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RESEARCH ARTICLE

A PHYTOTOOL TO MONITOR HEAVY METAL POLLUTION IN ROAD SIDE PLANT USING *PONGAMIA GLABRA*

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ABSTRACT

The *Pongamia* tree was evaluated as a phytotool of heavy metals such as Lead (Pb), Copper (Cu), Cadmium (Cd), Manganese (Mn), Zinc (Zn), Chromium (Cr) and Nickel (Ni) around Bagalkot. The soil samples at a depth (0-20cm) and *Pongamia glabra* leaves were taken from different sampling sites viz, S_1, S_2, S_3, S_4, S_5 on state high-way with high traffic roads passing through the Bagalkot (Karnataka) were determined by AAS. Results showed that both soil and *Pongamia* contained elevated levels of the metals. It was found that the primary source of the contamination occurs mainly by the vehicular emissions. The increased circulation of toxic metals in soils and *Pongamia* may result in the inevitable build up of such xenobiotics in food chain. The variation in heavy metal concentrations is due to changes in traffic density and anthropogenic activities. It is concluded that *Pongamia glabra* can be used as a phytotool to monitor heavy metal pollution in roadside plants.

INTRODUCTION

Industrial and mining activities, oil refineries and combustion of fossil fuels release pollutants in the atmosphere. The air pollutants includes oxides of carbon, sulphur, nitrogen and HCs and heavy metals. Currently, motor vehicle emissions contribute alarmingly to the accumulation of Pb, Cu, Zn, Mn and Cd in the road side environment. Alkyl lead compounds are continued to be added to petrol as antiknock activities, in addition to the use of unleaded petrol. Consequently, the combustion of Pb added petrol the release of Pb in the form of particulates through vehicular exhausts into the roadside environment such as soil and vegetation (Ho &Tai. 1988, Khattak. *et al*., 2013). Many studies have been made on Pb, little attention has been focused on the contamination of other trace metals on the roadside environment. Metals such as Fe, Cu, Zn and Cd are the essential components of many alloys, pipes, wire and tyres in motor vehicles and are released into the roadside environment as a result of mechanical abrasion. Cd and Zn are found together as part of many additives to lubricating oils. Cd in tyres is associated with Zn diethyl carbonate, a compound used in the process of vulcanization (Lagerwerff & Specht. 1970). The absorption and incorporation of heavy metals by road side plants facilitate their entry into the food chain. Singh *et al.,* (1995) employed roadside plants to monitor automobile exhaust pollution. Medicinal plants of *Apocynaceae* growing along the roadside have been employed as a phytotool to monitor toxic levels of heavy metals (Venkateshwar *et al*., 2005). Anthropogenic activities leads into the emission of various pollutants into the environment and different types of xenobiotics into the atmosphere. (Onder and Durson, 2006; Kho *et al*., 2007**;** Sarala *et al*., 2012). *Pongamia glabra* has been widely found all over the Bagalkot region as medicinal and shady bearing characteristics. The aim of this study was to investigate the sampling sites. The heavy traffic load are the main cause of pollution in this area in particular heavy metal pollution.

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MATERIALS AND METHODS

Bagalkot is the city of Northern region of Karnataka at latitude 16^0 04^1 N to 16^0 21^1 North and longitude 75^0 26^1 E to 76^0 02^1 Eastern. The city is suffered from high traffic density caused by vehicles. The *Pongamia glabra* and soil were collected during October 2013, which were three meters away from the State High way (Fig. 1 and Table**.** 1) passing through Navanagar. *Pongamia* samples were collected from each site at three random spots that were spaced approximately at one meter interval. The leaves were clipped with stainless steel scissors. All the samples of each site were then combined to give composite samples of about 300 to 500gm. The *Pongamia* samples were dried at 80°C for 48 hrs fine by powdered and sieved through 0.2mm sieve. One gram sample was digested using Gerhardt digestion unit using mixed acid digestion method (Allen *et al*., 1974). The digested material was diluted with double distilled water and filled through Whattman paper 41 and made upto 100ml. Similarly soil was dried, powdered and sieved through 0.2mm sieve. One gm of sample was digested Gerhardt digestion unit according to Allen *et al.,* (1974) method (mixed acid digestion method). The resulting extracts were diluted filtered through Whattman No 41 paper and made upto 100 ml using double distilled water and analyzed for heavy metals viz Pb (Lead), Cd (Cadmium), Cu (Copper), Zn (Zinc), Mn (Manganese), Ni (Nickel) and Cr (Chromium) with GBC-932 plus Atomic Absorption Spectrophotometer (Austrelia)with an air / acetylene flame and metal hollow cathode lamps. Respective wavelengths were used for the estimation of solutions for heavy metals were purchased from Siscochemical Laboratory Bombay (1000 mg/lt.) The working standards were prepared by serial dilution of standard stock solutions and were used for the calibration of the instrument (Allen *et al*., 1974).

RESULTS AND DISCUSSION

The ranges and arithmetic mean of heavy metal concentration of soil and *Pongamia* samples of state high-way and control sites are presented in the table 2.

The results shows that soil tends to accumulate more Pb than the *Pongamia* leaves and the highest Pb level found in the roadside soil was 138.71 µg/gm, whole the *Pongamia* it was found that 29.39 µg/gm. The mean soil Pb level of 96.74 µg/gm indicated considerable contamination of metal in the roadside environment, whereas, control soil has a baseline level of 72.51 µg/gm Pb much of the lead is rapidly washed onto the soil by rain water from the surface and also by the death and decomposition of the plant. The Pb deposited in soils and vegetation can also cause enhanced levels of lead in soil microorganisms (Harrison *et.al*., 1981; Khattak *et al*., 2013). The mean Cu slevel in roadside soil (49.71 µg/gm) was found to be much higher than the *Pongamia* (4.39 µg/gm). Arithmetic mean of Zn of the roadside soil of around Bagalkot shows a relatively high level of 188.31 µg/gm with a range of 32.29- 398.54 µg/gm. The range of Zn 24.51-35.18 µg/gm found in the *Pongamia* (roadside) is not much higher. This can be attributed to the fact that Zn as an essential element is normally present in uncontaminated plants up to 100 µg/gm (Ho and Tai, 1988). Cadmium level in roadside soil averaged about 2.5 µg/gm and was the lowest among the seven metals examined. The findings is in confirmation with the findings of Ho and Tai (1988).

Table 1. Sampling stations along state highway around the city of Bagalkot

Station No.	Sampling station	Nature of stations
Control	Navanagar (Bagalkot)	Unpolluted urban area- vehicular movement is negligible, unpolluted area with less disturbance
1	Navanagar Bypass road	Vehicular movement is high
2	Near Simikeri	Vehicular movement is high. Agricultural fields on either side of the road
3	Gaddankeri cross	Bricks factories around the Gaddankeri cross, vehicular traffic is high
4	Tulasigeri	Vehicular movement is high. Agricultural fields on either side of the road
5	Kaladagi	Vehicular movement is high. Agricultural fields on either side of the road
6	Lokapur	Vehicular movement is high. Agricultural fields on either side of the road

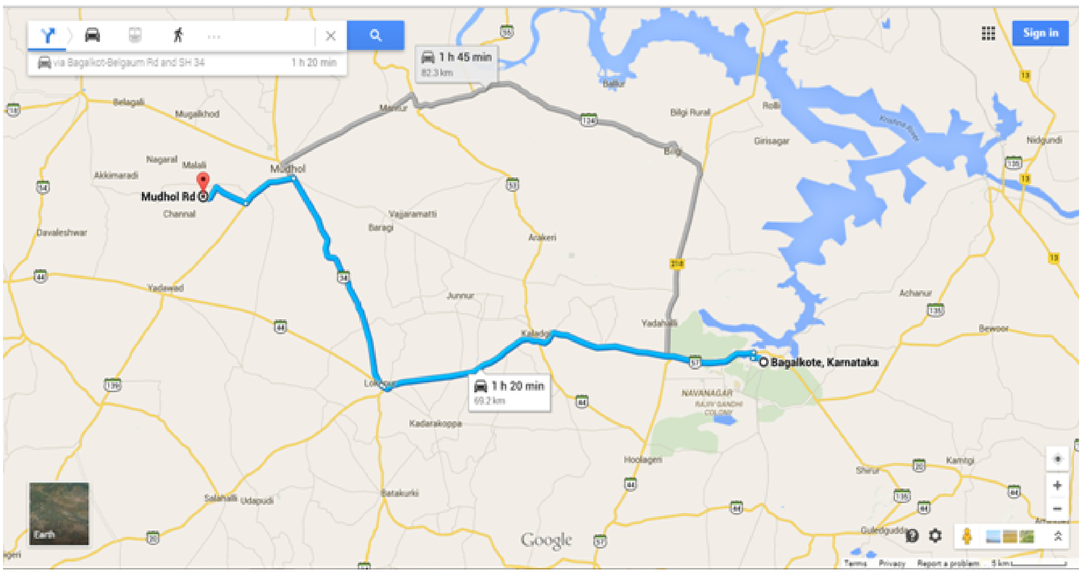

Fig 1.Map showing the State Highway passing around Bagalkot (Navanagar to Lokapur)

Table 2. Heavy metals in roadside *Pongamia* and soil

S.No	Heavy metals	Control Group (µg g^{-1} dry wt.)	Roadside *Pongamia* (µg g^{-1} dry wt.)		Control (µg g^{-1} dry wt.)	Roadside soil (µg g^{-1} dry wt.)	
			Range	Mean ± SE		Range	Mean± SE
1	Lead	18.46	20.56-29.39	23.73±1.84	72.51	82.91-141.84	96.74±8.71
2	Copper	2.15	3.95-5.78	4.89±0.35	34.91	39.54-59.29	49.71±3.51
3	Zinc	16.198	24.51-35.18	32.87±3.12	29.84	32.29-398.54	188.31±54.28
4	Cadmium	0.92	1.20-1.79	1.59±0.08	2.16	1.75-2.91	2.5±0.19
5	Manganese	15.93	29.01-73.10	56.80±7.41	1254.1	1257.9-2057.8	1538.34±26.56
6	Chromium	N.D*	1.29-9.5	4.91±2.25	121.41	131.90-958.21	324.54±2.46
7	Nickel	6.91	8.9-15.91	10.95±1.43	69.41	70.53-109.60	88.91±5.91

Both soil and *Pongamia* contained much higher levels of Mn than other metals examined. Roadside soil and *Pongamia* had average 1538.34µg/gm and 56.80 µg/gm of Mn respectively. High Mn content of the roadside soil may be attributed to the lithogenic factor apart from the vehicular pollution as indicated by the high values of Mn of control soil. Chromium level too was very high in roadside soil (324.54µg/gm) against the control value of 121.41µg/gm. In *Pongamia* it was found to be 4.91 µg/gm against the control (zero). Simple correlations (r > 0.60) between the metal Pb, Cu, Ni, Mn, Fe, Zn and Cd were calculated and are given in the table 3.

Table -3. Correlation coefficient of heavy metals in roadside soil and *Pongamia*

S.No.	Metal	r. value
1	Lead	0.628*
2	Copper	0.481*
3	Zinc	0.829*
4	Cadmium	0.748*
5	Manganese	0.529*
6	Nickel	0.331*
7	Chromium	0.215*

r= 0.60 and above have significant correlatio

Significant correlations between the metal levels in roadside soil and the *Pongamia* were found in Zn, Cd and Ni (r > 0.06). It may be indicating the bioconcentration of these metals in the *Pongamia* , in addition to aerial deposition. This may attributed to the favorable root environment (Sahu and Ranjini 1985) i.e soil conditions might have favored their absorption. Correlations in case of chromium, nickel, manganese and copper contents between soil and *Pongamia* were low due to low bioavailability of these metals owing to unfavorable root environment. Whatever excess content of these metals found in *Pongamia* was presumed to be due to the aerial deposition contributed by motor vehicles.

The order of increment of heavy metals in roadside soil is as follows: Mn > Cr > Zn > Pb > Ni > Cu > Cd whereas in *Pongamia* : Cd > Mn > Zn > Pb > Ni > Cr > Cu. The elevated levels of heavy metals in the roadside soil and *Pongamia* is an indication of airborne pollutants of roadside environment of the urban area of Bagalakot city around. Soils due to their cation exchange capacity (CEC), complexing organic substances, oxides and carbonates, have high retention capacity for the heavy metals (Yassoglou *et al.,* 1987). Thus, contamination levels increase continuously as long as the nearby sources remain active. During the last decade, the city of Bagalakot has witnessed sharp increase in vehicle number due to urbanization. Similar observation in *Pongamia glabra* in Madhurai city of southern region of Tamil Nadu (Thambavani and Vathana. 2013).

In soil, the lesser mobility of metals and its accumulation on a long-term basis, leads to overall higher contamination level of metals; whereas, in roadside *Pongamia* , it represents more accumulation due to turnover of plant materials (like new growths, the senescence followed by abscission of old parts) and meteorological influences (Kabata –Pendias and Pendias, 2001). Thus, the study of metal concentration of both roadside soil and *Pongamia* reflects the extent of aerial contamination of the roadside environment. The penetration of heavy metals into the food chains due to vehicular emissions may cause a long- range ecological and health hazard.

Conclusion

The results of our study indicate that the concentration of heavy metals such as Pb, Cd, Mn, Zn, Ni, Cu and Cr from the traffic area is an indicative of anthropogenic pollution. It was concluded that with an increase in the amount of heavy metals in soil and their uptake by plants also increase. The mobility of heavy metals showed that are highly translocated from soil to plant leaves in all the sampling sites. According to our study *Pongamia glabra* located in the sampling sites are said to be a heavy accumulator of metals. High metal concentrations in plants are contained in urban and highway roadsides due to the anthropogenic activities in addition to the traffic density. The heavy metal concentration was maximum in the study area around Bagalkot indicates the need for pollution control in around city environment. *Pongamia glabra* is widely distributed at Bagalkot (Navanagar) is used as roadside ornamental plant. In accordance with the data presented here *Pongamia glabra* possess all characteristic for its selected as biomonitor.

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