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ROLE OF TOTAL PHENOL IN THE RESISTANCE MECHANISM OF PLANTS AGAINST AIR POLLUTION

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ABSTRACT

Phenols are secondary metabolites, an important chemical constituent of plants. Phenolics are chemically diverse group of substances having various functions in plants. Nowadays air pollution has become a hot topic of research and discussion due to its global effects. Increased population, Industrialization, deforestation, dependency on automobiles all these factors act as cause of air pollution. They act in a synergistic manner to befoul the sanctity of natural environment. In the present paper, effect of air pollution on total phenol content in plants was estimated. Five common roadside plant species growing at the cross-roads of Ahmedabad city namely *Ficus benghalensis, F. religiosa, F. glomerata, Azadirachta. indica and Polyalthia longifolia* were selected for the study. Higher concentration of phenols in the leaves of plants, growing in polluted site compared to those growing in low polluted site was observed.

Key words : Phenol, Air pollution, Plants. Resistance mechanism. .

INTRODUCTION

Ahmedabad, a mega city of Gujarat, is continuously losing its grace and beauty under the growing pressure of densification of activities (Singh, 2004). Air is being continuously polluted by heavy traffic, industry, domestic fuel combustion; coal based thermal power plants and various agricultural activities from the adjoining areas. Trees are the major assets of the city working 24 hours every day for all of us to improve our environment and quality of life. They play an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide, {reg}oxygen and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the air environment (Escobedo *et al.,* 2008). Some plant species are more sensitive and act as biological indicators of air pollution. When exposed to airborne pollutants, most plants experienced physiological changes before exhibiting visible damage to leaves (Liu and Ding, 2008). Phenolics are chemically diverse group of substances having various functions in plants such as protection against herbivores, pathogens, ultraviolent radiation and for many other functions. Some authors have pointed out that phenolics are often stored at strategically important sites where they play a signalling role and often a direct role, in defence.

Table1: Description of sites selected

	Name of the site	Location in the city	Characteristics of site
Site-1	Power house	Northern region	Coal based thermal power emission region, light and heavy vehicles, vehicle density is less.
Site-2	Paldi	Western region	Heavy and light vehicles, frequent traffic congestion, vehicle density is more.
Site-3	Lal-darwaja	Central region	Market area, frequent congestion, traffic congestion, light vehicles density is more.
Site-4	S.T bus stand	Central region	Heavy and light vehicles, frequent traffic congestion, vehicle density is more.
Site-5	Naroda	Northeastern region	Industrial area, Heavy and light vehicles, density is more.
Site-6	Railway station	Central region	Railway tract, light vehicles, vehicle density is more.
Site-7	Residential area	Northern region	Light vehicles, no traffic congestion, vehicle density is less, open area.
Site-8	Control	Western region	Light vehicles, low- polluted area, open area.

In the present study phenol content was estimated in some common plants available at different cross-roads of Ahmadabad city.

MATERIALS AND METHODS

Description Of Sites Selected For Study:
Ahmedabad is located at 23° N and 72.58° E. The city spans an area of 205 sq km and population of over 6million. The air is being continuously polluted in urban areas through heavy traffic, industry, domestic fuel combustion; coal based thermal power plants and various agricultural activities from the adjoining areas. Table-1 gives the brief description of sites selected for the present study.

Parameter and Sampling:
At the height of two to three meters, fully expanded mature leaves were collected from each plant in the polythene bags and transported to the laboratory. The leaf samples were collected on seasonal basis and this frequency was strictly maintained throughout the year (November 2009 to October 2010).

Investigation of Total Phenol was carried out in five plants (*Ficus religiosa, Ficus benghalensis, Ficus glomerata, Azadirachta indica* and *Polyalthia longifolia)* by using the method given by Bray et al, 1954.

Measurment of Total Phenol:
100mg plant material was weighed and homogenate with 10 ml 80% ethanol. It was centrifuged at 5000-10,000 rpm for 10 minutes. Supernatant 1 was collected; while 10 ml 80% ethanol was added again to the residue, centrifuge it and supernatant 2 was mixed with supernatant 1 and used for estimation. Residue was discarded.1ml alcoholic aliquot was mixed with 1ml 20% Na_2CO_3 and 0.5 ml Folin-Ciocalteau's reagent. It was boiled for 10minutes at 100^0C in water bath. Final volume was made up to 20 ml with DW and O.D. was noted at 660 nm. PPT were filtered or centrifuged before reading. Blank was prepared in the same manner.

The result was expressed as mg/gm plant material.

RESULTS

The content of phenol, present in the leaves of all the five plants under study, growing in all the areas, has been presented in figure-1a-e.The present study showed significant variations of phenol content from species to species, station to

station and season to season in the plants exposed to different polluted sites.

F. religiosa:

The composition of phenol in the leaves of *F. religiosa* growing at all the sites has been shown in the fig-2a. As compared to the control area and low polluted area, at all the sites phenol, increased significantly, in different seasons. Phenol content was maximum at all the sites in winter season except at site-3 (Lal darwaja) where it was recorded to be maximum in summer. While minimum phenol content was found in rainy season except at site-3 (Lal darwaja) were it was minimum at winter. Overall maximum phenol content was observed at site-5 (Naroda, 1.031mg/g) and minimum at site-7 (Residential area, 0.379mg/g).

F. benghalensis:

The content of phenol in the leaves of *F. benghalensis* growing at all the sites has been shown in the fig (2b). As compared to the control area and low polluted area, at all the sites phenol content was higher. Phenol content was highest at all the sites in summer season and lowest in rainy season. But, this pattern was not observed at site-7 and 5 (Residential area and Naroda). It has been found that in Residential area it is maximum in winter and minimum in rainy. While, at Naroda it is maximum at summer but minimum in winter. Overall maximum amount of phenol was found in summer at site-5 (Naroda, 2.154mg/g) and minimum at site-8 (control, 0.40mg/g).

F. glomerata:

Fig: 1a) Phenol in the leaves of *F. Religiosa*

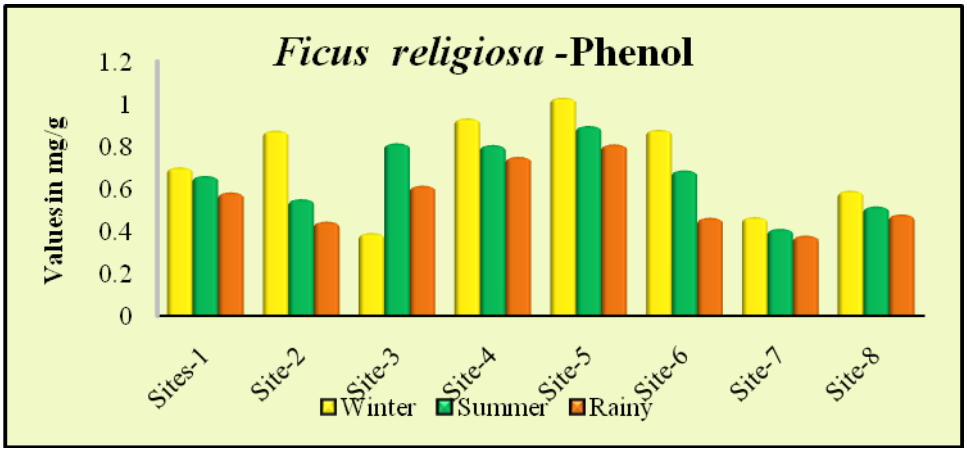


Fig: 1b) Phenol in the leaves of *F. Benghalensis*

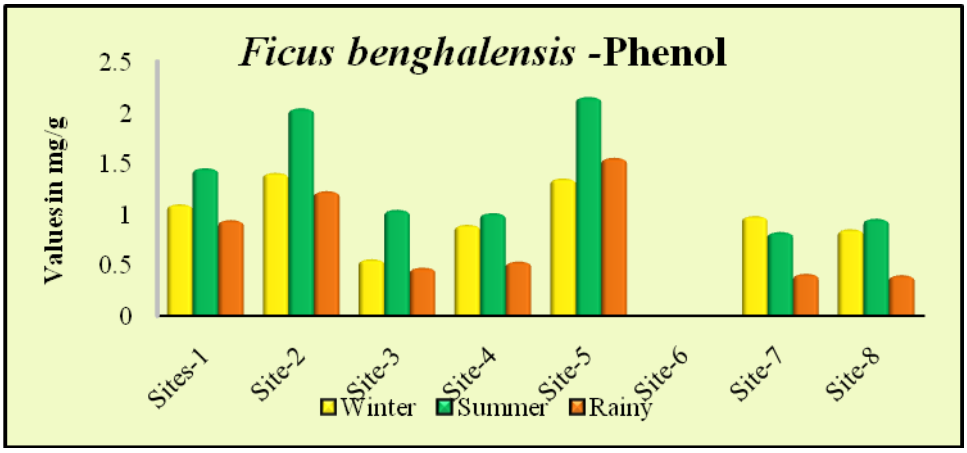


Fig: 1c) Phenol in the leaves of *F. glomerata*

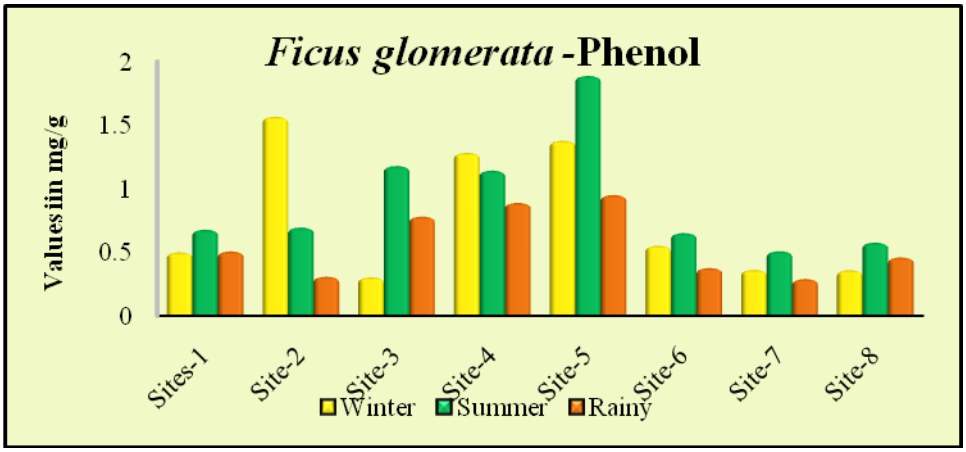


Fig: 1d) Phenol in the leaves of *A. Indica*

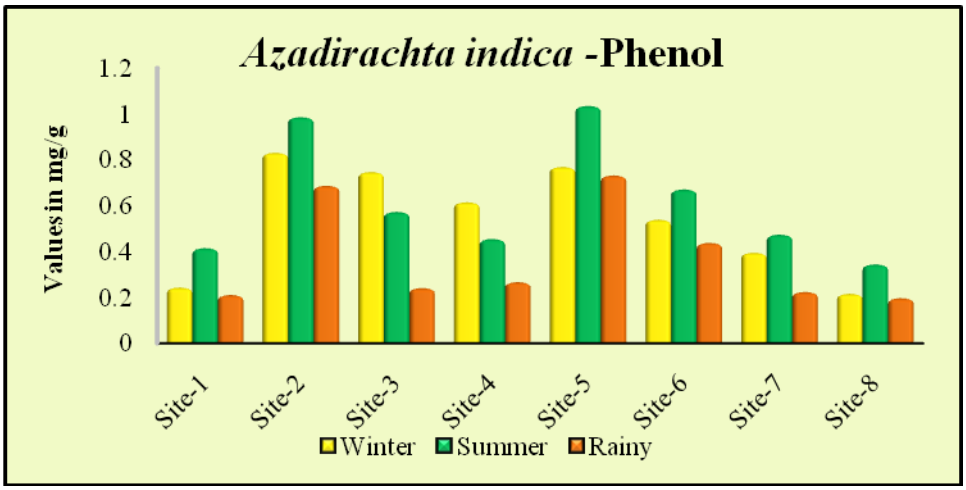
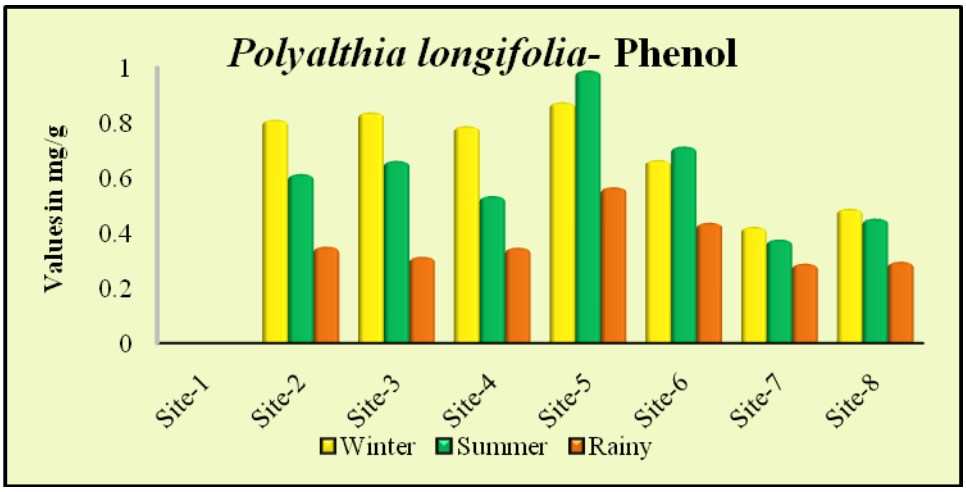


Fig: 1e) Phenol in the leaves of *P. Longifolia*



Site1-Powerhouse Site2-Paldi Site3- Laldarwaja Site4-STbusstand
Site5-Naroda Site6-Railway station Site7- Residential area Site8-Control.

The content of phenol in the leaves of *F .glomerata* growing at all the sites has been shown in the fig (2c). As compared to the control area and low polluted area, at all the sites phenol, increases, in different seasons.

Maximum phenol content was found in summer season at all the sites except at site-2 and 4 (Paldi and S.T) where it was maximum in winter season. At site 2, 4, 5, 6 and 7 (Paldi, S.T. bus stand, Naroda and Residential area) minimum content was found in rainy season. At site-3 and 8 (Lal darwaja and Control) minimum content of phenol was found in winter while at site-1 (Power house) no significant difference was found between winter and monsoon. Maximum phenol was observed at site-5 (Naroda, 1.889mg/g) and minimum at site-7 (Residential area, 0.289mg/g).

A. indica:

The content of phenol in the leaves of *A. indica* growing at all the sites has been shown in the fig (2d). As compared to the control area and low polluted area, at all the sites phenol, increased significantly, in different seasons. Phenol content was highest at all the sites in summer season except at site-3 and 4 (Lal darwaja and S.T) where it was higher at winter. At site-8 (Control area) no significant change was observed in winter and rainy season. Minimum phenol content was found in rainy season at all the sites. Overall maximum phenol was observed at site-5 (Naroda, 1.035mg/g) and minimum at site-8 (Control, 0.197mg/g).

P. longifolia:

The composition of phenol in the leaves of *P. longifolia* growing at all the sites has been shown in the fig (2e). As compared to the control area and low polluted area, at all the sites phenol, increased significantly, in different seasons. Phenol content was highest in winter season at all the sites except at site- 5 and6 (Naroda and Railway station) where it was maximum in summer season. Minimum content of phenol was obtained in monsoon at all the sites. Maximum phenol was observed at site-5 (Naroda, 0.992mg/g) and minimum atsite-7 (Residential area, 0.289mg/g).

DISCUSSION

During the course of ontogenesis, plants are subjected to different kinds of stress factors, such as drought, heat, herbivore/pathogen attack and air pollution (Paliyath et al. 1997). Most plants suffer from physiological and biochemical damage due to the exposure to temperatures higher or lower than optimal for growth (Grace et al. 1998). Although, the general role of phenolic compounds in plant physiology and allelopathy has been known for many years, a less well reported aspect is their activity as defence factors against various types of stresses caused by pathogens or adverse environmental conditions (Treutter, 2001).

In the present study higher concentration of phenols in the leaves of plants, growing in polluted site compared to those growing in low polluted site was observed. Increase of phenol content at polluted region can be consider as a resistance mechanism adopted by plants to protect themselves against stress caused by air pollutants. Air pollution can induce qualitative and quantitative changes in secondary metabolite composition (Zobel, 1996; Kanoun et al., 2001; Lopanen et al., 2001). According to Howell, (1974) accumulation of phenolics in leaves may reduce carbon fixation and ATP synthesis, and may stimulate the respiration and disintegration of chloroplasts.

An increase of the phenolic compound level has also been observed after the exposure of plants to several toxic pollutants by Giertych et. al, 1999. Rai et. al, 2007 have also reported significant increase in the total phenolic contents in wheat (*Triticum aestivum* L.) under air pollution stress. Gaseous pollutants like SO_2, NO_2, and other toxic particulate matter, enter inside the cell through stomatal pore or block the stomatal pore and alter the gaseous exchange, which ultimately disturbs the physiological activities. Increase of higher phenols in the leaves may be an adaptation to avoid the adverse effect of air pollution.

Air pollution influences the accumulation of phenolic contents in the leaves. This has also

been reported by Koukol and Dugger (1967), Menser and Chaplin (1969), Howell et al., (1971, 1974), Howell and krimmer (1973), Tomlinson and Rich (1973), Agrawal et al.,(1982), Pasqualini et al., (2003), and Pawar et al. (2010).

Harbowy & Balentine, (1997) had shown that the biosynthesis of phenolic compounds can be effectively induced by sunlight. Similar conclusion that climatic changes like high temperature stress promote production of phenolic compounds was also made by Christie et al. 1994, Dixon and Paiva 1995, Sıvacı and Sökmen 2004. In the present investigation also higher concentration of phenol during summer season was obtained at many sites in *F. benghalensis, F. glomerata* and *A. indica* might be due to air pollution as well as temperature stress. While, in *F. religiosa* and *P. longifolia* results are not in favour of the above said reason.

CONCULSION

From the above study it can be concluded that phenol plays an important role in the resistance mechanism of plants against air pollution. But as phenolic compounds are found throughout the plant kingdom and the type of compound present varies still more is research required in the field.

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