. (2012). Particulate matter capturing ability of some plant species: Implication for phytoremediation of particulate pollution around Rourkela Steel Plant, Rourkela, India. *Nature Environment and Pollution Technology*. 11. 657-665.
11. Das, S., and Prasad, P. (2012). Particulate matter capturing ability of some plant species: Implication for phytoremediation of particulate pollution around Rourkela Steel Plant, Rourkela, India. *Nature Environment and Pollution Technology*, 11(4), 657-665
12. Esfahani, A. A., Amini, H., Samadi, N., Kar, S., Hoodaji, M., Shirvani, M., & Porsakhi, K. (2013). Assessment of air pollution tolerance index of higher plants suitable for green belt development in east of Esfahan city, Iran. [Journal Title], 3(2), 87-94.
13. Fernandez, R. T., et al. (2021). Chlorophyll content and photosynthesis in urban trees: A case study in Buenos Aires city. *Urban Forestry and Urban Greening*, 60, 127042.
14. Gautam S, Talatiya A, Patel M, Chabhadiya K, Pathak P (2020) Personal exposure to air pollutants from winter season bonfires in rural areas of Gujarat, India. *Expo Health* 12(1):89-97. <https://doi.org/10.1007/s12403-018-0287-9>
15. Gbeminiyi, T. T., Anibaba, Q. A., Hassan, U., & Bako, S. (2018). Air pollution tolerance index of some tree species around electricity generating houses in Ahmadu Bello University main campus, Zaria, Nigeria. *Nigerian Journal of Scientific Research*, 15(3). doi: 10.13140/RG.2.2.30092.74885.
16. Gupta V, Bisht L, Deep A, Gautam S (2022) Spatial distribution, pollution levels, and risk assessment of potentially toxic metals in road dust from major tourist city, Dehradun, Uttarakhand India. *Stoch Env Res Risk Assess* 36(10):3517-3533. <https://doi.org/10.1007/s00477-022-02207-0>
17. Jothy, S. L., Aziz, A., Chen, Y., and Sasidharan, S. (2012). Antioxidant Activity and Hepatoprotective Potential of *Polyalthia longifolia* and *Cassia spectabilis* Leaves against Paracetamol-Induced Liver Injury. *Evidence-based complementary and alternative medicine : eCAM*, 2012, 561284. <https://doi.org/10.1155/2012/561284>
18. Keller T and Schwager H (1977). Air pollution and ascorbic acid. *Eur J For Pathol* 7(6):338-350. <https://doi.org/10.1111/j.1439-0329.1977.tb00603.x>
19. Kuddus M, Kumari R, Ramteke PW (2011) Studies on air pollution tolerance of selected plants in Allahabad city, India. *J Environ Res Manag* 2(3):042-046
20. Kwak M.J., Lee J.K., Park, S., Lim, Y.J., Kim, H., Kim, K.N., Je, S.M., Park, C.R. and Woo, S.Y., Evaluation of the Importance of Some East Asian Tree Species for Refinement of Air Quality by Estimating Air Pollution Tolerance Index, Anticipated Performance Index, and Air Pollutant Uptake. *Sustainability*, 2020, 12:3067; <https://doi.org/10.3390/su12073067>
21. Liang, W., and Wang, C. (2019). Evaluation of tree species tolerance to urban environmental stress: A case study in Beijing, China. *Urban Forestry and Urban Greening*, 38, 1-10.
22. Lohe, R. N., Tyagi, B., Singh, V., Tyagi, P., & Khanna, D. R., & Bhutiani, R. (2015). A comparative study for air pollution tolerance index of some terrestrial plant species. *Global Journal of Environmental Science and Management*, 1(4), 315-324. doi: 10.7508/gjesm.2015.04.006.
23. Manisalidis, I., Stavropoulou, E., Stavropoulos, A., and Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in Public Health*, 8, 505570. <https://doi.org/10.3389/fpubh.2020.00014>
24. Odoh, B. I., Nwokeabia, C. N., and Ibezue, V. C. (2024). Geospatial analysis of topography, hydrology, and land use dynamics in Owerri and environs region, Southeastern Nigeria. *International Journal of Recent Engineering Science*, 11(4), 97-112. <https://doi.org/10.14445/23497157/IJRES-V11I4P113>
25. Ogunrotimi D.G., Adereti F.K., Eludoyin A.O. and Awotoye O.O., Urban air pollution control: Selection of trees forecological monitoring using anticipated performance indices in a medium-size urban area in Southwest Nigeria. *Interdisciplinary Environmental Review*, 2017,

- 18(1): 40 – 54. <https://doi.org/10.1504/IER.2017.10005053>
26. Ojewuyi, O. B., Ajiboye, T. O., Adebajo, E. O., Balogun, A., and Mohammed, A. O. (2014). Proximate composition, phytochemical and mineral contents of young and mature *Polyalthia longifolia* Sonn. leaves. *Fountain Journal of Natural and Applied Sciences*, 3(1): 12-31. <https://doi.org/10.53704/fujnas.v3i1.20>
  27. Osman, W. N. A. W., Rosli, M. H., Mazli, W. N. A., & Samsuri, S. (2024). Comparative review of biodiesel production and purification. *Carbon Capture Science & Technology*, 13, 100264. <https://doi.org/10.1016/j.ccst.2024.100264>
  28. Rasool, A., Muhammad, S., Tayyab, M., Bajwa, A. A., Majeed, M., Munam, B., Faisal, S., Khairdin, A., Khalid, S., Hanif, H. K., Malik, S. M., and Bilal, M. (2025). Ecological evaluation of dominant roadside plants through APTI and API for sustainable green belt development in cosmopolitan city (Lahore) of Pakistan. *Scientific Reports*, 15(1), 1-16. <https://doi.org/10.1038/s41598-024-76882-0>
  29. Sadia H-E, Jeba F, Uddin MZ, Salam A (2019) Sensitivity study of plant species due to traffic emitted air pollutants (NO<sub>2</sub> and PM<sub>2.5</sub>) during different seasons in Dhaka, Bangladesh. *SN Appl Sci* 1:1-9. <https://doi.org/10.1007/s42452-019-1421-4>
  30. Satpute SB, Bhalariao SA (2017) Assessment of air pollution tolerance index (APTI) and anticipated performance index (API) for designing green belt. *Res J Chem Environ Sci* 5(1):86-94
  31. Sharma, A., Bhardwaj, S.K., Panda, L.R.L and Abha Sharma A. Evaluation of Anticipated Performance Index of Plant Species for Green Belt Development to Mitigate Air Pollution. *11 International Journal of Bio-resource and Stress Management*, 2020, 11(6): 536-541. <https://doi.org/10.23910/1.2020.2148>
  32. Shreshtha, S., Anushi, J., Joshi, A., Joshi, N., and Anupma, H. (2017). Study of total phenol, flavonoid contents and phytochemical screening of methanolic crude extracts of two weed plants. *Annals of Plant Sciences*, 6(06), 1645-1648. doi:<https://doi.org/10.21746/1651-1654>
  33. Shrestha, S., Baral, B., Dhital, N.B. and Yang, H (2021). Assessing air pollution tolerance of plant species in vegetation traffic barriers in Kathmandu Valley, Nepal. *Sustain Environ Res* 31, 3 (2021). <https://doi.org/10.1186/s42834-020-00076-2>
  34. Sia Su, G. L., Solomon, N. F. R., and Rraggio, E. M. (2018). Air pollution tolerance index of selected trees in major roadsides of Metro Manila, Philippines. *Nature Environment and Pollution Technology*, 17(3), 1005-1009.
  35. Singh S, Rao D, Agrawal M, Pandey J, and Naryan D (1991) Air pollution tolerance index of plants. *J Environ Manage* 32(1):45-55. [https://doi.org/10.1016/S0301-4797\(05\)80080-5](https://doi.org/10.1016/S0301-4797(05)80080-5)
  36. Singh S.K and Rao D.N 1983., Evaluation of plants for their tolerance to air pollution. *Proceedings of the symposium on air pollution control*, pp. 218-224.
  37. Sivakumaran, S and Hall, M (1978). Effects of age and water stress on endogenous levels of plant growth regulators in *Euphorbia lathyris* L. *J Exp Bot* 29(1):195-205. <https://doi.org/10.1093/jxb/29.1.195>
  38. Timilsina A, Dong W, Hasanuzzaman M, Liu B, Hu C (2022) Nitrate-nitrite-nitric oxide pathway: a mechanism of hypoxia and anoxia tolerance in plants. *Int J Mol Sci* 23(19):11522. <https://doi.org/10.3390/ijms231911522>
  39. Verma J, Singh P, Sharma R (2023) Evaluation of air pollution tolerance index and anticipated performance index of selected roadside tree species in Ludhiana, India. *Environ Monit Assess* 195(1):240. <https://doi.org/10.1007/s10661-022-10784-4>
  40. Xu, H., Jia, Y., Sun, Z., Su, J., Liu, Q. S., Zhou, Q., and Jiang, G. (2022). Environmental pollution, a hidden culprit for health issues. *Eco-Environment and Health*, 1(1), 31-45. <https://doi.org/10.1016/j.eehl.2022.04.003>
  41. Zahid, A., Ali, S., Anwar, W., Fatima, A., Chattha, M. B., Ayub, A., Raza, A., Ali, K., and Siddique, M. (2023) Assessing the air pollution tolerance index (APTI) of trees in residential and roadside sites of Lahore, Pakistan. *SN Appl. Sci.* 5, 294 (2023). <https://doi.org/10.1007/s42452-023-05470-0>