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Air Pollution effect on *Taberneamontana divaricata*: A comparative Study

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Abstract

A comparative study was conducted to assess the impact of air pollution on Taberneamontana divaricata plants, utilizing the Air Pollution Tolerance Index (APTI). Standard methods were employed to perform phytochemical tests, including pH, relative water content, total chlorophyll content, and total ascorbic acid, on the plant's leaves. The APTI was subsequently calculated for two sets of leaf samples: one obtained from a highly polluted roadside location and another from a nearby unpolluted park. The results of the study demonstrated that the leaves from the unpolluted park exhibited a higher APTI, indicating a moderate tolerance to air pollution, in contrast to the leaves from the polluted roadside, which displayed a lower tolerance, signifying sensitivity to pollution. These findings further underscore the importance of phytochemical composition, including factors such as pH, relative water content, total chlorophyll content, and total ascorbic acid, in determining a plant's tolerance to environmental stressors.

Keywords: *T. divaricata, Leaf, Total Chlorophyll Content, Total Ascorbic Acid content, Air Pollution Tolerance Index*

Introduction

Air pollution is a widespread issue that has far-reaching effects on various aspects of life, stemming from both natural and human-induced factors, which contribute to ecosystem degradation and pose risks to human health (Dwijendra *et al.,* 2023). Plants play a crucial role in restoring air quality equilibrium through their absorption and metabolic processes (Wei *et al.,* 2021). Particularly, roadside plants are efficient interceptors of airborne pollutants, significantly contributing to the assimilation and accumulation of harmful substances. Several previous studies have examined the adverse impacts of urban air pollution on the leaf structure of plants (Carreras *et al.,* 1996; Hirano *et al.,* 1995; Kulshreshtha *et al.,* 1994).

Air pollutants encompass substances like sulfur, nitrogen oxides, carbon monoxide, soot particles, as well as trace amounts of toxic metals, organic compounds, and radioactive isotopes. These pollutants can directly affect plants through their leaves or indirectly through soil acidification. Most plants undergo physiological changes before displaying visible leaf damage (Dohmen *et al.,* 1990). Therefore, researchers have focused on various parameters to study the adverse effects of air pollution, including chlorophyll content (Prasad and Inamdar., 1990; Rajkput and Agarwal., 2005; Petkovsek *et al.,* 2008; Chauhan and Kumar., 2008; Chauhan and Joshi., 2008 and 2010), relative moisture content (Falla *et al.,* 2000; Joshi and Chauhan., 2008), ascorbic acid content (Hoque *et al.,* 2007), and the Air Pollution Tolerance Index (APTI) of select plants (Karthiyayini *et al.,* 2005; Dwivedi and Tripathi., 2007). APTI helps identify the tolerance levels of different plant species (Singh and Rao., 1983; Singh *et al.,* 1991; Yan Ju and Hui., 2008; Agbaire and Esief., 2009).

One cost-effective and appealing approach to improving air quality and controlling air pollution is the use of plants to remove toxins, known as phytoremediation (Gajghate and Hassan., 1999). To understand the response of plants to air pollution at physiological and biochemical levels, researchers use the Air Pollution Tolerance Index (APTI), which is calculated using four biochemical parameters: pH, relative water content, total chlorophyll content, and total ascorbic acid content (Singh and Rao., 1983). Species with higher APTI values exhibit greater tolerance to air pollution than those with lower APTI values. Species with lower APTI values can serve as bio-indicators of pollution.

Tabernaemontana divaricata, often referred to as "crepe jasmine" or "Chandani," serves as a key repository of phytochemical compounds, demonstrating its significance in various applications, as substantiated by previous research findings. Hence, the present study was centered on assessing the Air Pollution Tolerance Index (APTI) of *T. divaricata* leaves. This investigation underscores the fact that the plant's ability to withstand air pollution is linked to the phytochemical composition in its leaves, which may be adversely affected by environmental pollution.

Methodology

Sampling

For this study, leaves of *T. divaricata*, which were authenticated by a Taxonomist from Safia College of Science in Bhopal, Madhya Pradesh, India. One set of samples was obtained from a location near a polluted roadside, while the other set was collected from a nearby unpolluted park in Bhopal city, Madhya Pradesh, India.

pH of Leaf Extracts

Two fresh leaf samples were combined with 10 ml of distilled water and the resulting leaf extract was filtered. The pH of the leaf extract was measured after calibrating the pH meter using a pH-4 buffer solution (Agbaire and Esief., 2009).

Relative Water Content (RWC)

The initial fresh weight of the leaves was recorded by weighing them. To obtain the dry weight, the leaves were dried in an oven at 70°C overnight, and the dry weight was subsequently measured. For the turgid weight, the leaves were soaked in water overnight, dried, and then weighed (Singh., 1997) and calculated with the formula as below:

Relative Water Content (%) = FW - DW / TW – DW x 100

Where, FW – Fresh weight of leaf, DW – Dry weight of leaf, TW – Turgid weight of leaf.

Total Chlorophyll Content

Fresh leaves from both plants were collected for the analysis of total chlorophyll content. For total chlorophyll determination, 0.5 g of fresh leaf material was ground and diluted in 10 ml of distilled water. A subsample of 2.5 ml was mixed with 10 ml of acetone and allowed to stand for 15 minutes. It was then filtered and centrifuged at 2500 rpm for 3 minutes. The optical density of the supernatant was measured at 645 nm and 663 nm using a digital spectrophotometer (Aminot and Rey., 2000). The concentrations of chlorophyll a and chlorophyll b (mg/g fresh leaf) were calculated using the following formula:

Total Chlorophyll: 20.2(A645) + 8.02(A663)

Chlorophyll a: 12.7(A663) – 2.69(A645)
Chlorophyll b: 22.9(A645) – 4.68(A663)

Total Ascorbic Acid Content

A standard calibration curve for ascorbic acid was established by plotting concentrations against the absorbance of ascorbic acid standard solutions. This was achieved by taking 10 ml of each standard solution (ranging from 5 to 25 µg/ml) and adding 1 ml of a $KMnO_4$ solution (100 µg/ml). The solutions were left to stand for 5 minutes, and the absorbance of these standard solutions was read at 530 nm against a blank. Following calibration, 10 ml of each extract sample (1 mg/ml) was placed in a test tube, and 1 ml of the $KMnO_4$ solution (100 µg/ml) was added. After standing for 5 minutes, the absorbance of these solutions was read at 530 nm against a blank using a UV/Visible spectrophotometer (Elgailani *et al.,* 2017).

Air Pollution Tolerance Index (APTI)

The determination of APTI (Air Pollution Tolerance Index) was carried out using the method outlined by Singh and Rao in 1983. The APTI was calculated using the following formula:

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

Where, A = Total ascorbic acid content (mg/g), T = Total chlorophyll (mg/g), P = pH of leaf extract, R = Relative water content of leaf.

Plant species are classified based on their APTI (Air Pollution Tolerance Index) values. Those with APTI values between 30 and 100 are considered tolerant to air pollution, while those with values between 17 and 29 are moderately tolerant. Sensitive plant species typically have APTI values ranging from 1 to 16, and those with APTI values less than 1 are considered highly sensitive to air pollution.

Result and Discussion

Observations of pH, relative water content, total chlorophyll content and total ascorbic acid for determination of APTI of both studied are depicted in table 1.

Table 1: Results of comparative study of APTI

Sample Name	pH of Leaf Extract	Relative Moisture (%)	Total Chlorophyll Content (mg/100 mg)	Total Ascorbic Acid Content (mg/100 mg)	APTI
Leaf 1	6.8	78.41	10.10 (Chlorophyll a- 8.19 and Chlorophyll b- 1.91)	5.651	17.39
Leaf 2	6.5	70.82	4.486 (Chlorophyll a- 4.194 and Chlorophyll b- 0.295)	0.114	07.19
Where, Leaf 1 = Leaf Collected From Unpolluted park, Leaf 2= Leaf Collected From Polluted Road Side					

The pH values were determined to be 6.8 for leaf extracts from an unpolluted park and 6.5 for leaf extracts from a polluted roadside. The relative water content was measured at 78.41% for leaves from the unpolluted park and 70.82% for leaves from the polluted roadside.

In terms of total chlorophyll content, the results showed 10.10 mg/100 mg in leaf extracts from the unpolluted park and 4.486 mg/100 mg in leaf extracts from the polluted roadside. The total ascorbic acid content was found to be 5.651 mg/100 mg for leaves from the unpolluted park and 0.114 mg/100 mg for leaves from the polluted roadside.

In an assessment of the Air Pollution Tolerance Index (APTI), a leaf sample obtained from an unpolluted park displayed a moderate level of tolerance with a value of 17.39. Conversely, a leaf sample collected from a polluted roadside exhibited a lower APTI value of 7.19, signifying the sensitivity of the plant species to air pollution.

Conclusion

In this study, comparative study of air pollution tolerance index (APTI) was calculated for two leaf samples, one sample was obtained from a heavily polluted roadside, while the other was collected from a nearby pristine park. The results of the study demonstrated that the leaves from the unpolluted park exhibited a higher APTI, indicating a moderate tolerance to air pollution, in contrast to the leaves from the polluted roadside, which displayed a lower tolerance, signifying sensitivity to pollution. These findings further underscore the importance of phytochemical composition, including factors such as pH, relative water content, total chlorophyll content, and total ascorbic acid, in determining a plant's tolerance to environmental stressors.

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