Explorer Research Article [Sanghi *et al.*, 6(1): Jan., 2015:4157-4160]
CODEN (USA): IJPLCP ISSN: 0976-7126

INTERNATIONAL JOURNAL OF PHARMACY & LIFE SCIENCES
(Int. J. of Pharm. Life Sci.)

Comparison of APTI Values of Some Medicinal Plants of Industrial Areas and Ratapani Wild Life Sanctuary in Raisen District of Madhya Pradesh

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Abstract

Today's growing population and increasing urbanization has resulted in a sudden increase in air pollution. Because of the detrimental effects of air pollution on humans, animals and plants, the ever increasing air pollution is causing concerns all over the world. Plants seem to be more sensitive to air pollution than animals including man. Various types of plants, being stationary and outdoor, are constantly exposed to air pollutants in the environment, where these plants absorb, integrate and accumulate pollutants on their foliar surface that leads to loss of vegetation and long lasting irreversible changes in ecosystem. The response of different plant species to these pollutants varies considerably. Some of the plants act as sinks for the abatement of air pollution in urban and industrial habitats. Since different plant species vary considerably in their susceptibility to air pollutants, it becomes important to screen plants for their sensitivity/tolerance levels. The present study is therefore based upon the evaluation of the susceptibility level of plants to air pollutants. Four parameters, viz. ascorbic acid (A.A), total chlorophyll (TCh), relative water content (RWC) and leaf extract pH were determined and combined together in a formulation signifying the Air Pollution Tolerance Index (APTI) of plants. APTI values of 7 plant species growing in industrial areas and Ratapani Wildlife Sanctuary were calculated. The APTT values of plants (*Abrus precatorius* L., *Gloriosa superba* L., *Tinospora cordifolia* Hook.) were higher than evergreen plants (*Achyranthes aspera* L., *Acorus calamus* L., *Andographis paniculata* L., *Phyllanthus niruri* L.), suggesting that plants have more capability to tolerate the high pollution level. Also the same plant species growing in different areas showed variations in APTI values. In general, the plants growing in industrial areas had higher APTI values followed by the areas of Ratanpani Wild life Sanctuary. This indicates that exposure to pollutant gases induces increase in the parameter values responsible for higher APTI.

Key-Words: Medicinal Plants, APTI, Wild Life Sanctuary, Madhya Pradesh

Introduction

Air pollution is certainly not a new phenomenon. Air pollution is a major problem arising mainly from industrialization (Odilara, *et al*,. 2006). Air pollutions can directly affect plants via leaves or indirectly via soil acidification (Steubing, *et al*, .1989). Various types of plants are constantly exposed to air pollutants in the environment, where these plants absorb, integrate and accumulate pollutants on their foliar surface. The result of these interactions is extensive loss of vegetation and irreversible changes in the ecosystem which may be long lasting. Air pollution is one of the severe problems that deteriorates ecological conditions and can be defined as the fluctuation in any atmospheric constituent from the value that would have existed without human activity.

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The response of different plant species to these pollutants varies considerably. Some of the plants are sensitive and others tolerant. Some sensitive species are quick to show injury symptoms when exposed to air pollutants. These species are fit to be designated as air pollution detectives or indicators. Bioaccumulator species accumulate polluting compounds even if the air is polluted temporarily or has such low concentrations that the detection of pollutants in the air is difficult. Hence, these plants can be used as an early warning indicator for particular pollutants. Studies have also shown the impacts of air pollution on Ascorbic acid content (Hoque,, *et al.*, 2007), chlorophyll content (Flowers *et al.*, 2007), leaf extract pH (Klumpp *et al.*, 2000) and relative water content (Rao, 2006). However, the air pollution tolerance index (APTI) is a simple and useful index based on the values of four different biochemical parameters i.e. ascorbic acid , leaf extract pH, total chlorophyll and relative water contents, that have been used for identifying tolerance levels of plant species (Singh and Rao, 1991; Yan-Ju and Ding, 2007).

In the present study, species tolerant and sensitive to air pollution have been identified with respect to the above mentioned four biochemical parameters. Main objectives of the study were as follows:-

- To detect the common plants for their tolerance level of air pollutants in Raisen District.
- To detect the sensitive species and tolerant species of plants which can be recommended for use as bioindicators and pollutant sink respectively for air pollutants in polluted areas of Raisen District.
- To study any change in APTI of selected species in response to pollution.

Material and Methods

Study area

The study area was Raisen District. The minimum temperature in winter is down to 5^o C and maximum temperature in summer goes up to 48^o C.

For carrying out the APTI studies, fresh leaves from different plant species were collected from two different areas:

Industrial areas and Wild life Sanctuary which is located in the South-Western part of the Raisen District. The areas selected are between 77^0 31' 32'' and 78^0 4' 3'' east longitude and between 23^0 6' 17'' and 22^0 49' 47'' North latitudes.

Sampling techniques

Following steps were taken during sampling:

1. Plants selected for sampling were mostly common species which are available all over Raisen District.
2. The samples were collected in morning between 7:30-9:00 a.m. because during day time the parameters get altered. Main change occurs in *relative* water content of plants.
3. The height of plants from which the samples were taken was 2-5 ft.
4. Samples were taken both from shaded areas and illuminated areas.
5. Just after sampling, fresh weight was taken and all the samples were enclosed in plastic packets.
6. These plant samples were analyzed within 3-4 hours of sampling.

Determination of Ascorbic Acid

Ascorbic acid is a strong reductant and high amounts of this substance favours pollution tolerance in plants (Keller and Schwager. 1977; Lee et al., 1984).The level of this acid decline on pollution exposure (Keller and Schwager, 1977) was studied. Plants maintaining high ascorbic acid, even under polluted conditions are considered to be tolerant to air pollutants. Ascorbic acid of fresh leaves from plant species was analyzed using a method based upon the reduction of 2, 6-dichlorophenolindophenol (Keller and Schwager, 1977).

Determination of Total Chlorophyll

Chlorophyll level in plants decreases under pollution stress (Spedding and Thomas, 1973). Bell and Mudd (1976) suggested that tolerance of plants to SO_2 might be liquefied with synthesis or degradation of chlorophyll. Thus plants having high chlorophyll content under field conditions are generally tolerant to air pollutants. Total chlorophyll is determined according to the method described by Arnon, (1949).

Determination of Relative Water Content

Relative water content (RWC) is associated with protoplasmic permeability of leaves (Oleinikova, 1969). Leaf relative water content was determined and calculated by Singh, 1997.

Determination of Leaf-Extract pH

Higher level of leaf extract pH in plants under polluted conditions may increase their tolerance level to air pollutants. So, decline in pH is greater in sensitive than that in tolerant plant species (Scholz and Reak, 1977). pH was determined by the method given by Agarwal, *et al.*, (1991).

Determination of Air Pollution Tolerance Index (APTI) of Plants

The APTI was determined by using the formula developed by Singh and Rao (1983) and Kousar, *et al*., (1988).

Results and Discussion

The present study highlights the results obtained from the analysis of plant leaves of various species for determining APTI. The values of ascorbic acid (mg/g), total chlorophyll (mg/g), leaf extract pH and relative water content (Percent) are studied. From these parameters, the APTI value of these plant species has been calculated. Based upon these values of Air Pollution Tolerance Index (APTI), the plant species are categorized by the way of showing response i.e. More Sensitive (MS), Sensitive (S), Intermediate (I) and Tolerant (T).

Out of the 7 species which were studied from the industrial area for their Air Pollution Tolerance Index (APTI), 3 species were found to be tolerant. The maximum APTI value was found in *Gloriosa superba*. The main contributing factor towards this high APTI value is high value of Ascorbic acid and chlorophyll content.

Out of the same 7 species, which were studied from residential areas for their Air Pollution Tolerance Index (APTI), a total of 45% species were found to be sensitive/intermediate and 7 species were of tolerant category. The APTI values ranged from 8.28-24.86. The lowest values were of *Achyranthes aspera* and *Acrous calamus*, which means that their species was found to be more sensitive to pollutants in Ratanpani Wildlife Sanctuary area. The lower value of APTI was due to less Ascorbic acid content in these species.

In the arid climatic conditions, the dust deposition interference with photosynthesis in plant leaves and reduced relative water content, both play a significant role in determining their sensitivity towards air pollution. Both these conditions increase the sensitivity of plant species towards air pollution and make them more sensitive.

According to these observations, the species having lower APTI values (more sensitive) can be recommended for use as bioindicators. In general, the plants growing in industrial areas have higher APTI than those in Ratanpani Wildlife Sanctuary in Raisen District. This clearly indicates that exposure to pollutant gases induce in parameter value for higher APTI.

Conclusion

Plant e.g. *Abrus precatorius* L., *Gloriosa superba* L., *Tinospora cordifolia* Hook are examples of plants with higher APTI and suitable for growing as green belt around industrial areas and road sides. APTT values may increase in plants through acclimatization or continuous exposure to pollutant gases.

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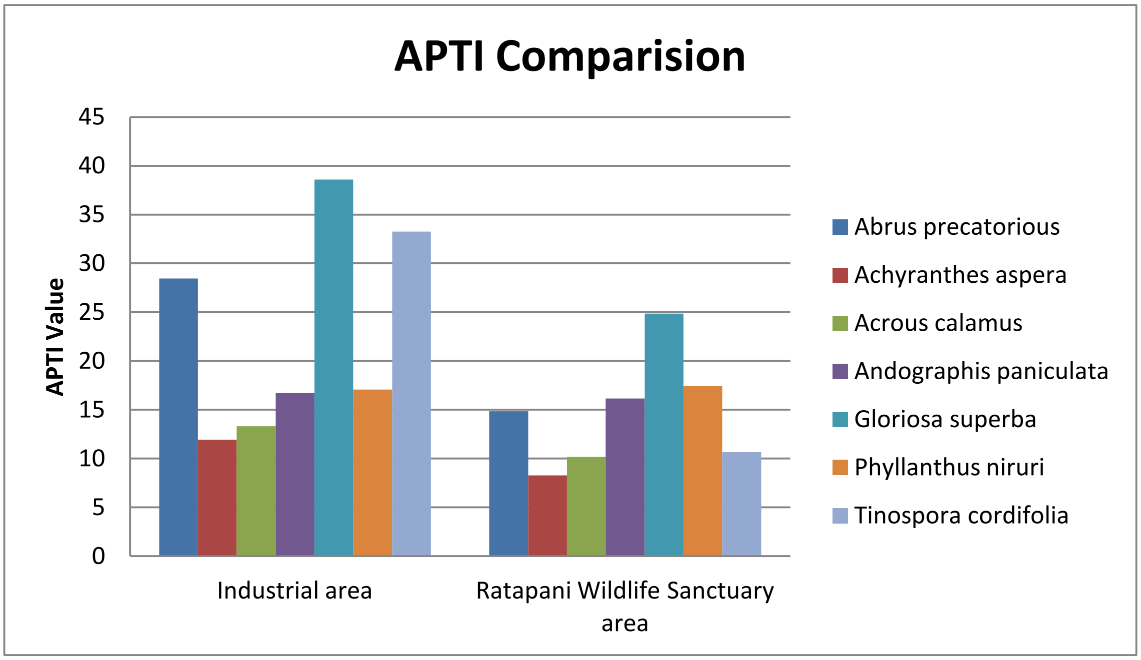
Table: 1 APTI of Plant Species from Industrial Area and Ratanpani Wildlife Sanctuary in Raisen District

Sr.	Name of Plant Species	APTI of Industrial area	APTI of Ratapani Wildlife Sanctuary area
1	*Abrus precatorious*	28.4385	14.8318
2	*Achyranthes aspera*	11.9248	8.2745
3	*Acrous calamus*	13.3068	10.1836
4	*Andographis paniculata*	16.7196	16.145
5	*Gloriosa superba*	38.5685	24.86
6	*Phyllanthus niruri*	17.056	17.4354
7	*Tinospora cordifolia*	33.2577	10.646



How to cite this article

Sanghi S.B., Sharma C. and Sanghi S.K. (2015). Comparison of APTI Values of Some Medicinal Plants of Industrial Areas and Ratapani Wild Life Sanctuary in Raisen District of Madhya Pradesh. *Int. J. Pharm. Life Sci.*, 6(1):4157-4160.

Source of Support: Nil; Conflict of Interest: None declared

Received: 01.12.14; Revised: 14.12.14; Accepted:08.01.15