



Studies on Air Pollution Tolerance Index of Indoor Plants for Interior Landscaping

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Abstract: The present investigation comprised of assessment of 20 indoor plants for air pollution tolerance index APTI were selected based on various biochemical parameters such as total chlorophyll content, leaf extract pH, relative water content and ascorbic acid content. Maximum relative water content was in *Zamioculcas zamiifolia*, ascorbic acid in *Sansevieria trifasciata*, total chlorophyll content in *Syngonium podophyllum* and leaf extract pH was in *Epipremnum aureum*. Based on APTI index *Zamioculcas zamiifolia*, *Sansevieria trifasciata*, *Epipremnum aureum*, *Diffenbachia camille* and *Aglaonema commutatum* were most effective for indoor air pollution tolerance and can be recommended to be used in indoor landscaping for urban areas.

Keywords: Air pollution tolerance index, Indoor plants, Urban landscape, Indoor pollution, Air quality

Plants have been linked with environment, health and happiness. The importance of indoor air quality to human health has become of increasing interest where people often spend over 85-90% of time in indoor environments, either at the workplace or residential (Marc et al 2018). Indoor plants have recently gained high popularity, especially in the post-Covid era (Han 2020 and Singh 2020). In urban areas, most citizens have long-term exposure to large amounts of harmful chemicals indoors, whether at home or working at the office (Shi et al 2015, Lukcso et al 2016). People are usually exposed to a higher intake or breathe in a greater concentration of air pollutants because these pollutants are more prevalent indoors than outdoors (Zhang et al 2017). According to WHO, indoor air pollution has been among the top 5 risks to public health (WHO 2022). As per a report by IHME, 2.6 million people died in 2016 owing to illnesses attributed to indoor air pollution. The sensitivity and tolerance to pollution in plants depend upon various biochemical parameters like ascorbic acid content, chlorophyll, relative water content and pH. The response of plants to air pollution can be assessed by the air pollution tolerance index which is being used by landscapers in selecting plant species for a particular area in order of their pollution tolerance. The effectiveness of plant species as bio-indicator or tolerance to air pollution depends upon the air pollution tolerance index. The tolerance and sensitivity to air pollutants depend on parameters like chlorophyll content, ascorbic acid content, leaf pH and relative water content. Chlorophyll content decreases due to the production of reactive oxygen species

in the chloroplast under stress. Plants are also initial acceptors of air pollution and act as scavengers (Mahecha et al 2013). Hence, there is a need to screen plants based on APTI for their use as bio-indicators or to determine if they are tolerant to indoor air pollution.

MATERIAL AND METHODS

Area of study: The present investigation was carried out during the years 2021-22 and 2022-23 at the greenhouse complex, at Navsari Agricultural University, Navsari. Geographically, Navsari is situated at the coast of the Arabian Sea at 20° 57' North latitude and 72° 54' East longitude at an altitude of about 11.98 meters above the mean sea level.

Collection of samples: The study was conducted for the evaluation of different indoor plants based on their Air Pollution Tolerance Index. In this experiment, 20 indoor pot plants were grown in a 50 percent shade net house at the greenhouse complex, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture, during the years 2021 and 2022. Indoor plants selected for the present study are given in Table 1. The data on different biochemical parameters were recorded during June and September for two years *i.e.* 2021 and 2022 done. To study various biochemical parameters, leaf samples from the selected 20 indoor plant species were collected and analysed the different standard procedures. The leaf samples were brought to the laboratory in the ice box and washed with ordinary water, then with 0.1 N HCL, followed by distilled water for biochemical analysis.

Biochemical parameters: The ascorbic acid content (mg/g) in the leaves of different plants was estimated by the A.O.A.C. (1980) method. Total chlorophyll content (mg/g) in the leaves of different plants was estimated by using the method given by Hiscox and Israeistam (1979). Determination of pH was done by using a pH meter (Model – ESICO 1013) with a buffer solution of pH 4 and 9 (Barrs and Weatherly 1962). The relative water content (%) of the samples was estimated (Singh 1977). The air pollution tolerance index was determined by using biochemical parameters such as ascorbic acid t, total chlorophyll ct, relative water, and leaf extract of pH parameters through the following formula.

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

Where,

A = Ascorbic acid content (mg/g), T = Total chlorophyll content (mg/g)

R = Relative water content (%). P = Leaf extract of pH

Statistical analysis: All the data were analysed statistically using the OPSTAT software.

RESULTS AND DISCUSSION

Significant variation in biochemical parameters and air

pollution tolerance index of selected 20 indoor plant species was observed (Table 2).

Relative water content (%): The maximum relative water content (%) was in *Zamioculcas zamiifolia* followed by *Aglaonema commutatum*, *Sansevieria trifasciata* and *Diefenbachia camille*. There was a variation in relative water content in different plant species, which may be due to their different genetic makeup. Higher relative water content in *Zamioculcas zamiifolia*, *Aglaonema commutatum* and *Sansevieria trifasciata* may have favoured plants' resistance to stress conditions. Tsega and Deviprasad (2014) and Ogunkunle et al (2015) observed higher water content in plants under stress conditions such as air pollution.

Ascorbic acid (mg/g) content: *Sansevieria trifasciata* showed maximum ascorbic acid (mg/g) content followed by *Zamioculcas zamiifolia* and *Epipremnum aureum*. The variation in ascorbic acid content in different plant species may be due to their different genetic makeup (Chen et al 2004). Further, the increase in the level of ascorbic acid may result owing to the respective plant defence mechanism as suggested by (Cheng et al 2007). Stress conditions have been indicated to trigger plant defence mechanisms by increasing ascorbic acid levels in plants (Yannawar and Bhosle 2013).

Total chlorophyll (mg/g) content: *Syngonium podophyllum*

Table 1. Morphological characters of selected indoor plant species

Plant species	Common name	Family	Habit
<i>Aglaonema commutatum</i>	Chinese evergreens	Araceae	Evergreen herbaceous perennial shrub
<i>Anthurium andraeanum</i>	Flamingo flower plant	Araceae	Flowering potted plant
<i>Begonia rex 'Cultorum'</i>	Wax Begonia	Begoniaceae	Flowering potted plant
<i>Chlorophytum comosum</i>	Spider ivy	Asparagaceae	Succulents
<i>Dieffenbachia camille</i>	Dumb cane	Araceae	Evergreen herbaceous perennial pot plant
<i>Dracaena reflexa</i>	Song of india	Asparagaceae	Succulent shrub
<i>Epipremnum aureum</i>	Money plant	Araceae	Climber
<i>Howarthia fasciata</i>	Little zebra plant	Asphodelaceae	Succulents
<i>Nephrolepis exaltata</i>	Sword fern	Nephrolepidaceae	Fern
<i>Peperomia obtusifolia</i>	Baby rubber plant	Piperaceae	Succulents
<i>Peperomia 'Scandens Green'</i>	Cupid peperomia	Piperaceae	Succulents
<i>Philodendron erubescens</i>	Red leaf philodendron	Araceae	Evergreen herbaceous perennial climber
<i>Philodendron 'Golden Goddess'</i>	Lemon lime philodendron	Araceae	Evergreen herbaceous perennial climber
<i>Portulacaria afra</i>	Elephant bush	Didiereaceae	Succulents
<i>Rhapis excelsa</i>	Broad leaf lady palm	Arecaceae	Palm
<i>Sansevieria trifasciata</i>	Snake plant	Asparagaceae	Succulents
<i>Sansevieria masoniana</i>	Mason's congo	Asparagaceae	Succulents
<i>Spathiphyllum wallisii</i>	Peace lily	Araceae	Herbaceous perennial indoor plant
<i>Syngonium podophyllum</i>	Arrowhead plant	Araceae	Climber
<i>Zamioculcas zamiifolia</i>	ZZ plant	Araceae	Succulents

Table 2. Biochemical parameters and APTI index of selected indoor plant species (Pooled data of 2021-2022)

Genotype	RWC (%)			Ascorbic acid content (mg/g)			Total chlorophyll (mg/g) content			Leaf extract pH			Air pollution tolerance index (APTI)		
<i>Aglaonema commutatum</i>	94.54			0.79			0.65			6.83			10.10		
<i>Anthurium andraeanum</i>	86.57			0.21			0.23			6.64			8.78		
<i>Begonia rex 'Cultorum'</i>	86.80			0.22			0.46			2.51			8.75		
<i>Chlorophytum comosum</i>	91.58			0.22			0.76			7.78			9.32		
<i>Dieffenbachia Camille</i>	94.24			0.79			0.59			7.41			10.12		
<i>Dracaena reflexa</i>	90.12			0.20			0.65			7.33			9.16		
<i>Epipremnum aureum</i>	92.39			0.80			0.69			7.83			10.14		
<i>Howarthia fasciata</i>	85.91			0.22			0.24			5.72			8.72		
<i>Nephrolepis exaltata</i>	90.09			0.29			0.59			7.06			9.23		
<i>Peperomia obtusifolia</i>	86.14			0.28			0.41			7.33			8.84		
<i>Peperomia 'Scandens Green'</i>	89.03			0.24			0.63			6.71			9.06		
<i>Philodendron erubescens</i>	85.32			0.25			0.12			6.61			8.69		
<i>Philodendron 'Golden Goddess'</i>	88.84			0.33			0.48			6.69			9.10		
<i>Portulacaria afra</i>	87.96			0.28			0.11			4.46			8.91		
<i>Rhapis excelsa</i>	86.93			0.57			0.78			5.11			9.03		
<i>Sansevieria trifasciata</i>	94.53			0.83			0.64			6.63			10.18		
<i>Sansevieria masoniana</i>	89.29			0.31			0.17			5.80			9.10		
<i>Spathiphyllum wallisii</i>	87.16			0.24			0.73			6.34			8.87		
<i>Syngonium podophyllum</i>	89.33			0.20			0.84			6.78			9.08		
<i>Zamioculcas zamiifolia</i>	95.08			0.80			0.70			7.45			10.21		
Mean	89.59			0.40			0.52			6.45			9.27		
	G	Y	G×Y	G	Y	G×Y	G	Y	G×Y	G	Y	G×Y	G	Y	G×Y
CD (p=0.05)	0.58	0.16	1.10	0.034	0.014	0.041	0.02	0.01	0.03	0.11	0.04	0.16	0.10	0.04	0.17

showed maximum total chlorophyll content followed by *Rhapis excelsa*. These plants having more total chlorophyll content acts an indicator of tolerance against air pollution (Chandawat et al 2014). Begum and Harikrishna (2010) also reported that chlorophyll content varies from species to species, as well as other biotic and abiotic conditions.

Leaf extract pH: Among selected 20 indoor plant species, the maximum leaf extract pH was in *Epipremnum aureum* followed by *Chlorophytum comosum*. The pH of the leaf extract serves as an air pollution sensitivity indicator. Plants having low pH are known to be more sensitive while those having around 7 or more pH are more tolerant against air pollution (Chauhan et al., 2012, Kumar and Nandini 2013). High pH can increase conversion efficiency from hexose sugar to ascorbic acid, whereas low leaf extract pH has shown a strong correlation with air pollution sensitivity (Escobedo et al 2008, Pasqualini et al 2011).

Air pollution tolerance index (APTI): The maximum APTI was in *Zamioculcas zamiifolia*, which was statistically at par with *Sansevieria trifasciata* followed by *Epipremnum aureum*, *Dieffenbachia camille* and *Aglaonema commutatum*.

APTI is inter-relation of different plant species to different biochemical parameters viz. ascorbic acid content, chlorophyll content, water content and leaf extract pH. Thus, high APTI in *Zamioculcas zamiifolia*, *Sansevieria trifasciata*, *Epipremnum aureum*, *Dieffenbachia camille* and *Aglaonema commutatum* could be a result of higher water content and ascorbic acid content. The effectiveness of plant species as bio-indicator or tolerance to air pollution depends upon the air pollution tolerance index (APTI). APTI index is the capability of plants to survive against air pollution and helps to determine the tolerance and sensitivity of plants against air pollution. APTI in plants among different species is influenced by chlorophyll content, ascorbic acid, relative water content and leaf extract pH as variation in air pollution tolerances varying from species to species and region earlier observed in indoor plants (Gholami et al 2016, Kumar et al 2022).

CONCLUSIONS

Indoor plants are capable of mitigating indoor air pollution is clearly identified in the study. The indoor plant's species

viz., *Zamioculcas zamiifolia*, *Sansevieria trifasciata*, *Epipremnum aureum*, *Diffenbachia camille* and *Aglaonema commutatum* have high APTI index and are found to be capable to combat against indoor air pollution. The indoor plant species having higher APTI index have more chances of survival and growth in the indoor polluted area. *Zamioculcas zamiifolia*, *Sansevieria trifasciata*, *Epipremnum aureum*, *Diffenbachia camille* and *Aglaonema commutatum* were the best indoor plants to tolerate indoor air pollution and can be suggested for the urban area having high pollution levels in indoor environmental conditions such as residential areas, offices, banks or shopping malls.

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