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Full Length Research Paper

Leaves of roadside plants as bioindicator of traffic related lead pollution during different seasons in Sargodha, Pakistan

Naima Huma Naveed[1]*, Aima Iram Batool[1], Fayyaz Ur Rehman[2] and Uzma Hameed[1]

[1]Department of Biological Science, University of Sargodha, Sargodha Pakistan.
[2]Department of Chemistry, University of Sargodha, Sargodha Pakistan.

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Plants are important bioindicators of heavy metal environmental pollution. For this purpose a study was conducted during winter and summer seasons in Sargodha, Pakistan. Three roadside plants that is *Dalbergia sissoo* Roxb., *Prosopis juliflora* L. and *Eucalyptus* spp. were collected from different locations. The study area was divided into five on the basis of traffic density and industrial pollution. These were Urban, Suburban, Industrial, Roadside and Rural. It was found that lead concentration was highest in the plants that were collected from industrial site in *Dalbergia* during winter and summer that is 421.43 ± 1 9.30 and 429.37 ± 14.49 ug g^{-1} respectively and lowest at the control site (rural site) 69.57 ± 36.80 ug g^{-1} in *Eucalyptus* during winter and 61.89 ± 35.97 ug g^{-1} in *Prosopis* during summer. All the three selected plants proved to be good indicators of lead pollution and due to their diverse distribution in different parts of the world their leaves can be used as bioindicators of lead pollution.

Key words: Bioindicator, lead, roadside plants, seasonal variation.

INTRODUCTION

Among the heavy metals, lead (Pb) has long been known as potential hazard to health (Rowchowdhury and Gautum, 1995; Shen et al., 1996; Nariagu et al., 1996; Kim et al., 1996; Shannon and Graef, 1996). Fossil fuels combustion and exhaust emission have been identified as primary sources of atmospheric metallic nuisance (Onianwa and Adoghe, 1997; Moller et al., 2005; Aribike, 1996). Aerosol and deposited dusts in urban areas comprise of ample amounts of many potentially toxic trace metals in comparison with those found in non-urban areas.

Burnt petrol from motor vehicles, release significant quantities of sulphur dioxide, NO_x, carbon monoxides, lead and suspended particulate matter. Trees in cities are more prone to heavy metal pollution due to pervasive pressure of auto vehicular emissions (Li et al., 2007). Plant leaf is the most sensitive part to be affected by air pollutants as major physiological processes are concentrated in the leaf (Renjini and Janrdhanan, 1989). Plants near road ways have relative increase of Pb deposition due to vehicles using leaded petrol (Prodgers and Inskeep, 1881; Bu-Olayan and Thomas 2002). Among heavy metals, lead and cadmium toxicity has become important due to their constant increase in the environment.

The high sensitivity of plants towards some pollutants means that a great variety of plants can be used as bioindicators of heavy metals pollution in soil. Wenzel and Jockwer (1999), Namiesnik and Wardenski (2000), Chandhari and Gajghate (2000), Wittig (1993) and Markert (1993) worked on the basic criteria for selection of species as a bioindicator. The major criteria are species should be represented in large numbers all over the monitoring area, have a wide geographical range, be possible to differentiate between airborne and soil-borne heavy metals, be easy to sample and there should be no identification problems. *Dalbergia sissoo* Roxb., *Prosopis juliflora* L. and *Eucalyptus* spp. were selected for this study as the plants that are the most common roadside in most of the areas of Sargodha, Pakistan and can serve as bioindicators of lead pollution. Several studies have

*Corresponding author. E-mail:naimahuma@yahoo.com. Tel: 923216077929.

Table 1. Mean Lead concentration of three different roadside plants during winter and summer.

	D. sissoo Roxb.		*P. juliflora* L.		*Eucalyptus*	
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
Urban	305.52 ± 66.41	312.85 ± 97.23	296.95 ± 109.13	322.42 ± 106.88	264.53 ± 120.92	353.23 ± 72.53
Suburban	113.84 ± 14.40	154.51 ± 44.13	239.83 ± 16.45	287.73 ± 40.80	269.66 ± 167.64	269.73 ± 25.40
Industrial	421.43 ± 19.30	429.37 ± 14.49	319.40 ± 101.23	322.34 ± 101.09	344.18 ± 104.96	348.52 ± 107.04
Roadside	159.84 ± 164.90	270.39 ± 93.45	191.25 ± 35.92	384.77 ± 75.93	112.65 ± 36.78	247.02 ± 123.52
Rural	112.46 ± 13.68	146.54 ± 53.36	95.35 ± 22.39	61.89 ± 35.97	69.57 ± 36.80	129.32 ± 51.95

shown that heavy metals are responsible for certain diseases that have lethal effects on man and animals (Jarup, 2003; Michalke, 2003; Silva et al., 2005). For this reason various Government Departments and several Non-Government Organizations (NGOs) are much concerned about the effects of vehicular emission on the environment. However, information on roadside contamination with heavy metals especially Pb in Sargodha is limited, and attempts to bridge this gap forms the thrust for this study. Sargodha, a city located in Punjab Province, Pakistan, has an estimated population of 550,000 and area of 4426 Acre. It is an agricultural trade center with various industries. Therefore, the present study aimed at the determination of the extent of lead contamination in roadside plants.

METHODOLOGY

Samples of plants were collected from different locations during end December, 2008 (winter collection) and end May, 2009 (summer collection). These sites were roadsides (extreme polluted area), industrial (very much polluted area), urban (polluted area), suburban (little polluted area) and rural (control site). In line with the criteria given by Wittig (1993) and Markert (1993), three plants (*D. sissoo Roxb.*, *P. juliflora* L. and *Eucalyptus* sp.) were selected as bioindicators of pollution.

Leaf samples from different sites were washed to remove dust particles and oven-dried for 24 h. Leaf samples crushed into fine powder. A weighed quantity of dried sample material (0.1 g) digested by modified method described by Wolf (1982). Sulfuric acid (231-639-5) as added to the plant samples as 2 mL/0.1 g of the plant material and samples were incubated at room temperature for 24 h. The incubated material heated on hotplate and hydrogen peroxide was added after the fume emission was stopped and this process continued until the whole material was colorless. The volume made 50 ml with the help of distilled water and the samples were ready for analysis. The chemicals of BDH, Riedel- de Haen and MERK companies were used without further purification for present study.

Concentrations of Pb analyzed in plant samples by an atomic absorption spectrophotometer (AA 6300 Shimadzu). All the concentrations reported are in ugg^{-1}. A statistical treatment of the data carried out using the Xcel Statistics (XISTAT) software. Statistical differences of the means checked out using Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Heavy metal concentration in industrial and urban sites was significantly higher than the others (Table 1). Industrial roadside with the highest human activities regarding industrial aspect (brick industry, chemical and soap industry), together with high vehicular density congestion shown the highest Pb levels (429.23 µg g^{-1}) in D.S which is significantly higher than that of rural sites (61.89 µg g^{-1}) in *P. juliflora* in summer while in winter it was (420 µg g^{-1}) in *D. sissoo Roxb.* in industrial site and lowest in rural (53.88 µg g-1) in *Eucalyptus* spp. Similar observations were made by Aksoy and Ozturk (1996) and Al-Shayeb et al. (1995) Pb concentration in roadside trees of Quetta was ranging from 44.30 ± 18.384 µg g^{-1} (Zaidi et al., 2005). The high lead level as reported by the Natural Resources and Environment Research Institute in Prosopis was 32.0 µg g^{-1} (Al-Shayeb et al., 1995). The results found in our study were also in agreement with the findings of Aksoy *e*t al. (2000), Al-Shayeb et al. (1995) and Aydinalp and Marinova (2004). The Pb levels in leaves were highest in industrial areas followed by roadside and urban. The high Pb level in industrials areas could be as a result of emissions through smoke from factories. Roadsides were prone to Pb particles. This could be as a result of wind action and vehicular emission.

In 1992, gasoline was globally observed as the major contributor of atmospheric Pb from human activities (UN, 1996). The results of this study indicate that industrial, roadsides, urban sites are seriously polluted with Pb. However, progressive reduction in the lead content in petrol in most of the developed countries has decreased Pb level in the atmosphere, human blood and vegetation (Eisenreich et al., 1986; Jensen and Laxen, 1987; Belles et al., 1995; Pirrone et al., 1996). Pb is generally added to the environment by aerial deposition alongside the roads in proportion with the density of traffic and distance from roads.

Figure 1 shows the comparison of lead concentration in *P. juliflora* L. during summer and winter. Highest Pb concentration was found in roadside area during summer and exceptin the rural area. *P. juliflora* L. is considered as very good indicator of Pb pollution as reported by Bounessah and Al-Shayeb (2005). Similar results were shown by Bu-Olayan and Thomas (2002) taking *Prosopis* as bioindicator of lead contamination in Kuwait, where leaves of *Prosopis* collected from industrial area contain highest Pb concentration followed by highways and city

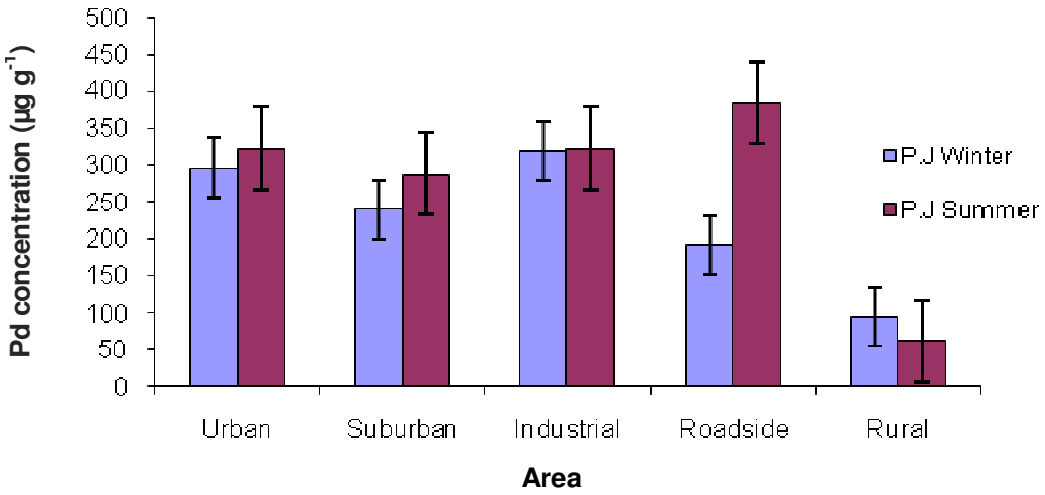

Figure 1. Comparison of means of Pb concentration (ug g-^{1}) in *P. juliflora* L. collected from different areas during winter and summer. D.S-*D. sissoo* Roxb., Euc-*Eucalyptus* sp., P.J-*P. juliflora* L.

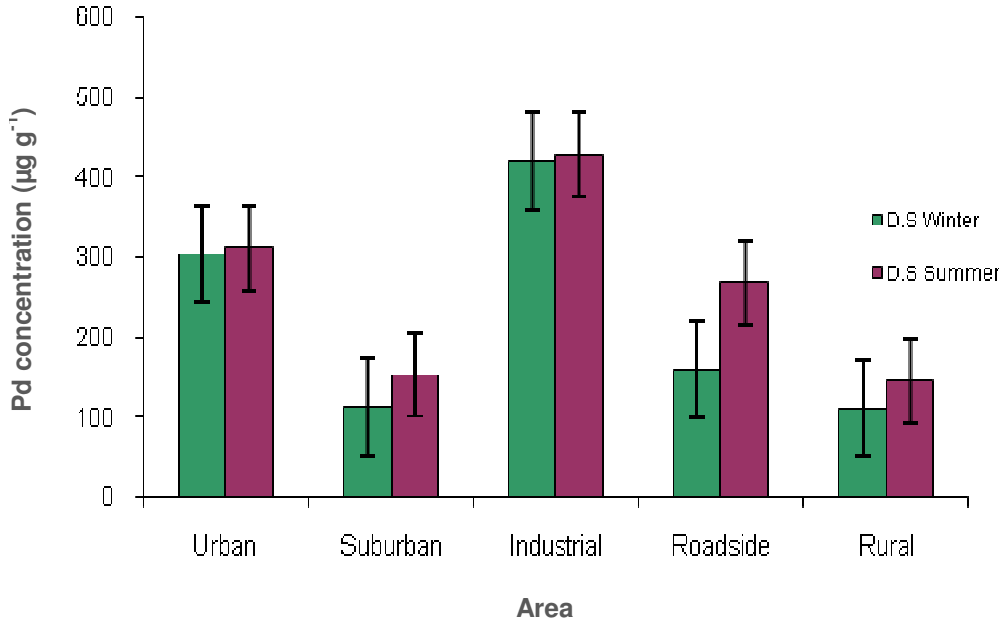

Figure 2. Comparison of means of Pb conc. (ug g-^{1}) in *D. sissoo* Roxb. Collected from different areas during winter and summer.

areas.

In *Dalbergia,* highest concentration of lead was observed in industrial areas and lowest in case of control site that was with very little traffic activities (Figure 2). While *Eucalyptus* plants showed highest concentration in urban areas in summer and lowest in control site (Figure 3). Aksoy et al. (2000) and Zaidi et al. (2005) made similar observations. The plants selected in our study fulfill the criteria of bioindicators as given by Wittig (1993) and Markert (1994) and thus can be the useful bioindicators of the area. All the study sites show high concentration of Pb than that of the lower limit of contamination (Ross, 1994).

Conclusion

The concentration of Pb that is considered toxic in plants lies in range of 30 to 400 ug/g. In present study Pb, concentration found to be in the range of 61 to 429 µg g^{-1}.

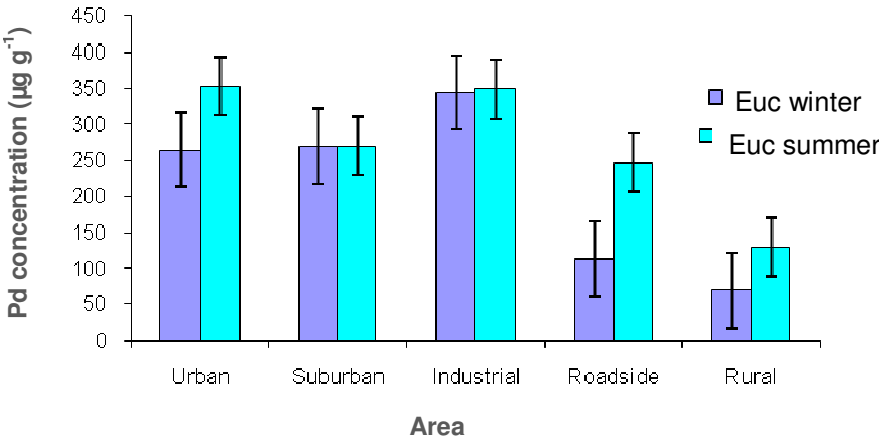

Figure 3. Comparison of means of Pb concentration (ug g^{-1}) in *Eucalyptus* plants collected from different areas during winter and summer.

This shows that the environment of the Sargodha is being contaminated with the heavy metals. There is need to have some safety measure to overcome this environmental metal toxicity. The results also showed that all the three plants that were selected as possible bioindicators are good indicators of the traffic related pollution in the area.

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