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AIR POLLUTION TOLERANCE INDEX (APTI) OF SELECTED TREES FROM VIMALA COLLEGE CAMPUS

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Simple Summary: Capturing and storing the atmospheric greenhouse emission of CO_2 by continual or enhanced biological processes is mentioned as Bio-sequestration which happens through increased rates of photosynthesis. Since photosynthesis depends on using the sun's energy to synthesize sugar from CO_2 and water, higher CO_2 concentrations make plants more efficient. When the concentration of CO_2 within the air around a plant leaf rises, it is often absorbed more quickly, increasing the speed of photosynthesis. Green plants functions as a sink and filter to mitigate pollution by absorption, adsorption, detoxification, accumulation, and metabolization while maintaining growth, thereby improving air quality by adding oxygen to the atmosphere. The response of plant species to pollution are often calculated using comprehensive studies on the APTI of various plants. The pollution tolerance index is an analytical relationship that assesses plant species' tolerance to pollution supported leaf biochemical parameters like leaf extract pH, relative water content, vitamin C, and total chlorophyll.

Abstract: Urban areas exposed to pollution require tolerant plant species to thrive there and give naturalbenefits. The present study is an attempt to document the Air Pollution Tolerance Index (APTI)of selected trees from Vimala College Campus, to analyze their air pollution tolerance capacity.The assessment of the Ascorbic Acid, pH, Relative Water Content and Total Chlorophyll Content of the leaves of the selected tree species was done to determine the APTI. The APTI of the plant ranged from 7.445 to 9.711 with *Bambusa vulgaris* having the highest value which indicates it's high tolerance of air pollutants from the assessment and *Acacia sinuata* with the lowest value and least tolerant. The study also put forward the suggestion model for urban areasand urban campuses.

Key Words: APTI, pH, Ascorbic acid, Relative water content, Total chlorophyll, Tolerant trees

Introduction

Trees growing in urban areas get affected at the maximum by the pollution as they are the primary recipients to different air pollutants and show varied levels of tolerance and sensitivity.As the trees are being continuously exposed to the environment, they show noticeable or slight changes depending on their sensitivity level because they attract, gather, and combine pollutant simpinging on their leaf surface. Chlorosis, necrosis, and epinasty are the most visible symptoms in the leaves. The response of plant species to pollution are often calculated using comprehensive studies on the APTI of various plants. The air pollution tolerance index (APTI) is a plant's intrinsic ability to withstand air pollution stress, which is currently a major concern in both industrial and non-industrial areas.

The Air Pollution Tolerance Index (APTI) was developed by Singh and Rao and has been used in studies such as

Green belt development traffic noise reduction and pollution mitigation at roadside sites and near factories. APTI can be computed using the parameters like chlorophyll content, leaf pH extract, relative water content and ascorbic acid content. The change in biochemical parameters such as pH, relative watercontent, ascorbic acid, and total chlorophyll is directly proportional to the strength of the pollutant in the atmosphere. The trees having higher tolerance index rate are tolerant towards air pollution and can be used as a source to control air pollution, whereas the trees having less tolerance index can be used as an indicator to know the rate of air pollution.

A comparative study with a mathematical hypothesis for Air Pollution Tolerance Index was conducted in several parts of Indian villages by government through various projects such as Clean Development Mechanism and Village-based Forest Restoration in Central India, Identifying Systems for Carbon Sequestration and Increased Productivity in Semi-arid Tropical Environments, Women for Sustainable Development Plan Vivo Forestry Project, etc. But compared to other developed countries and cities, evaluation of air pollution tolerance index is less common in Kerala. However, several works of selected plant species along roadsides, industrial and urban areas in several districts are some of the studies conductedin Kerala on Atmospheric Tolerance Index. In this context, the present work was conducted inVimala College Campus which focuses on evaluating APTI and to select the most tolerant andbest-suited plants for urban green space growth. As this research was conducted on a small college campus, similar studies can be conducted in large form, among any part of the city in order to identify the best plants for reducing air pollution in urban areas.

Study Area

The study area, Vimala College Campus is a part of Thrissur Corporation and is located at Ramavarmapuram, Thrissur District, Kerala (Figure 1). The geographical location of Vimala College lies between 10.553215385472264 latitude and 76.22682776972341 longitudes of Thrissur district, according to the Survey of India Toposheet No. 58 B and 49 N. The campus has a total area of 26 acres. The average annual rainfall ranges between 2310.1 and 3955.3 mmin the district with mean annual rainfall of 3198.133 mm. The average annual maximum temperature is 32.30^0C and minimum temperature 23.3^0C. The humidity is higher during monsoon months from June to October and is around 93% during morning hours and 76% during evening hours. The main sources of air pollutants in the study area are pollutants from road traffic.

Figure 1. Study area

Materials and Methods

Field Survey of Trees and sampling in the Campus

The survey process was conducted during the months February – March 2021. Seven most diameter and height showing trees were selected. Measuring of Bamboo species were done by wrapping the whole culm and measuring the diameter at breast height. Species were identified using standard floras to the species level, including its scientific name and family. The fully expanded leaves from all the sites were collected in polythene bags and transported to the laboratory. The leaves were washed out thoroughly with distilled water. Three replicates were used for each plant.

Determination of Air Pollution Tolerance Index (APTI)

In order to assess the air pollution tolerance index of these tree species, biochemical parameters like ascorbic acid content, total chlorophyll content, leaf extract pH and relative water content(RWC) were estimated. Air pollution tolerance index (APTI) was determined by the method given by Singh and Rao. The samples were estimated for Leaf-extract pH, relative moisture content, total chlorophyll and ascorbic acid.

Estimation of leaf extract pH:

Leaf-extract pH is estimated by collecting 0.5 g of fresh leaf material which is ground to paste using mortar and pestle. It is then dissolved in 50 ml of distilled water and leaf-extract pH was measured by using calibrated digital pH meter.

Estimation of Relative Moisture Content (Relative Water Content):

Relative moisture content was estimated by collecting fresh leaf samples from the study area and were brought immediately to the laboratory and washed thoroughly in tap water and then in distilled water. The excess water was removed with the help of filter paper. The initial weights of samples were taken (FW). The leaves were then immersed in water overnight, blotted dry and then weighed to get the turgid weight (TW). The leaves were then dried overnight in an oven at 70^0C and reweighed to obtain the dry weight (DW). The noted weights of leaves are then put in the equation given below to get the Relative Water Content (RWC).

$$\mathrm{RWC} = \frac{(\mathrm{FW} - \mathrm{DW})}{(\mathrm{TW} - \mathrm{DW})} \times 100$$

Where,

$\mathrm{FW} = \mathrm{Fresh\ Weight}$

$\mathrm{DW} = \mathrm{Dry\ Weight}$

$\mathrm{TW} = \mathrm{Turgid\ Weight}$

Estimation of Total Chlorophyll content:

Total Chlorophyll content was measured by the method of Arnon. 1g of finely cut and well mixed sample of leaves was taken in to a clean mortar and pestle. The leaves are then grinded with addition of 20 ml 80 % acetone until the colour of the leaves disappear. Centrifuge at 5000 rpm for 5 minutes and the supernatant are transferred to a 100 ml volumetric flask. The volume is made up to 100 ml with 80% Acetone and the optical density was read at 645nm and 663nm wavelengths on a spectrophotometer against the solvent blank (80% Acetone). The concentration of the chlorophyll pigments was calculated using the following formula and the results are expressed in mg/g fresh weight.

Total chlorophyll = [(20.2 X OD at 645) – (8.02 X OD at 663)] x Dilution factor

$$\textbf{Dilution Factor} = \frac{\mathbf{V}}{\mathbf{(1000\times W)}}$$

Were,

OD = Optical Density

V = Final volume of chlorophyll extract in 80% Acetone (ml)

W = Fresh weight of the tissue extracted (gm)

Estimation of Ascorbic acid content (AA):

Ascorbic acid content (mg/g) was measured using spectrophotometric method. 1 g of the fresh foliage was put in a test-tube, 4 mL oxalic acid - EDTA extracting solution was added, then 1 mL of orthophosphoric acid and then 1mL 5% tetraoxosulphate(VI)acid added to this mixture, 2 mL of ammonium molybdate was added and then 3 mL of water. The solution was then allowed to stand for 15 minutes. After which the absorbance at 760 nm was measured with a spectrophotometer. After obtaining all the biochemical parameter values, the Air Pollution Tolerance Index (APTI) was calculated using the given formula:

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

Were, A= Ascorbic acid content (mg/g)

T= Total chlorophyll (mg/g)

P = pH of leaf extract

R = Relative Water Content of leaf (%)

Estimated values of Air Pollution Tolerance Index (APTI) were categorized into Sensitive, Intermediate, Tolerant and Highly tolerant.

Results and Discussion

From the tree species showing maximum height and diameter value, species selected for Air Pollution Tolerance Index (APTI) analysis are *Bambusa vulgaris*, *Bambusa tuldoides*, *Acacia sinuata*, *Murraya paniculata*, *Garcinia gummi-gutta*, *Ficus religiosa* and *Artocarpus incises* (Table:1). *Ficus religiosa* showed the maximum pH (Fig: A) value which has a big impact on photosynthetic activity [8] and the least was found for *Garcinia gummi-gutta*. Quantitative analysis of Total Chlorophyll Content (Fig: C) showed maximum value in *Acacia sinuata* with 0.426597 mg/g and minimum value in *Garcinia gummi-gutta* with 0.0393564 mg/g. Total chlorophyll is used as a measure of photosynthetic activity, biomass productivity, and growth [14, 21]. The maximum Relative Moisture Content (Fig: B) which can tolerate long periods of drought [31] was estimated in *Bambusa vulgaris* with 94.827% and minimum value was estimated in *Acacia sinuata* with 64.0522%. Decreased RWC reduces stomatal conductance and thus CO2 assimilation [17]. *Murraya paniculata* with 1.371mg/g was estimated the maximum in the analysis of Ascorbic acid content (Fig: D) which is a significant electron donor in photosynthesis [12]. and minimum in *Bambusa tuldoides* with 0.286mg/g. Air Pollution Tolerance Index (APTI) (Table: 2, Fig: E) was estimated maximum for *Bambusa vulgaris* with 9.711 and minimum value was estimated for *Acacia sinuata* with 7.445. All the selected tree species were indexed as highly tolerant. The APTI of plants can vary from place to place due to geographic and climatic variations, differences in air quality, temperature, humidity, etc. [25,33].

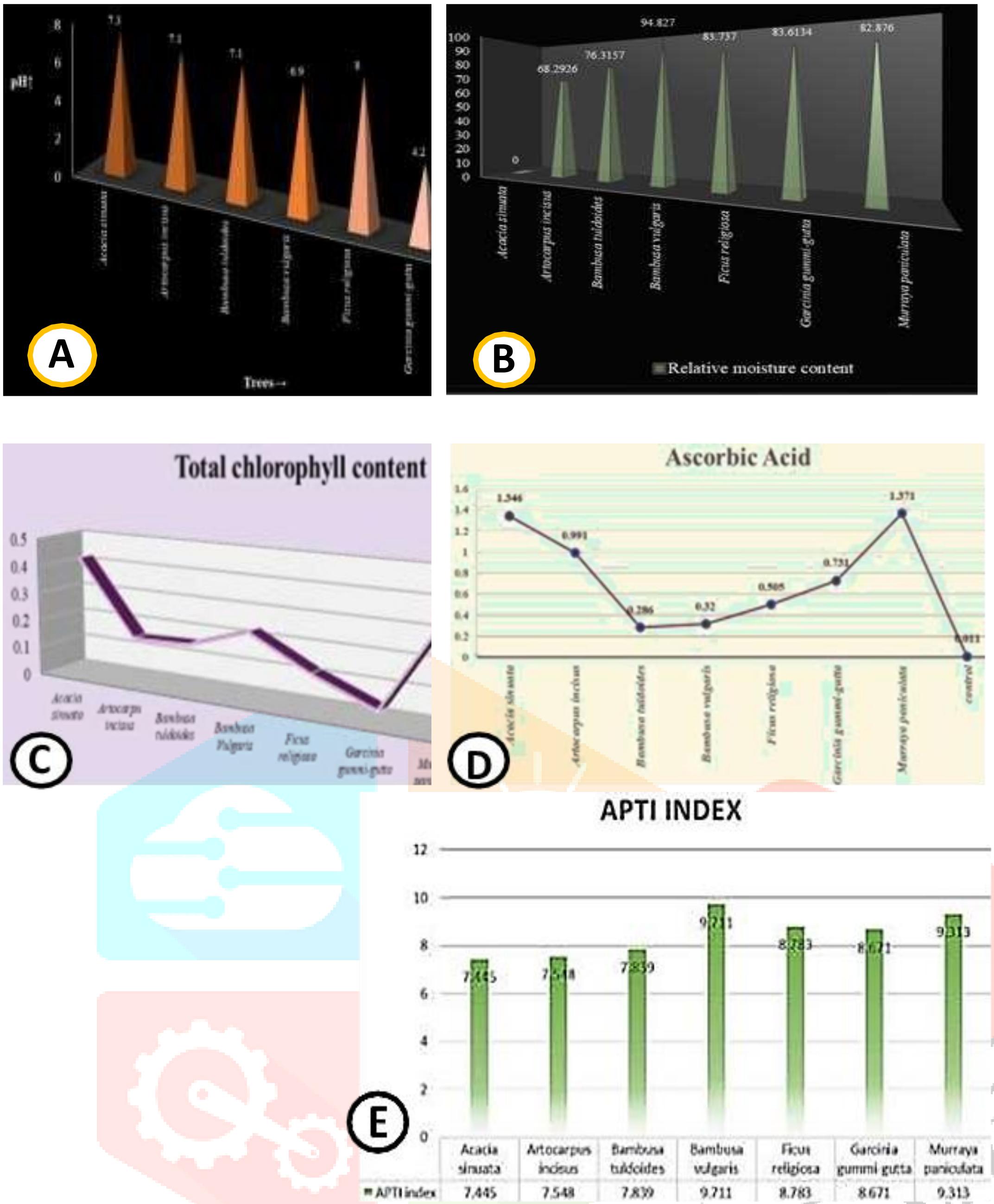
Table 1: Selected tree species with Family, Diameter, Height, and analytical parameters values of APTI

Sample	Family	Diameter (inches)	Height (feet)	pH	Total chlorophyll content (mg/g)	Relative moisture content (%)	Ascorbic Acid (mg/g)
Acacia sinuata	Fabaceae	108.9	22.96	7.3	0.426	64.0522	1.346
Artocarpus incisus	Moraceae	68	39.37	7.1	0.156	68.2926	0.991
Bambusa tuldoides	Poaceae	345	60.69	7.1	0.163	76.3157	0.286
Bambusa vulgaris	Poaceae	514	52.49	6.9	0.235	94.827	0.320
Ficus religiosa	Moraceae	62	52.49	8.0	0.124	83.737	0.505
Garcinia gummi-gutta	Clusiaceae	73	42.65	4.2	0.039	83.6134	0.731
Murraya paniculata	Rutaceae	120	16.40	7.1	0.383	82.876	1.371
Control	-	-	-	7.3	0.001	-	0.011

Table 2: Categorization of selected tree species according to its Air Pollution Tolerance Index values (APTI)

Index value and Category	No.	Sample	APTI	Category
4.0-5.0→ Sensitive 5.0-6.0→ Intermediate 6.0-7.0→ Tolerant > 7.0→ Highly tolerant	1	*Acacia sinuata*	7.445	Highly tolerant
	2	*Artocarpus incisus*	7.548	Highly tolerant
	3	*Bambusa tuldoides*	7.839	Highly tolerant
	4	*Bambusa vulgaris*	9.711	Highly tolerant
	5	*Ficus religiosa*	8.783	Highly tolerant
	6	*Garcinia gummi-gutta*	8.671	Highly tolerant
	7	*Murraya paniculata*	9.313	Highly tolerant

Fig: A - Quantitative analysis of pH, **Fig: B** - Quantitative analysis of Relative moisture content**Fig: C** - Quantitative analysis of Total chlorophyll content, **Fig: D** - Quantitative analysis of Ascorbic Acid content and **Fig: E** - Air Pollution Tolerance Index (APTI) values.



Conclusion

The present investigation tried to find out the Air Pollution Tolerance Index (APTI) by following disciplines like the field survey and sampling, estimation of leaf extract pH, Relative Moisture Content (Relative Water Content), Total Chlorophyll content and Ascorbic acid content (AA). The site for analysis was selected based on the urbanized exposure. During the survey, *Acacia sinuata*, *Artocarpus incises*, *Bambusa tuldoides*, *Bambusa vulgaris*, *Ficus religiosa*, *Garcinia gummi-gutta and Murraya paniculata* showed the maximum height and diameter and were selected for the analysis. *Bambusa vulgaris* showed maximum Relative moisture content and APTI value and *Acacia sinuata* showed maximum total chlorophyll content and minimum APTI value. *Ficus religiosa* showed maximum pH value and *Murraya paniculata* with maximum ascorbic acid content. From this study it is found out that all the selected species comes under the category "Highly tolerant" and could be a great contributor for tree planning in urban areas especially *Bambusa vulgaris* which valued the most in the analysis. This analysis can be implemented in other urban areas and in rural areas to find out species with high Air Pollution Tolerance Index (APTI) for better tree planning or for enhancing the current status.

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