TREE LEAVES AS BIO INDICATORS FOR MONITORING ATMOSPHERIC HEAVY METALS IN KANCHIPURAM TOWN

R. Sumathi^{1,✉} and G. Sriram²

^{1,*}Department of Civil & Structural Engineering,
Sri ChandrasekharendraSaraswathiViswaMahaVidyalaya, Enathur, Kanchipuram - 631561,
(Tamilnadu) India

²Department of Mechanical Engineering,
Sri ChandrasekharendraSaraswathiViswaMahaVidyalaya, Enathur, Kanchipuram - 631561,
(Tamilnadu) India

✉Corresponding Author: sumathiram72@gmail.com

ABSTRACT

Environmental pollution from heavy metals has tremendously increased across the world. The sudden expansion of industrial activities and rapid growth in population lead to the increased concentration of pollutants in the Kanchipuram town, hence it is very essential to monitor their concentration in the ambient air. Tree leaves have been used as a feasible tool to measure and observe the heavy metals level in this region. In this research, selected tree leaves were sampled from the different locations of the town and heavy metal such as Iron, Lead, Copper, Zinc, Aluminum, Cadmium, Arsenic, Chromium and Manganese deposited on them were analyzed by Inductively coupled plasma mass spectrometry. Among nine metals selected for the analysis Iron and Aluminum were in higher concentration in all the selected sites from all the samples and Copper, Zinc, Manganese were in lowest concentration in some of the samples collected from a few sites. Lead, Cadmium, Chromium and Arsenic were not identified in any samples collected at all sites. This experimental analysis clearly indicated that the absorption capacity of heavy metals differs from species to species and with sampling locations. The emission of heavy metals was from various man made activities and it should be controlled by stringent rules and regulatory measures. Hence this study proved the tree species chosen should acted as an effective tool for Iron, Aluminum and Manganese in the ambience environment.

Key-words: Correlation, Heavy Metals, *Syzigum cumini*, *Ficus Religiosa*, *Pongamia Glabra*, Accumulation

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INTRODUCTION

Air Pollution is one of the global issues which poses a severe threat to the environment. It affects the social, economic and the human community. The explosive growth of population and increased industrial activities were the main causes for environmental pollution.^{1,2} The role of vehicular emissions, combustion of fossil fuels and rapid growth of urbanization deteriorate the quality of air and it has been well documented.^{3,4} Out of various components of air pollutants, heavy metals form an important group due to its toxicity.⁵ Most of the increased industrial and human activities increasing the level of heavy metals in the environment.⁶ The quality of air, water, soil, activities of microorganisms, plant growth etc., are severely affected by the increasing level of heavy metals concentrations.^{7,8} When the heavy metals density goes beyond their limits they are called as silent killer otherwise simply they are known as toxic metals.⁹ Hence the analysis of heavy metals in the air is of greater importance to regulate and maintain the better quality of environment in the cities and towns.

The necessary steps were required to monitor the environment. Monitoring by equipment is expensive, possible for limited areas, required skilled labor and supervision. These difficulties are overcome by bio monitoring using plants which are inexpensive, distributed widely and available in all areas.^{10,11} Bio indicators are used for monitoring the environmental health in a best way and different varieties of higher plants acts as bio indicators.^{12,13, 14} The rate of accumulation, distribution and deposition of heavy metals and gaseous pollutants were easily determined by the use of biological indicators.¹⁵ Lower types of plants such as lichens and mosses were widely used for monitoring heavy metals due to its greater accumulation rate.

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Now a day higher vascular plants are used highly as an indicator by reason of the lower plants are very rare species, difficult to transport and not suitable for a higher degree of pollution in urban areas.¹⁶ Plants are used to reduce or remove the toxic pollutants from the ambient air mainly in urban and suburban areas. Airborne particulates in the environment are reduced by the plants using intercepting mechanism. The degree of reception and adsorption capacity differs from species to species without showing any identifiable effects.¹⁷

The intention of this present work is to examine the concentrations of heavy metals in the air such as Iron, Lead, Copper, Zinc, Aluminum, Cadmium, Arsenic, Chromium and Manganese in the Kanchipuram town. Therefore, three different types of plant species such as *SyzigumCumini*, *FicusReligiosa* and *PongamiaGlabra* were selected as bio indicators for trace metals. The samples were collected from various places in Kanchipuram town and the analysis of trace metals were carried out by Inductively coupled Mass spectrometry.

EXPERIMENTAL

Material and Methods

Species

Syzigum cumini is the evergreen tree growing up to a height of 30m and has a life of more than 100 years. All parts of these plants are used as medicinal values. This tree is planted on the roadside and provides shadow and attracting birds and butterflies. The fruit of the plant is called as fruits of the God(Fig.-1).

Ficus Religiosa is a semi evergreen dry season deciduous and grown up to a height of 30m. It is a perennial tree planted on road sides and place for the birds and bats. This plant is used for medicinal purpose and worshipped by the religious people. (Fig. -1)

Pongamia Glabra is the evergreen tree and easily growing up to a height of 12m. These plants are grown on roadsides and in parks. These trees provide shade and the oil taken from this will be converted into biodiesel(Fig.-1).

Study Area

Kanchipuram, the city of thousand temples is one of the Historical places of Tamil Nadu and it is very famous for silk weaving hence called as silk city. It is situated on Palar River and 72Km from Chennai, the capital of TamilNadu. This city covers an area of 11.61Km². It lies between 77° 28' to 78° 50' longitudes and 11° 00' to 12° 00' latitudes. The population of the town is 1, 64,265 as per the census taken in 2011 but now days it is getting increased due to various industries established in and around this place and also very nearer to Chennai. Traffic density is also getting increased due to various famous and historical temples. All these factors lead to increase the pollution in this town area.

Syzigum cumini

PongamiaGlabra

FicusReligiosa

Fig.-1

Sampling Sites

In this study, the sites were selected in a distributed pattern such as industrial areas, Institutional cum research areas on National Highway, sensitive areas on state highway, heavy traffic area, commercial area and residential area as given in Table-1.

Table -1: Name of the Sampling Sites

Site Number	Sampling Sites	Nature of the site
Site 1	Vella Gate (WG)	Industrial area(Rice mills)
Site 2	Near Cancer Institute	Institutional areas
Site 3	CSI hospital	Sensitive areas
Site 4	Moongilmandapam	Heavy traffic area
Site 5	Collectrate	Commercial area
Site 6	Pallavarmedu	Residential area

Sampling

The leaves from three species such as *Syzigium cumini*, *FicusReligiosa* and *PongamiaGlabra* were collected at the height more than 1.8m. The samples were gathered in airtight zip lock polyethylene bags and brought to the laboratory for the analysis of heavy metals deposited on the leaves. Closed-system mineralization was used in Microwave digestion and inductively coupled plasma mass spectrometry was utilized for analyzing the heavy metals.¹⁸

Statistical Analysis

The results collected from the study were correlated using Pearson's correlation coefficient and statistical analysis was done with the SPSS software package. The results were given in Table -2 and Table -3.

Table -2: Heavy Metals Deposited on Three Species From Six Sites

Species	Parameters	Mean	Max	Mini	SD	Median
<i>Syzigum Cumini</i>	Fe	29.72	62	0	24.71	23.65
	Cu	0	0	0	0	0
	Zn	3.92	11.7	0	4.85	2.3
	Al	17.17	39.4	0	15.59	13
	Mn	3.42	12.8	0	4.97	1.9
<i>Ficus Religiosa</i>	Fe	27.32	38.8	14.9	8.86	29.55
	Cu	0.45	2.7	0	1.10	0
	Zn	7.02	10.9	4.6	2.19	6.6
	Al	16.78	26.1	12	4.99	15.4
	Mn	6.85	8.1	5.5	0.89	6.75
<i>Pongamia Glabra</i>	Fe	50.08	125.4	10.4	41.23	43.15
	Cu	1.20	4.3	0	1.91	0
	Zn	8.92	19.3	0	8.27	7.8
	Al	34.65	86.3	2.7	30.99	21.75
	Mn	7.63	22.5	0	9.27	5.45

RESULTS AND DISCUSSION

Heavy metals spread out in the ambient air were proved clearly in the present study. The concentration of heavy metals analyzed from the deposition on leaves differs from species to species and also with the sites chosen for sampling. The level of pollution in the air was varied depends upon the area where the samples were collected. Some heavy metals were found in higher concentrations near sensitive areas and in other areas their concentration were varied slightly. Most of the heavy metals were found in lesser amount and below their detectable limit. The test results attained from the study proved that there was no noticeable difference in the heavy metals concentration collected from various sites, but clearly specified the type of species influenced their levels in the air.¹⁹

From the analysis carried out for nine heavy metals, Fe was detected in all the selected sites with varying concentrations. This highest value of Fe came from the old and outdated vehicles or equipment, deterioration of any machines. The experimental results prominently said that the heavy metals deposited on the leaves of *Syzigum Cumini* was higher than *FicusReligiosa* but lesser than *Pongamia Glabra* except in site1,2 and 3 as shown in Table -2. The concentration of iron ranged from 62 to below detectable limit and in *Syzigum Cumini* and found with higher value near Pallavarmedu and not identified in industrial areas. In *Ficus Religiosa* Fe value ranged between 38.8 and 19.1 and the highest value noted near CSI hospital and lowest values in industrial area. The accumulation

capacity of *Pongamia Glabra* for Fe was found to be more than the other two species and it should be ranged between 125.4 to 10.4. The highest value of Fe of this species was identified near CSI hospital and lowest concentration near Moongil Mandapam. This experimental results, distinctly shown the correct disposal methods and trees grown in large scale near the cancer institute reduced the level of Fe in the ambient environment. From the correlation study it was noted that Fe was a significant correlation with Al in all the three species and weak correlation with Cu, Zn and Mn in *Syzigium Cumini* and *Ficus Religiosa* but significant correlation with Mn in *Pongamia Glabra* as shown in Table -4.

Like Fe, Al also identified in all the three species from the selected six sites. Al makes way into the environment through huge containers such as drums and bottles and from industrial plants.²⁰ The accumulation capacity of Al by *Pongamia Glabra* was relatively greater than the other two species. The concentration of Al in *Syzigium Cumini* was ranged between 39.4 and below the detectable limit. In *Ficus Religiosa* the value varied from 26.1 to 12 and in *Pongamia Glabra* the figure was on higher side ranged from 86.3 to 2.7. Al was comparatively found with higher value near CSI hospital and in Vella Gate area than other sites, it is clearly shown that there was a greater disposal of Al and it leads to increase its level in the surrounding environment.(Figs.-2,3 and 4)

The results obtained from the correlation shown that Al was a significant correlation with Mn in *Pongamia Glabra* and positive correlation with Mn in the other two species.

Similar to Fe and Al, Zn was also found in all the selected six sites from three species, but it was not absorbed by *Syzigium Cumini* in three sites. The major sources of Zn was from the combustion of fire wood, Petroleum etc., greater use of insecticides and pesticides and brake shoes used in all vehicles.²¹ The Zn deposited on *Syzigium Cumini* ranged from 11.7 to BDL and its value was higher near CSI hospital and with BDL in the sites selected within the town. In *Ficus Religiosa*, the level ranged between 10.9 and 4.6 and was found higher near Pallavarmedu and lowest values in Moongil Mandapam area. The concentration of Zn deposited on *Pongamia Glabra* was on the higher side than the other two species and its value ranged between 19.3 and BDL. Near Cancer Institute, Vella Gate and Hospital area, the Zn content was found more than the other three sites. From correlation study, Zn were significant relation with Mn in *Syzigium Cumini* and *Pongamia Glabra* but a negative correlation with Mn in *Ficus Religiosa*. Zn was weakly correlated with Al in all three species.

Mn was found near Vella Gate, Cancer Institute and CSI Hospital and it was identified from all the three species, but in the remaining sites it was taken only by *Ficus Religiosa*. The concentrations of Mn in the sites were due to the utilization of greater amount of insecticides and pesticides.²² The deposition of Mn on the leaves of *Syzigium Cumini* was ranged from 12.8 and BDL and the highest value was found near CSI hospital.

In *Ficus Religiosa* the level varied from 8.1 to 5.5 and the concentration of Mn in *Pongamia Glabra* was high compared than the other two species and found near CSI hospital. The level was significantly higher only in the areas where the usage of pesticides was more and reduced values within the town.

The prime source for Cu is from the combustion of coal, more usage of brake pads in vehicle and diesel engines. Experimental results obtained from this study shown that copper was found near Cancer Institute and CSI hospital and accumulated only on the leaves of *Pongamia Glabra* and not absorbed by other species, but identified in *Ficus Religiosa* only in Pallavarmedu areas with lower value compared to other sites. From the correlation study it was observed that Cu was not shown any relationship in *Syzigium Cumini*, it clearly implied that the absorption capacity for Cu by this species is very low or negligible. In *Ficus Religiosa* and *Pongamia Glabra* it was shown the significant correlation with Zn but positive correlation with Mn in *Pongamia Glabra* and negative correlation with Mn in *Ficus Religiosa*. Zn was weakly correlated with Al in both the species.

Other heavy metals such as Cr, Cd, As and Pb was not detected in any samples collected from all the sites. This is due to the continuous technical improvement in the automotive field, usage of unleaded fuel and stringent rules and regulations made on the heavy metals emissions in the air.²³ The level of Pb in the ambient air was reduced to 89 percentage by the stringent rules and regulatory efforts taken and followed by Environmental Protection Agency.²⁴ Regression equation for Fe Vs Cu, Zn, Al and Mn in three species were shown in Figs.-5,6 and 7.

In the present study concentrations of Fe and Al was found on the higher side and the values were exceeded their threshold limits. Mn, Zn and Cu were with lowest concentrations and the other metals such as, Pb, Cd, Cr and As were noticed below their detectable limits.

Fig.-2: Heavy Metals Concentrations at Selected Sites in *SyzigumCumini*

Fig.-3: Heavy Metals Concentrations at Selected Sites in *FicusReligiosa*

Fig.-4: Heavy Metals Concentrations at Selected Sites in *PongamiaGlabra*

Table -3: Correlation Co- efficient for the Heavy Metals Deposited on Species at Selected Sites

Species	Parameters	Fe	Cu	Zn	Al	Mn
<i>Syzigum Cumini</i>	Fe	1				
	Cu		.a			
	Zn	0.107	.a	1		
	Al	0.949	.a	0.407	1	
	Mn	0.262	.a	0.952	0.525	1
<i>Ficus Religiosa</i>	Fe	1				
	Cu	0.259	1			
	Zn	0.081	0.870	1		
	Al	0.753	0.110	0.247	1	
	Mn	0.335	-0.740	-0.567	0.489	1
<i>Pongamia</i>	Fe	1				

<i>Glabra</i>	Cu	0.204	1			
	Zn	0.250	0.715	1		
	Al	0.955	0.267	0.480	1	
	Mn	0.771	0.646	0.774	0.879	1

Fig.-5: Regression Equation for Fe Vs Cu,Zn,Al and Mn in *Syzigium Cumini* Fig.-6: Regression Equation for Fe Vs Cu,Zn,Al and Mn in *Ficus Religiosa* Fig.-7: Regression Equation for Fe Vs Cu,Zn,Al and Mn in *Pongamia Glabra*

CONCLUSION

The study of heavy metals concentration in Kanchipuram was pioneer and wanted one to improve the quality of the environment. The present research work was exhibited the use of *Syzigium Cumini*, *Ficus Religiosa* and *Pongamia Glabra* are the very best indicator of pollution caused by heavy

metals. The sources of the heavy metal pollution are not only from the vehicular emission, but also from the greater application of pesticides and the combustion process. The results gained from the present work stated that the absorbed concentration of Fe and Al were higher level compared than other metals such as Mn, Zn and Cu and a few metals as Pb, Cd, Cr and As were below their detectable limits. The reaction of species to the absorption of pollutants vary from species to species and with sampling sites. Compared to the other two species *Pongamia Glabra* shown a better absorption capacity with slight variations, although *Syzygium Cumini*, *Ficus Religiosa* are also used as an effective tool for bio monitoring of the ambience.

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