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RESEARCH ARTICLE

Evaluation of air quality through various bioparameters near Valankulam lake, Coimbatore

Ramachandran, B.[1,*], Yaazhini, J.[1], Danya, U.[1] and Vimal Priya, S.[2]
[1]Department of Botany, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India.
[2]Department of Botany, Kongunadu Arts and Science College (Autonomous), Coimbatore - 641029, Tamil Nadu, India.

ABSTRACT

Road and bridge construction close to lakes generates a lot of dust, which pollutes the air in that area. This is about the negative effects of vegetation activities. Some have the tolerance capacity, while others do not, leading to adverse effects. The study focuses on the air pollution tolerance index (APTI) of trees near Valankulam Lake in Coimbatore. Physiological and biochemical factors were employed to determine the APTI. The leaves of 19 trees were collected for the study and tested for ascorbic acid, total chlorophyll concentration, leaf pH, and relative water content. *Albizzia lebbeck* was found to have the highest tolerance value (88.81), followed by *Ficus religiosa*, *Bougainvillaea spectabilis*, *Nerium oleander*, *Ricinus communis*, *Thevetia peruviana*, *Azadirachta indica* and *Tamarindus indica*. *Tectona grandis* (8.01) is the most vulnerable to pollution, followed by *Pongamia pinnata*, *Vitex negundo* and *Tecoma stans*. According to the findings, the tolerant species can serve as a source, while the sensitive plants serve as a signal of pollution.

Keywords: APTI, Ascorbic content, Chlorophyll content, Leaf pH, Relative water content

1. INTRODUCTION

Most nations are currently dealing with complications associated to air pollution. Its brutality has been worsened in recent decades by increased industry and urbanization [1]. Minor variations in air structure can have an impact on organism growth, development and persistence. Trees, because of their perpetual nature, have a bigger influence on air pollution than any other living entity. It has been discovered that particle and gaseous pollutants have a deleterious impact on plant physiology [2]. Development and nutrient content of plant depends on the atmospheric pollutants in the environment, as pollutants damage plants through leaves, roots and vegetative sections of tree species or soil acidity. Several biochemical, physiological and morphological characteristics regulate pollution uptake and deposition by plant leaf surfaces [3]. While leaves are directly exposed to air pollution, they exhibit visible and apparent harm such as chlorosis, necrosis, abscission, dwarfing and epinasty. As a consequence, leaves are an important organ of a tree that can directly reflect the negative effects of air pollution. Therefore, the reaction of trees to air pollutants can be used to monitor the state of air pollution in a specific location [4].

Trees, on the other hand, have been noticed as possible living entities capable of trapping and metabolizing air pollutants and, as an outcome, contributing to improved urban air quality by releasing oxygen into the atmosphere [5]. Air pollutants are primarily removed by plants by uptake through leaf stomata, and once inside the leaf, gases pass into intercellular spaces and are absorbed by water films. Plants cultivated in such a way that they act as pollution sinks are referred to as greenbelts, and their tolerance to air pollutants is limited [6]. A measure of a plant's tolerance for air pollution is the Air Pollution Tolerance Index. Screening methods for plants for their tolerance level to air pollutants are significant because sensitive plants can serve as bio-indicators and tolerant plants can serve as sinks for decreasing air pollution in urban and industrial regions. So, in order to assess plant susceptibility to air pollutants, four parameters, namely leaf extract pH, relative water content, ascorbic acid content and chlorophyll content, were obtained and computed combined in a formulation denoting the Air Pollution Tolerance

*Correspondence: Ramachandran, B., Department of Botany, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India. E.mail: ramachandran4667@gmail.com

Index (APTI). The Air Pollution Tolerance Index (APTI) scale strategy, which is based on the fluctuation of determined biochemical parameters, can be employed to categorize plant species as tolerant or sensitive [7]. As a consequence of the construction of bridges, the plants around the Valankulam lake in Coimbatore are subjected to lot of dust. The study focuses on the plant's air pollution tolerance index near the lake to determine which plants are tolerant and which are sensitive to pollution. As a way to recommend different types of plants that can be planted there as a green belt. Marine macroalgae, also known as seaweeds, boast an impressive array of phytochemical compounds and antioxidant properties that contribute to their significant biological value. These algae are rich sources of various bioactive compounds such as flavonoids, phenolic compounds, carotenoids, and phycobiliproteins. These phytochemicals exhibit potent antioxidant activity, effectively scavenging free radicals and mitigating oxidative stress within the body [10]. The diverse range of antioxidants present in marine macroalgae not only aids in their defense against environmental stressors but also offers immense health benefits to humans. Regular consumption of these algae has been linked to potential anti-inflammatory, anti-aging and disease-preventive effects due to their ability to neutralize harmful free radicals and support overall health and well-being. As a result, the exploration of marine macroalgae for their antioxidant and phytochemical properties holds promise for both pharmaceutical and nutritional applications [7].

The present study is mainly based on the phytochemical and antioxidant activities of selected macroalgae, *Padina tetrastromatica* Hauck which is collected from Kannur coast, Kerala.

2. MATERIALS AND METHODS

2.1. Sample Collection

The Ukkadam - Valankulam Lake is a calm lake in Coimbatore, Tamil Nadu, and located one kilometre from Coimbatore Junction. It is one of the most visited locations in Coimbatore and is situated between Trichy Road and Sungam Bypass Road. Fresh leaves of 19 plant species were collected from this region (Table 1 & Figure 1). All species were identified with the help of standard literature and verified with the help of experts in the field of taxonomy.

Table 1. List of plants taken for APTI analysis

S. No	Binomial Name	Family Name	Common name
1	*Albizzia lebbeck* (L.) Benth.	Fabaceae	Mimosa Tree
2	*Azadirachta indica* (A. Juss)	Meliaceae	Neem Tree
3	*Bougainvillea spectabilis* Willd.	Nyctaginaceae	Great Bougainvillea
4	*Caesalpinia gilliesii* (Hook.) Klotzsch.	Fabaceae	Bird of Paradise
5	*Delonix regia* (Boj.ex. Hook) Raf.	Fabaceae	Flame Tree
6	*Ficus religiosa* L.	Moraceae	Sacred Fig
7	*Lantana camara* L.	Verbenaceae	West Indian Lantana
8	*Millingtonia hortensis* L.f.	Bignoniaceae	Indian Cork Tree
9	*Muntingia calabura* L.	Muntingiaceae	Jamaica Cherry
10	*Nerium oleander* L.	Apocynaceae	Nerium

11	*Peltophorum pterocarpum* (DC.) Backer ex K. Heyne	Fabaceae	Copper Pod
12	*Pongamia pinnata* (L.) Pierre	Fabaceae	Pongamia Oil Tree
13	*Ricinus communis* L.	Euphorbiaceae	Castor Oil Plant
14	*Tamarindus indica* L.	Fabaceae	Tamarind
15	*Tecoma stans* (L.) Juss.ex.Kunth	Bignoniaceae	Yellow Bells
16	*Tectona grandis* L.f.	Lamiaceae	Teak
17	*Thespesia populnea* (L.) Soland ex Correa	Malvaceae	Indian Tulip Tree
18	*Thevetia peruviana* (Pers.) K. Schum	Apocynaceae	Yellow Oleander
19	*Vitex negundo* L.	Lamiaceae	Chinese Chaste Tree

Ascorbic acid content: Ascorbic acid content was determined by following Omaye's method [8]. 1g of fresh material was ground in a pestle and mortar with 5ml of 10% Trichloroacetic acid. The extract was centrifuged at 3500rpm for 20 minutes. The pellet was re-extracted twice with 10% Trichloroacetic acid and the supernatant was made to 10ml. To 0.5ml of extract, 1ml of DTC (3g of 2,4, Dinitrophenyl hydrazine, 0.4g of thiourea and copper sulphate were dissolved in 100ml of 9N H_2SO_4) reagent was added and mixed thoroughly. The tubes were incubated at 37^{o}C for 3 hours and to this 0.75ml of ice cold 65% H_2SO_4 was added. The tubes were then allowed to stand at 30^{o}C for 30 minutes. The resulting colour was read at 520nm in a spectrophotometer.

Total Chlorophyll Content: The total Chlorophyll content was determined according to the method of Arnon [9]. For the total chlorophyll analysis, 0.5g leaves were grounded and diluted to 10ml in distilled water. A sub sample of 2.5ml was mixed with 10ml acetone and filtered. Optical density was read at 645nm (D645) and 663nm (D663). Optical density of total chlorophyll is the sum of chlorophyll a and chlorophyll b. The following formula is used to estimate chlorophyll a and chlorophyll b.

Chlorophyll a = [12.7 x OD at 663nm] – [2.69 x OD at 645nm] x V / 1000 W

Chlorophyll b = [22.9 x OD at 645nm] – [4.68 x OD at 663nm] x V / 1000 W

Same method is followed for carotenoid but the optical density was read at 480nm and 570nm.

Carotenoid = [7.6 x OD at 480nm] – [1.49 x OD at 570nm]

Total Chlorophyll content = Chlorophyll a + Chlorophyll b (mg/g)

(W – Weight of the leaf tissue; V – The total volume of the extract used for test.)

Leaf pH estimation: About 100mg of fresh leaves were collected, dried and were homogenized in 10ml of double distilled water and were filtered and the pH of the filtrate containing the leaf extract was examined using calibrated pH meter with pH 4 and pH 9.

Relative Water Content: This was estimated by Barr and Weatherly method. Fresh weight was obtained by weighing the leaves. The leaf samples were then immersed in water over night blotted dry and then weighed to get the turgid weight. The leaves were then dried overnight in a hot air oven at 70^{o}C and reweighed to obtain the dry weight. The relative water content was determined and calculated by the formula:

Relative water content % = (FW - DW) / (TW - DW) x 100

(FW – Fresh weight; DW – Dry weight; TW – Turgid weight)

APTI: The air pollution tolerance indices of the selected plants were determined by the method of Singh & Rao [11]

APTI = A (T+P) + R / 10

A – Ascorbic acid content of leaf sample (mg/g F.wt)

T – Total Chlorophyll content of leaf sample (mg/g F.wt)

P – pH of leaf extract

R – Relative water content of leaf sample (%)

Species category with respect to APTI [12] (Table 2).

Table 2: Categories of APTI

APTI	Class
< 1	Very Sensitive
1 – 16	Sensitive
17 – 29	Intermediate
30 – 100	Tolerant

3. RESULTS AND DISCUSSION

Plants that are constantly exposed to the environment absorb, accumulate, and assimilate contaminants that come into contact with their foliar surfaces. Changes in plant activity can be noticed visibly as a result of the plant's tolerance rate. The leaf parameters of certain trees were estimated in this study, including ascorbic acid content, total chlorophyll content, leaf pH and relative water content. These statistics are used to determine the obtained samples' air pollution tolerance index. The estimated APTI is compared to the special category, and the plants are classified as either sensitive or tolerant of pollution.

Ascorbic acid content: Ascorbic acid, also known as vitamin C, has several functions in plant physiology, notably having an impact on leaves. *B. spectabilis* has the highest ascorbic acid content (72.95 mg/g), followed by *T. indica* (39.9 mg/g) and *F. religiosa* (33.5 mg/g). The lesser content was absorbed in *A. lebbeck* (1.18 mg/g) (Figure 2).

Total Chlorophyll content: Chlorophyll content is essential for photosynthesis in plants. The plant samples with the highest chlorophyll concentration include *P. pterocarpum* (63.1 mg/g), *A. lebbeck* (60.9 mg/g), *M. hortensis* (57.2 mg/g) and *T. populnea* (49.1 mg/g). *T. grandis* (0.12 mg/g) has the least amount of chlorophyll (Figure 3).

pH of the Leaf extract: The plant's pH represents the impact of the plant's health and growth. Acidic plant species include *A. lebbeck*, *A. indica*, *D. regia*, *L. camara*, *M. hortensis*, *N. oleander*, *P. pterocarpum*, *P. pinnata*, *R. communis*, *T. populnea* and *T. peruviana*, whereas alkaline plant species include *C. gilliesii*, *F. religiosa*, *M. calabura*, *T. indica*, *T. stans*, *T. grandis* and *V. negundo*. The pH of *B. spectabilis* is the only species that is neutral.

Relative water content: The relative water content (RWC) of plant tissues, particularly leaves, is a metric used to determine their water status. *M. hortensis* (92.68 %) has the highest relative water content, in addition *A. indica* having 86.44 %, *B. spectabilis* having 82.97 %, *D. regia* having 82 % and *P. pinnata* having 80.81 %. The relative water content capacity of *F. religiosa* (19.22 %) is the lowest (Figure 4).

APTI: The Air Pollution Tolerance Index (APTI) is a numerical expression that measures a plant species' ability to withstand air pollution. *A. lebbeck* has the highest tolerance rate in the current study, with 88.81 and it is a pollution tolerant plant, while *T. grandis* has the lowest tolerance rate, with 8.01 and it is a very sensitive plant. *F. religiosa* (70.59), *B. spectabilis* (67.3), *N. oleander* (66.86), *R. communis* (60.05), *T. peruviana* (51.51), *A. indica* (45.08) and *T. indica* (43.53) are pollution-tolerant plant species. *D. regia* (28.75), *M. calabura* (27.85), *C. gilliesii* (27.65), *L. camara* (20.87), *P. pterocarpum* (20.01), *M. hortensis* (17.67) and *T. populnea* (17.3) are trees that are both tolerant and sensitive to air pollution. *T. stans* (15.37), *V. negundo* (14.63) and *P. pinnata* (12.93) are the pollution-sensitive plant species (Table 3 & Figure 5).

Coimbatore's urban areas are rapidly expanding, accompanied by an increase in pollution caused primarily by dust from the construction of buildings, roads and bridges. This dust settles on the leaves and other plant parts in the surrounding area.

This deposition affects plants by lowering the rate of photosynthesis and other plant activity. The current study was conducted to determine the pollution tolerant plants that are present near the Valankulam area of Coimbatore. The air pollution tolerance index was derived for 19 plant samples using leaf parameters such as ascorbic content, chlorophyll content, pH and relative water content. It is important to note that different plant species may have different requirements for ascorbic acid, chlorophyll content, pH, and relative water content. Additionally, maintaining an appropriate balance of these parameters is critical for optimal plant growth and development. The antioxidant defence, enzyme activity and disease resistance of the plant are all affected by ascorbic acid concentration. Light absorption, photosynthesis, stomatal regulation, leaf coloration and nutrient absorption are all controlled by chlorophyll concentration in the leaves. The pH of the leaf influences water intake, pigment stability and general plant health. Drought stress, water management, water stress, and crop productivity are all monitored by relative water content.

Figure 1. Trees taken for the study

Table 3. Air Pollution Tolerance Index of the Samples

S. No.	Binomial Name	AA (mg/g)	TCl (mg/g)	pH	RWC (%)	APTI	Assessment
1	*A. lebbeck*	**1.18**	60.9	6.1	37.24	**88.81**	Tolerant
2	*A. indica*	19.2	12.08	6.9	86.44	45.08	Tolerant

3	*B. spectabilis*	**72.95**	1.1	7	82.97	67.3	Tolerant
4	*C. gilliesii*	26.8	1.72	7.1	40.22	27.65	Intermediate
5	*D. regia*	12.02	10.2	6.9	82	28.75	Intermediate
6	*F. religiosa*	33.5	11.28	9.22	**19.22**	70.59	Tolerant
7	*L. camara*	7.92	16.58	4.69	40.3	20.87	Intermediate
8	*M. hortensis*	1.31	57.2	6.98	**92.68**	17.67	Intermediate
9	*M. calabura*	25.5	13.85	8.15	35.55	27.85	Intermediate
10	*N. oleander*	26.8	16.32	6.25	63.74	66.86	Tolerant
11	*P. pterocarpum*	2.52	**63.1**	6.2	25.5	20.01	Intermediate
12	*P. pinnata*	3.7	7.5	5.61	80.81	12.93	Sensitive
13	*R. communis*	25.3	16.47	5.08	55.38	60.05	Tolerant
14	*T. indica*	39.9	2.398	7.2	52.39	43.53	Tolerant
15	*T. stans*	14.13	1.36	7.17	33.23	15.37	Sensitive
16	*T. grandis*	2.23	**0.12**	9.1	59.6	**8.01**	Sensitive
17	*T. populnea*	1.71	49.1	6.73	77.6	17.3	Intermediate
18	*T. peruviana*	23.6	15.34	3.8	63.48	51.51	Tolerant
19	*V. negundo*	13.7	0.14	8.1	33.38	14.63	Sensitive

Figure 2. Ascorbic Acid (mg/g)

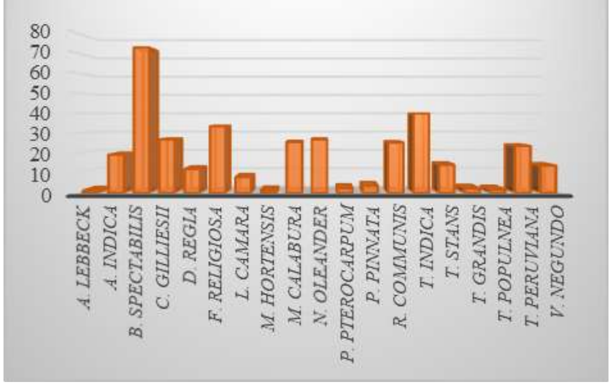
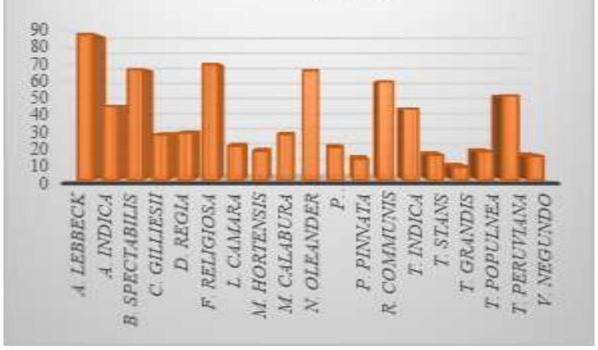


Figure 3. Total Chlorophyll content (mg/g)



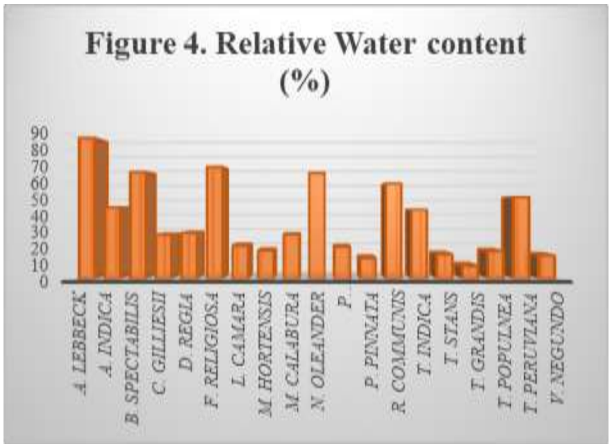


Figure 4. Relative Water content (%)

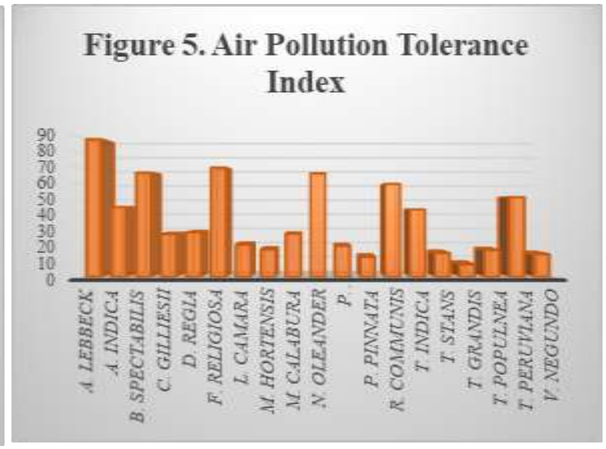


Figure 5. Air Pollution Tolerance Index

4. CONCLUSION

Plants, in general, have a certain level of contamination tolerance. *A. lebbeck* is the most tolerant of pollution in this study, followed by *F. religiosa*, *N. oleander*, *B. spectabilis*, *R. communis*, *T. peruviana*, *A. indica* and *T. indica*. These trees can be planted near polluted areas to absorb pollution. Similarly, *T. grandis* is particularly susceptible to pollution, as are *V. negundo*, *P. pinnata* and *T. grandis* and these trees can be grown as pollution indicator.

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